Freistaat Bayern

RegioneEmiliaRomagna

Catalunya

6th EUREGEO

Munich | Bavaria, Germany
june 9th | 12th 2009

EUropean Congress on REgional GEOscientific Cartography and Information Systems

Earth and Man

Proceedings
Revised Digital Edition

Volume II

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6th European Congress on Regional Geoscientific Cartography and Information Systems

EUREGEO

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LANDESAMT FÜR VERMESSUNG UND GEOINFORMATION BAYERN

Bayerisches Landesamt für Umwelt

Scientific Programme

Monday, June 8th

8:00 Pre-congress excursion to the Impact Crater Nördlinger Ries
Start at the congress site: Bavarian Agency for Surveying and Geographic Information (Landesamt für Vermessung und Geoinformationen Bayern) Alexandrastraße 4, 80538 München

Pre-congress excursion to Landslides in the Bavarian Alps
Start at the congress site: Bavarian Agency for Surveying and Geographic Information (Landesamt für Vermessung und Geoinformationen Bayern) Alexandrastraße 4, 80538 München

Tuesday, June 9th

12:00 Registration: Montgelas Saal at Congress site
Bavarian Agency for Surveying and Geographic Information (Landesamt für Vermessung und Geoinformation Bayern LVG, Alexandrastraße 4, 80538 München)

14:00 Official Opening by the Promoting Committee at Allerheiligenhofkirche of the Residenz München (entrance from Marstallplatz in front of Instituto Cervantes)

Melanie Huml, Staatssekretärin im Bayerischen Staatsministerium für Umwelt und Gesundheit

Marioluigi Bruschini, Assessore alla Sicurezza territoriale. Difesa del Suolo e della Costa. Protezione civile. Regione Emilia-Romagna

Oriol Nel•lo i Colom, Secretari per a la Planificació Territorial. Departament de Política Territorial i Obres Públiques. Generalitat de Catalunya

15:00 Welcome by the Scientific and Local Organizing Committee

Albert Göttle, President of the Bavarian Environment Agency

Keynote lectures

Ian Jackson, British Geological Survey: *174 years and you still haven't finished? – do geological surveys have a role in the 21st century knowledge economy?*

Guiseppe Bortone, Emilia-Romagna Region: *The contribution of the Emilia-Romagna Region to the 6th European Congress on Regional Geoscientific Cartography and Information Systems EUREGEO*

Oriol Nel•lo i Colom, Government of Catalonia: *Geology, landscape and spatial planning*

Luca Demicheli, EUREGEOSURVEYS: *Geology bridging Europe*

18:00 **Get-together party** at congress site Bavarian Agency for Surveying and Geographic Information

Wednesday, June 10th

8:45 Hall B 402 Soldner Saal (congress site)

Elmar Ahr, Bayerisches Landesamt für Vermessung und Geoinformation:

Welcome address at the Bavarian Office for Surveying and Geographic Information

9:00 Hall A 302 Reichenbach Saal session 10A1
Geohazards
Land instabilities

Hall B 402 Soldner Saal session 10B1
Application of maps, 3D-modelling and information systems for geoscientific analysis
Information systems

Hall C 500 Apian Saal session 10C1
Geothermal energy and other georesources

10:45 Coffee break and poster sessions corresponding to oral presentations

11:15 Hall A 302 Reichenbach Saal session 10A2
Geohazards
Seismic hazards

Hall B 402 Soldner Saal session 10B2
Application of maps, 3D-modelling and information systems for geoscientific analysis
Information systems *(cont'd)*

Hall C 500 Apian Saal session 10C2
Application of maps, 3D-modelling and information systems for geoscientific analysis
Digital mapping

13:00 Lunch break

14:30 Hall A 302 Reichenbach Saal session 10A3
Soil conservation

Hall B 402 Soldner Saal session 10B3
Geodata infrastructures
INSPIRE/One Geology

Hall C 500 Apian Saal session 10C3
Use of geophysical and remote sensing methods and technology

16:00 Coffee break and poster sessions corresponding to oral presentations

16:30 Hall A 302 Reichenbach Saal session 10A4
Soil conservation *(cont'd)*

Hall B 402 Soldner Saal session 10B4
Geodata infrastructures
INSPIRE/One Geology *(cont'd)*

Hall C 500 Apian Saal session 10C4
Former climate evolution at regional scale

20:00 Kaisersaal of the Residenz München (entrance from Kaiserhof and Hofgarten)
State reception by the Freistaat Bayern

Thursday, June 11th

9:00 Hall A 302 Reichenbach Saal session 11A1
Geodata infrastructures

Hall B 402 Soldner Saal session 11B1
Application of maps, 3D-modelling and information systems for geoscientific analysis
3D-Modelling

Hall C 500 Apian Saal session 11C1
Geological heritage and popularisation of geosciences

10:45 Coffee break and poster sessions corresponding to oral presentations

11:15 Hall A 302 Reichenbach Saal session 11A2
Geodata infrastructures *(cont'd)*

Hall B 402 Soldner Saal session 11B2
Application of maps, 3D-modelling and information systems for geoscientific analysis
3D-Modelling *(cont'd)*

Hall C 500 Apian Saal session 11C2
Geological heritage and popularisation of geosciences *(cont'd)*

13:00 Lunch break

14:30 Hall A 302 Reichenbach Saal session 11A3
Geothermal energy and other georesources
Mineral resources

Hall B 402 Soldner Saal session 11B3
Application of maps, 3D-modelling and information systems for geoscientific analysis
Geoscientific Cartography

Hall C 500 Apian Saal session 11C3
Geological heritage and popularisation of geosciences *(cont'd)*

16:00 Coffee break and poster sessions corresponding to oral presentations

16:30 Hall A 302 Reichenbach Saal session 11A4
Geothermal energy and other georesources
Mineral resources *(cont'd)*

Hall B 402 Soldner Saal session 11B4
Application of maps, 3D-modelling and information systems for geoscientific analysis
Coastal system management

Hall C 500 Apian Saal session 11C4
Geohazards – ***Floods***
Water resources

Friday, June 12th

9:00 Hall A 302 Reichenbach Saal session 12A1
Use of geophysical and remote sensing methods and technology

Hall B 402 Soldner Saal session 12B1
Geohazards
Land instabilities

Hall C 500 Apian Saal session 12C1
Coastal system management

10:45 Coffee break and poster sessions corresponding to oral presentations

11:15 Hall A 302 Reichenbach Saal session 12A2
Geothermal energy and other georesources
Water resources

Hall B 402 Soldner Saal session 12B2
Geohazards
Land instabilities *(cont'd)*

Hall C 500 Apian Saal session 12C2
Health aspects in Geology

13:00 Hall B 402 Soldner Saal
Closing ceremony

Saturday, June 13th

8:00 Post-congress excursion to Landslides in the Bavarian Alps
Start at the congress site: Bavarian Agency for Surveying and Geographic Information
(Landesamt für Vermessung und Geoinformationen Bayern)
Alexandrastraße 4, 80538 München

Statement of the Scientific Committee

Albert Göttle, Ulrich Lagally, Xavier Berástegui, Antoni Roca, Michela Grandi, Raffaele Pignone, Luca Montanarella and Luca Demicheli

After first informal operational contacts in 1992 the Geological Surveys of Emilia-Romagna, Catalonia and Bavaria organized the "1st Congress on Regional Geological Cartography and Information Systems", which took place in Bologna in June 1994. The target of this congress was to present and discuss approaches, experiences and working results in the field of applied geosciences obtained by the geological surveys of the partner regions. At that time experts as well as users dealing with problems and solutions of geoscientific issues on a regional level started to exchange experiences

- *to present and identify the opportunities for geological research and analyses, which arise from local requests. They were able to compare the benefits from locally oriented approaches with the more nationwide or academically directed objectives, which tend to more general demands;*

- *to initiate the evaluation and application of these methodologies used in many regions of Europe and also the Mediterranean region.*

The series of congresses, carried out every three years since then, developed to an important meeting place for researchers, providers of geoscientific data and users. After the meetings in Bologna (1994), Barcelona (1997), Munich (2000), Bologna (2003) and Barcelona (2006) the sixth edition is now held in Munich again.

In 2000, the Secretary General of EuroGeoSurveys and the Head of the European Soil Bureau of the European Commission joined the Scientific and Organization Committee for the congresses. One objective of the co-operation of European and regional authorities is to complement the congress programme, focussing on issues of regional relevance, with important per-spectives on the European level.

The vivid dialogue, which started more than 15 years ago, shall continue in the future! It proved to be an active and lasting way to exchange experiences amongst numerous participants coming from all over Europe and even from Africa, Asia and America. The congress brings together those, who study the characteristics of a territory, work out solutions to environmental problems or focus on the application of geological know-how in their respective regional and national environment. In order to reach this target all efforts rely in an increasing way on information systems for the management of environmental data and the production of geothematic maps.

Like its precursors, the successful congress in Barcelona in 2006 ended with a joint document by the Scientific Committee as a conclusion and recommendation resulting from that meeting. The major topics of this document are presented as follows:

1. *Cooperation between European regions has demonstrated to be a very effective way in order to foster synergies and cost savings by facilitating exchange of experiences, methodologies and "best practices";*

2. *The construction of a "Europe of the Regions" can also be achieved by "bottom-up" initiatives by the Regional services;*

3. *Natural hazards, like landslides, earthquakes and floods, as a major topic, emphasizes the necessity to support hazard assessment for mitigation and prevention of risks;*

4. *Risk mitigation policy requires involvement of local experts in order to ensure that the information generated will be accepted and recognized by the local population;*

5. *Regional Geological Surveys have to take part in defining the regional and local development plans for urbanization and infrastructure;*

6. *For all these reasons we need geoscientific data acquisition based on field mapping and other complementary techniques, as well as digital interoperable information systems;*

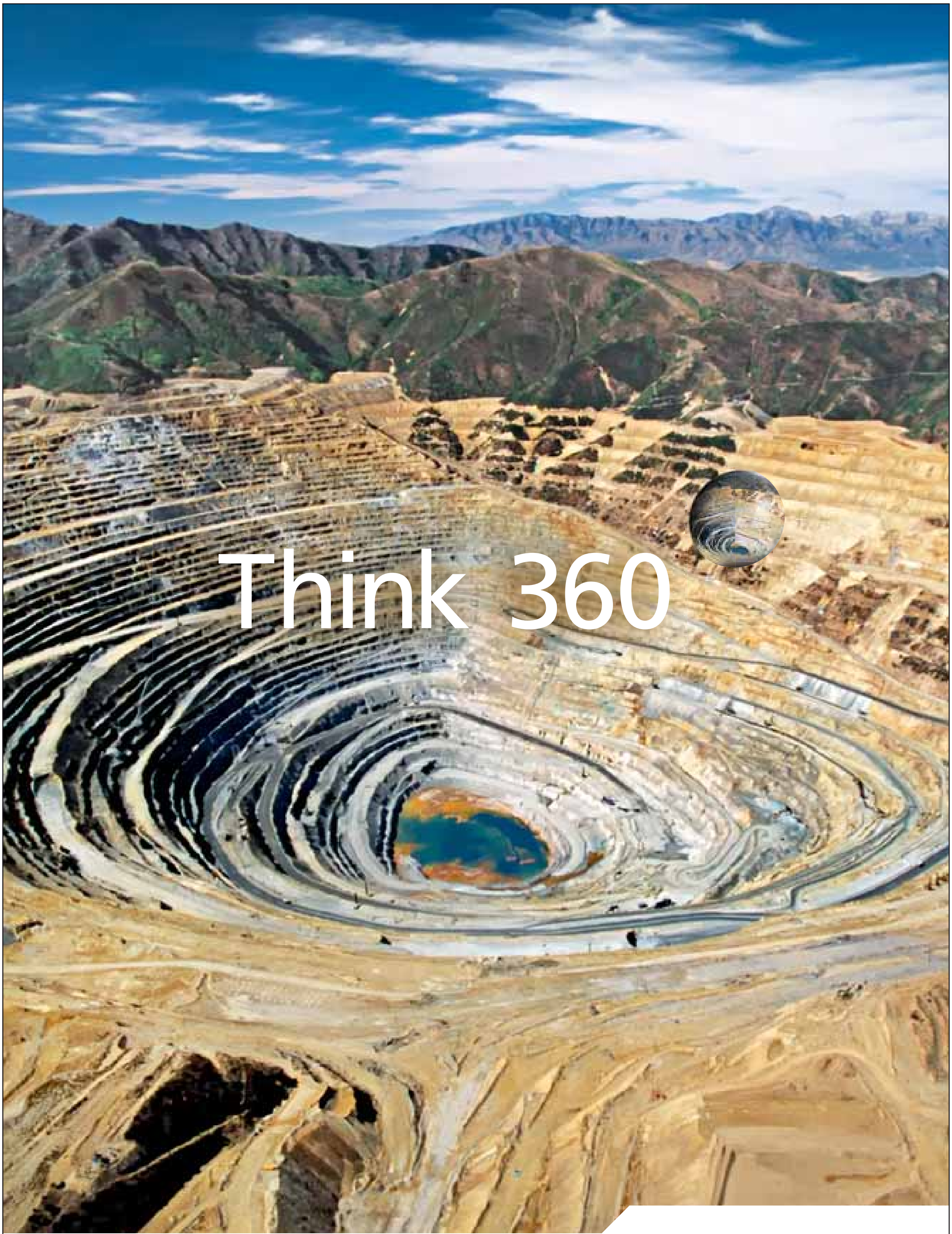
7. *Geo-scientific information has then to be translated by experts for a wide range of end-users with diversified social, economic and environmental concerns;*

8. *The next conference, to be organized in Munich in 2009, should be included in the International Year of the Planet Earth as one of the final events of this global initiative.*

The sixth **Eu**ropean Congress on **Re**gional **Geo**scientific Cartography and Information Systems (EUREGEO) in Munich focuses on the mandate and working results of geological, hydrological and soil surveys. More than 240 extended abstracts together with key note lectures, working group meetings and excursions will assure the success of this congress. With its subheading "Earth and Man" the discussion about the system Earth and mankind living on and from Earth shall be stimulated. In particular, the contribution to society needs and administration requirements will be analysed. Special emphasis will be put on the different operating levels in the quest for land planning and sustainable development, applying European, national, regional and local directives. The conclusions to be reached in this meeting should promote and encourage the integration of the geological and soil services into the society, which they serve.

The Scientific Committee, together with the Local Organising Committee, has the pleasure to welcome all participants to Munich. Have a fruitful conference and a pleasant stay in the capital of Bavaria!

Munich, June 9, 2009


Think 360

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Geological heritage and popularisation of geosciences

Oral

Poster

Topic – Coastal system management

RETRIEVAL OF WATER CONSTITUENTS FROM MULTIPLE EARTH OBSERVATION SENSORS IN LAKES, RIVERS AND COASTAL ZONES

Thomas Heege (1); Viacheslav Kiselev (1); Daniel Odermatt (2); Joerg Heblinski (1); Klaus Schmieder(3); Tri Vo Khac (4) and Trinh Thi Long (4)

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(4) Southern Institute for Water Resources, 2A Nguyen Bieu St., Dist. 5, Ho Chi Minh City, Viet Nam.

REMOTE SENSING, WATER QUALITY, SUSPENDED MATTER, PHYTOPLANKTON, COAST, LAKE, RIVER

ABSTRACT

Earth observation sensors collect valuable data of aquatic systems, which are further used for the retrieval of concentrations of water constituents such as suspended matter and phytoplankton. Different sensors deliver data with various spatial and temporal resolution ranging from 1 day to approximately a month in time and from 1km to 3m in space, high spatial resolution being connected with low temporal resolution and vice versa. In order to have detailed information on both spatial distribution of water constituents and their temporal variability, that is especially important for small aquatic objects like rivers and lakes, it is necessary to combine the data from several sensors. This creates certain problems as also spectral and radiometric resolutions of the sensors can be different.

The use of the modular image processing system MIP for the integration of data from different sensor is advantageous as it ensures standardized product outputs for a variety of satellite sensors such as MERIS, MODIS, SPOT, IKONOS, RapidEye. The processing chain of this system is automatically adapted to the sensor parameters as well as to the region specific inherent optical properties (SIOP) of the water basin. Various worldwide applications and time series for lakes, rivers and coastal areas are demonstrated and discussed.

METHODS

The algorithms of MIP are based on a coupled retrieval of atmospheric and water properties providing for the best fit of measured and model radiances in all spectral channels. The number of retrieved water species and final products depend on the spectral and radiometric resolution of the sensor. At least two parameters, namely suspended matter and atmospheric aerosol optical depth, are retrieved in addition to the automatic water detection. For higher number of channels also the absorbing water constituents such as Colored Dissolved Organic Material (CDOM) and phytoplankton can be derived.

MIP consists of a set of relatively independent modules each of which implements a physically distinct algorithm. The architecture of MIP in general is defined by the choice of iterative inversion of RTE as a basic line of processing scheme.

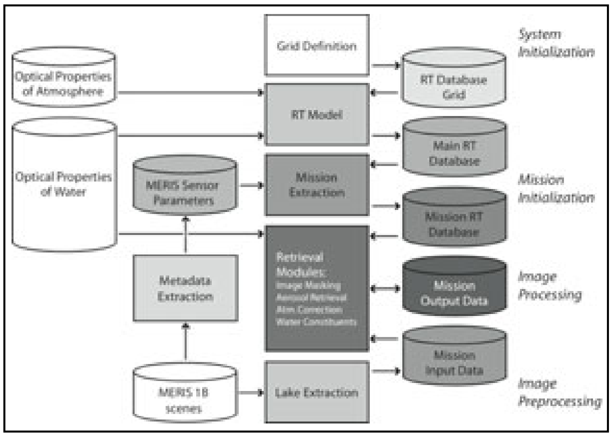

Figure 1 – Scheme of image and metadata preprocessing (lower workflows) and MIP processing (upper workflow), with the retrieval modules as consolidating element in the centre. Darker shad-ing indicates onward progress (from Odermatt 2008).

Atmospheric model of MIP is aimed at the regularization of the RTE inversion. Atmosphere is characterized by a comparatively low number of parameters and in the present version of MIP the model of the atmosphere follows the main features of that adopted in MODTRAN code (Abreu & Anderson, 1996).

The model of water composition serves the same aim as the model of the atmosphere. Scattering, backscattering and absorption coefficients of water bulk are expressed as a linear combination of corresponding location dependent normalized optical properties of water species with concentrations as weighting factors.

The requirements to RTE solver for modeling observations of water bodies in MIP are rather strict. The solution have to be obtained with high accuracy as only small part of total reflected radiance is reflected by water bulk and is in reality the useful signal. The RTE solver based on finite element method (Kiselev et al, 1994, 1995, Bulgarelli et al, 1999) is found to be the most appropriate for this purpose.

The retrieval of media properties, i.e. the inversion of RTE, is performed by fitting the simulated sensor channel radiances to those observed. The retrieved values give the minimum to the functional:

$$\min_{\tau} G(\tau) = \min_{\tau} \sum_{i=1}^{N_{ch}} w_i \left\{ L_i^{(0)} - L_i\left[\tau, \vec{c}(\tau)\right] \right\}^2 \qquad (1)$$

where $L_i^{(0)}$ = measured radiance in the i-th channel

N_{ch} = number of channels

τ = atmospheric optical thickness

w_i = user defined weight of the *i*-th channel

$L_i\left[\tau, \vec{c}(\tau)\right]$ = modeled radiance at sensor level

$\vec{c}(\tau)$ = vector of water constituent concentrations (chlorophyll, total suspended matter, yellow substance) retrieved from remote sensing data at fixed value of τ.

The last vector is calculated by minimizing the mean square difference between retrieved underwater reflectances corresponding to the given τ and those calculated for species concentrations $\vec{c}(\tau)$ according (Albert&Mobley, 2003).

The results of radiative transfer modeling are stored in special MIP databases both with high spectral resolution and with channel responses of specific sensors. The high resolution database (main database) contains data for a reasonable interval of values of observation geometry parameters, such as solar angles, observation heights, view angles and azimuths, and also for different values of media parameters. Databases with modeled channel radiances (sensor databases) are calculated by averaging high resolution radiances from the main database with channel response functions as weights. This approach allows fast adaptation of the system to different sensors and variations of their parameters during the flight period.

MIP system was applied for processing of images of different satellite and airborne sensors and demonstrated stable and reliable performance (see e.g. Heege et al. 2003, 2004, Odermatt et al. 2008).

APPLICATIONS

Various worldwide applications and time series from Lakes (e.g. Lake Sevan, Bodensee) over rivers (e.g. Ems, Mekong) up to Coastal areas (e.g. West-Australia, Vietnam and Chile) were processed. Satellite data from the sensors MODIS (250m, 500m and 1km resolution), MERIS (300m, 1km), SPOT 4+5 (10-20m), Landsat ETM (28m)and ASTER (15 m), QuickBird and IKONOS (3m) are used. The processing chain and inversion algorithm demonstrates robust performance and is also used for long term monitoring of industrial offshore activities with up to daily temporal resolution. In general, the number of retrievable parameters and the product quality depend on sensor characteristics (spectral resolution, radiometric sensitivity and calibration) and observation conditions (e.g. sun glitter existence).

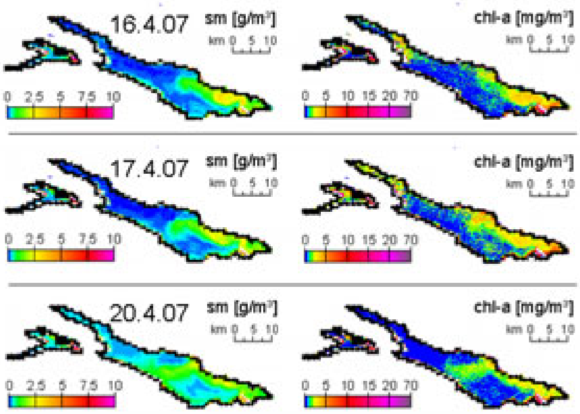

Figure 2 – Spatial distribution of suspended matter (SM) and Chlorophyll a (chl-a) in Lake Constance, calculated from MERIS 300m resolution data.

A special attention in this case must be paid to the calibration of sensor channels as inaccuracies in calibration coefficients can result in artificial inhomogeneity of temporal trends. For producing quantitatively reliable retrievals the calibration of each sensor was investigated systematically in comparison with radiative transfer modelling results. E.g. for ASTER, we observed dominant differences of radiances between MODIS and ASTER especially in the NIR region, as also demonstrated by Yamanoto et al. 2008.

Essential for stable results is also the optimization of the regional Inherent Specific Optical Properties (SIOP), which describe the specific absorption and scattering properties of the water constituents and differ between e.g. turbid rivers and clear coastal waters.

Accuracy estimates therefore always depends on 1) spectral, radiometric resolution, calibration and stability of satellite sensors, 2) range and specific optical properties of water constituents, 3) atmospheric and sunglitter conditions.
Accuracy estimates therefore can be provided only in relation to a specific sensor, region and range of optical properties. Suspended matter and turbidity is usually the most uncritical parameter (e.g. RMSE Lake Constance or at industrial offshore validation tests approx. 10-30%, Odermatt et al. 2008, Heege & Fischer 2004, correlation coeff. >0.8), while chlorophyll depends much more on sensor specifications and other in-water optical conditions of e.g. colored dissolved organic material (RMSE Chl approx. 30-70% for Lake Constance). For the Mekong we conducted two validation campaigns in 2008 and 2009 that improved the SIOPs, but we could not measure simultaneous ground truth with satellite recordings. However, the satellite products reflect largely the right range for turbidity and suspended matter, and are consistent between the retrieval with different sensors. Ongoing validation works from the latest campaign in 2009 will help to settle the physical description of the intermediate turbid Mekong river system and improve the results also for the small scale features.

The SIOPs could be optimized for all applications demonstrated here, but not for the extreme turbid river Ems. The so far unkown scattering coefficients of suspended matter are expected here much lower due to particle agglomeration than the used scattering coefficients derived for lakes and coastal areas. Therefore, the derived turbidity concentrations from ASTER for the river Ems obviously underestimate the real values. In this case, direct in situ measurements are necessary to optimize the SIOPs and the satellite based retrieval results.

CONCLUSION

The combined use of several sensors for monitoring of aquatic objects was found to be helpful and able to produce reasonable results. However, a special attention must be paid to the calibration as the difference in water species concentrations retrieved from the images of different sensors can result just from inaccuracies

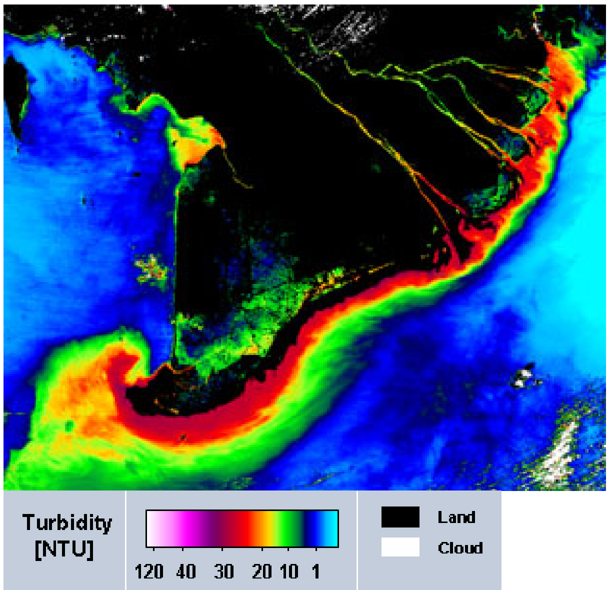

Figure 3 – Spatial distribution of turbidity and suspended matter in the Mekong delta from MODIS 250 m resolution. January 22, 2007.

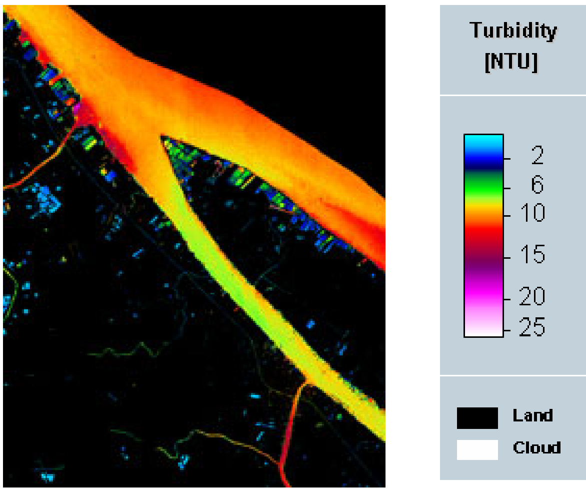

Figure 4 – Distribution of turbidity retrieved from QuickBird in the Mekong delta, January 27, 2007.

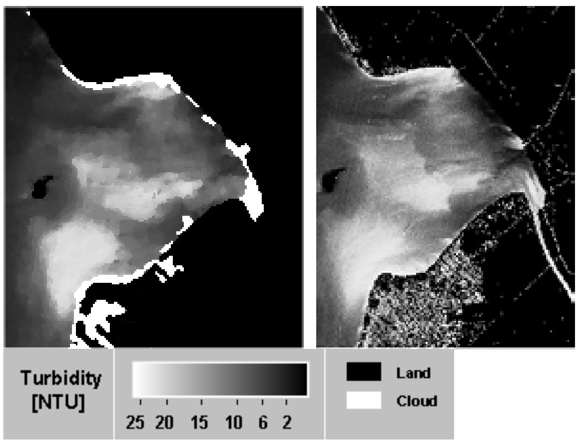

Figure 4. Turbidity in Rach Gia Bay/Vietnam, retrieved from MODIS 250 m resolution (left) and SPOT5 (right) images, images recorded January 8, 2008, 3:10 UTC

in calibration coefficients and lead to artificial inhomogeneity of temporal trends. Intercalibration with well calibrated sensors is applied and helps to overcome this challenge, but should be verified in long term time series in order to prove the systematical calibration differences.

ACKNOWLEDGEMENTS

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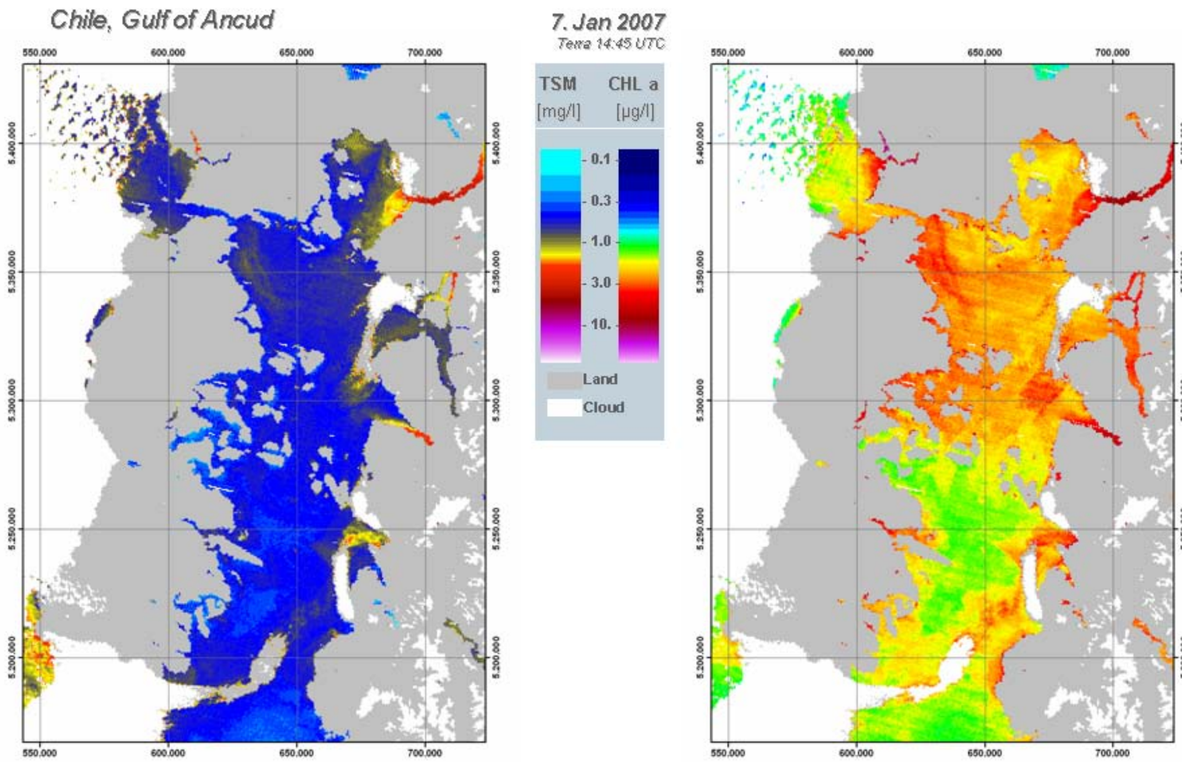

Figure 4 – Distribution of suspended matter and chlorophyll in the Gulf of Ancud/Chile near Chiloe

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AN INFORMATION SYSTEM FOR INTEGRATED COASTAL ZONE MANAGEMENT

Paolo Lupino [(1)]; Alessandro Bratti [(2)]; Piergiorgio Scaloni [(2)]; Giovanni Perego [(3)] and Paolo Di Giacomo [(4)].

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(2) Regione Lazio, Centro Monitoraggio per la Gestione Integrata della Zona Costiera (CM-GIZC).
(3) Man and Machine, GIS Product Manager.
(4) Alpha Consult srt.

Lazio Region (Environmental Direction – Management of Protected Marine Area), through the Integrated Coastal Zone Management Monitoring Center (ICZM-MC), has launched an experimentation to make its data about territory, mainly those relating to coastal zones and marine environment, available.

INTRODUCTION

The main objective of the ICZM Information System is to support the defence, management and planning of coastal zones and marine areas, by overcoming the difficulties still existing in exchanging territorial information among different administrations and stakeholders in this field.
On this occasion, the best I.T. technologies - equipped with the most recent standards - have been tested in order to achieve a real interchange of structured information among the different stakeholders, in accordance with the purposes of the European Directive INSPIRE.

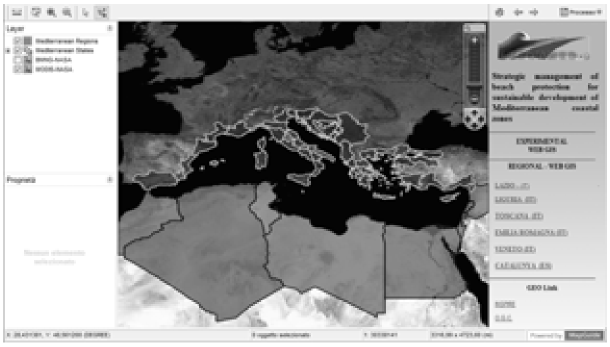

Figure 1 – Mediterranean Regions

These testing activities will be also used in the future initiative EURIOMCODE (European, Interregional and Mediterranean Observatory for Coastal Zone Defence and Management), proposed in the framework of the INTERREG IIIC Regional Framework Operation BEACHMED-e, and whose partner leader is Lazio Region.

WEB GIS SYSTEM

This System is defined as "a set of information of organization's interest and technical body and organizational system that such information acquires, it processes, it makes available and it uses"(1). It is composed of a geographic database made of basic elements (points, lines, areas) and rasters, linked to a relational database that characterises and qualifies the information associated to the basic elements.

The prototype system is now available on the Web Site www.beachmed.eu, in the section "Cartography", with the title Regional Web GIS - Lazio (IT).

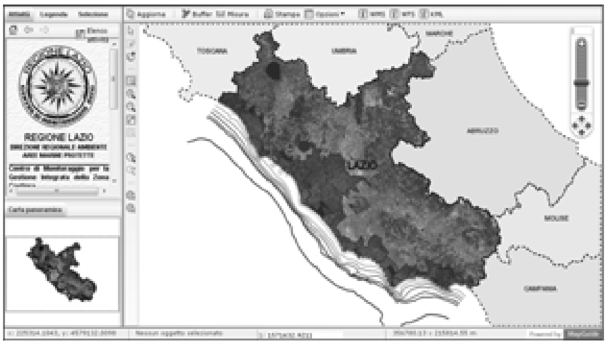

Figure 2 – The prototype of Lazio Region's Web GIS System for Coastal Zones.

In the section "Maps" of the web site, three Cartographies have been uploaded: the main cartography, which represents Lazio and the coastal Municipalities, and two detailed cartographies of Ponza and Ventotene.
The main cartography is composed of a raster, diversified among different visualisation scales: from 1:5.000 to 1:1.000.000. The main map has been structured on 11 topics composed of 50 layers:

1. Administrative boundaries
2. BASIC Cartography
3. Altimetry
4. Hydrology of littoral
5. Coastal use
6. Shorelines
7. Coastal Marine Environment
8. Coastal protected sites
9. Marine constraints
10. Marine Geology
11. Ortho-photo

The services have been diversified according to target users.

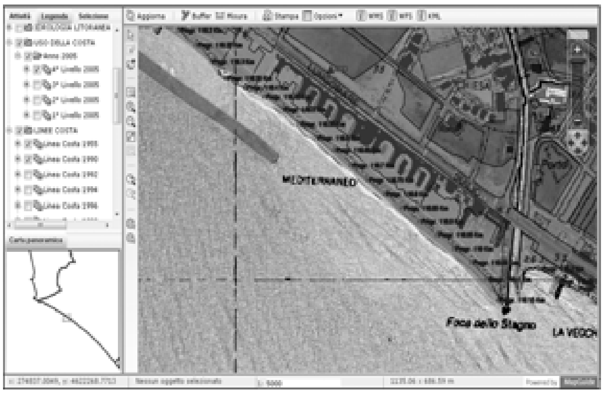

Figure 3 – Detailed Cartography of Web GIS System 1:5000

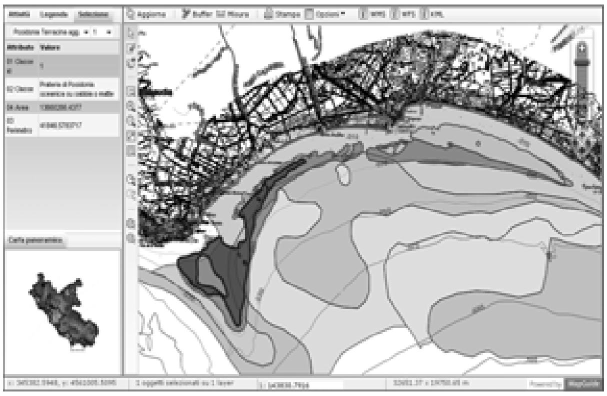

Figure 4 – Sedimentology of surface and posidonia oceanica

One of the most innovative aspects of Web GIS System is represented by the Ajax technology (Asynchronous JavaScript and XML), used for the data transfer.
This technology enables to submit "asynchronous" requests to a Web Server, thus improving the Web Site performances. This is especially true for Web GIS, when it has to provide large quantities of data in a timely manner. Moreover, this technology is compatible with all the main browsers and operative Systems and it does not need a plug-in installation to visualise maps.

INTEROPERABILITY AND DATA INTERCHANGE

ICZM-Monitoring Center has always considered the exchange of data between different administrations working in the same territory as very important. Previous experiences with Web GIS Systems, developed since 2000, made these exchanges possible thanks to special addresses, using the owners' data formats of the cartographic server in use.
Nowadays instead, different standard formats are available. Therefore, the formats we decided to use are those elaborated by the Open Geospatial Consortium (OGC), Web Map Service (WMS) for raster images and by the Web Feature Service (WFS) for vector data. The Keyhole Markup Language (KML) - developed on the basis of XML starting from Google Maps and Google Earth - was also added and it is spreading with good results.

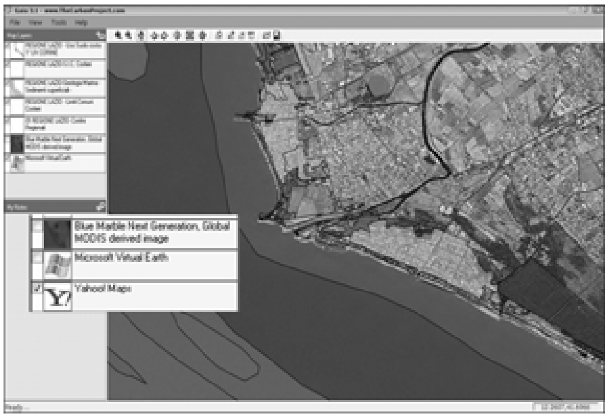

Figure 5: Cartography visualised with WMS, overlapped to data coming from Microsoft Virtual Earth and Yahoo Maps

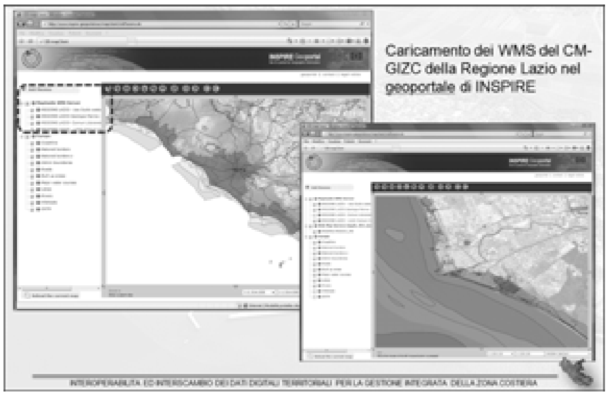

Figure 6: Cartography visualised with VMS in the geo-portal INSPIRE

In particular, for less experienced users and for public users, it has been possible to visualise and examine cartography on Google Earth, thanks to widget KML. It is interesting to remark that KML is now part of the Open GIS Consortium (OGC) standards, 2.2 version. KML have been built on postponed mode, that is to say that the vector element is supplied directly by the MapGuide Cartography server, while the attributes of the single elements have been enriched with information and links, directly written in html code.

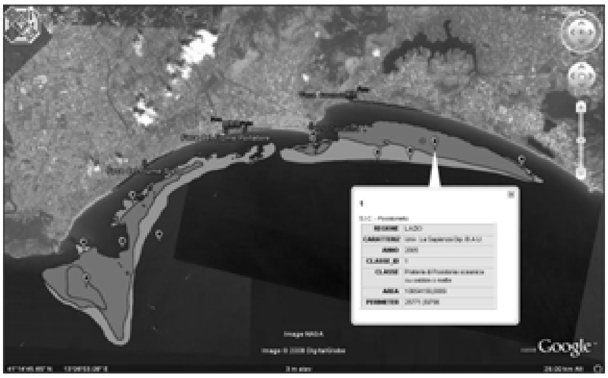

Figure 7: Cartography visualised in Google Earth with attributes

The access functions to WMS, WFS and KML services, are located on the top of Ajax viewer. WMS catalogue is composed of seven themes that are georeferenced to ETRS89 system, OGC code.

CHARACTERISTICS OF DATA

All vector data are expressed in ETRS89, while raster data are expressed in UTM33N ED50. Therefore, the projection of all the elements on the cartographic portal is expressed in UTM33N ED50 System. WMS/WFS/KML services (for vector data) are expressed in ETRS89 in order to be available for everybody and to fit all the projections.
More than 8.000 vector and raster files expressed in different geospatial formats (Sdf, Shp, Dwg, Ecw, Geotiff, ecc.) have been used so far; they are linked to a relational database composed of 24.000 records (Microsoft SQL Server).

GIS SOFTWARE

The organisation and the editing of data as well as the analysis of territorial dynamics have been carried out with AutoCAD Map 3D. Thanks to the new FDO technology, it has been possible to integrate data coming from very different sources. Moreover, GDL 2009 application (Alpha Consult - Roma) has made it possible to organise data in a harmonised and univocal way according to the architecture foreseen for this System.
Autodesk MapGuide Enterprise is being used to publish data on the Web. It uses the same FDO technology and supports the most recent standards, also thanks to the its Open Source version.
Autodesk MapGuide Studio was used for the authoring section, due to its close relation with the server and its user-friendly mode.

TERRITORIAL INFORMATION SYSTEM

This System is structured as a client/server architecture. The client part uses different cartographic work-stations located in several offices, using the geographical data editing and authoring tools provided for the Web GIS.

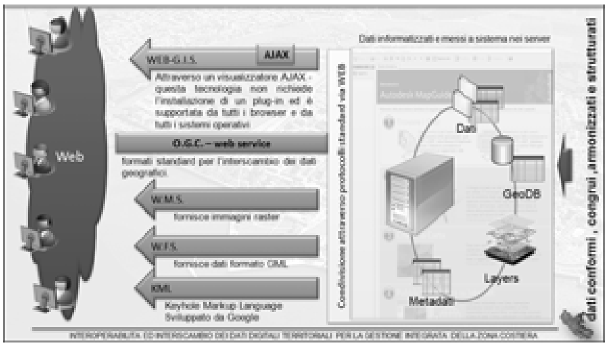

Figure 8: System structure

The data to be shared on the Web are contained in a computer farm equipped with a dedicated 10GB broadband fibre optic network and composed of two servers: one dedicated to the online cartography services with Autodesk MapGuide Enterprise, and the other specialised in database services with Microsoft SQL 2005.

OBJECTIVES FOR THE FUTURE

The work that has been carried out so far will be further developed by implementing the geographical digital data shared with Web GIS in a quantitative and qualitative way. We intend to develop Web data management services (WPS - Web Processing Service) for the research, examination and analysis of data, also using Map Algebra local operators on WCS (Web Coverage Service).
Finally, it is vital to publish metadata in accordance with the ISO/TC211 commission standards, as provided for by the directive INSPIRE.

NOTES

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CARTOGRAPHIC TOOLS ORIENTED TO SUPPORT ICZM AND COASTAL SPATIAL PLANNING AND MANGEMENT

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KEY WORDS: Coastal Zone Management, Spatial planning, Geographic Information System, Coastal Vulnerability,

INTRODUCTION

Emilia-Romagna Regional Council (RER) is engaged in several activities related to 'Coastal Zone Management Programme'. RER has adopted the ICZM Guidelines, by Act n. 645 of 20th January 2005, which define some priorities such as strengthening of knowledge framework and new defence strategy based on extensive use of nourishment tecniques. Besides the ICZM Guidelines face the coastal issues privileging an integrated and cross-sector approach, with the aim to define principles for all the coastal activities and positively address the factors affecting this area, both land and sea-side. According to these principles the Emilia-Romagna Region was involved in the PlanCoast project (Spatial Planning in Coastal Zones), financed by INTERREG III B CADSES (2006 – 2008) European Programme, that was even oriented to strengthen the role of spatial planning as driving force for the ICZM implementation. The Geological, Seismic and Soil Survey (SGSS) of Emilia-Romagna has contributed by up-dating the Coast Information System (SIC) with themes covering all ICZM fields. Further result were the definiton of most important vulnerability indexes of environmental threats to our coastal zone. Experimental cartography of coastal area vulnerability was carried out for Ferrara Province

METHODS

Geographical Information Systems (GIS) are tools facilitating the reporting, management and exchange of territorial data and as such are indispensable to spatial planning and integrated coastal zone management. This form of good practice is already widespread in spatial planning though often lacks thorough analysis especially where environmental factors and risks are concerned. The GIS can be further improved by building thematic databanks of different fields developed on a territorial scale.
The European Union has recently addressed this problem by providing operative tools such as the GIS database for European coasts (scale 1:100,000) and guidelines for the "implementation of local information systems for coastal erosion management" which were released by the European Commission's Environment Directorate-General as part of the EUROSION programme and published in 2004 (European Commission, 2004).
With reference to them Emilia-Romagna Region has already created the Coastal Information System (SIC) (Perini et al 2006; Perini et al. 2007), which quickly took off thanks to financing obtained via the European project CADSEALAND (2004-2006) (Deserti et al., 2006). This involved the collection, organisation and processing of a great deal of data relating to the physical aspects of the entire region's coastal environment. It also saw the carrying out of basic studies aimed at compiling a complete knowledge framework of the Emilia-Romagna coastal area such as the shoreline and land use changes (Cibin et al. 2007).
Within Plancoast EU project this activity was enhanced thanks to several exchange with other European structures involved in coastal and marine zone integrated management and planning. In particular the following activities were carried out:
1. A SIC up-date project was launched across the various thematic areas of ICZM (integrated coastal zone management), involving different departments. New SIC thematic fields and new analytical tools to be used in spatial planning and management of coastal zones were created;
2. New tematic maps and statistical reports were produced with a view to creating a knowledge framework and general maps to be used in spatial planning of coastal zones across the whole region;
3. An analytical procedure to assess vulnerability of the physical coastal system was tested in the Ferrara area and vulnerability indexes were defined.
At the same time, the SIC staff designed a GIS website allowing access to data via the internet, that have been published at the SGSS website http://www.regione.emilia-romagna.it/wcm/geologia/canali/cartografia/sito_cartografia/web_gis_costa.htm

Figure 1 – example of web-Gis interface

DATABASE IMPROVEMENT

Coastal spatial-planning requires the integrated analyses of different thematisms and parameters, concerning all relevant fields of the region's coastal and marine environment. In order to facilitate this procedure it was planned to up-date the Coast Information System (SIC). A further important aim was than to make all data available via Web so that also people not expert of GIS tools could gain access to the coastal data. The first objective of the project was supported by Plancoast funds and the following targets were reached:

1. Selection of thematisms related to spatial-planning and ICZM managent to be implemented and stoktaking of involved office.
2. Stoktacking of available data and of their format, using an already existing questionnaire fixed up in the SIC
3. data collection and validation; updating of the SIC structure creating new thematic areas respect to Eurosion proposal
4. Project and development of the new geodatabase extended to marine area was carried out.

At first we considered the thematic field included in Eurosion scheme and not yet compiled, such as: hydrodinamics; demography; heritage and economic assets. In a second stage other ICZM sectors such as fishery, turism etc. were compiled. Finally attention was turned to collect data concerning the real use of the sea, often in conflict among them and in particular with coastal defence.

The most important contributes to the SIC concern 'hydrodinamic' and 'sea use', and
Hydrodynamics contains all information relating to marine weather and climate (wind, wave activity, currents, etc).
This data is vital to the following areas:
coastal risk analysis (erosion, flooding, etc)
coastal defence planning
design of coastal area buildings and offshore plants
design of buildings for fisheries and aquaculture
This task fell to ARPA-SIM, the region's hydrometeorological services department, which collected and analysed historical data in order to plot the sea-weather climate for the northern Adriatic.
Arpa-Sim's input has thus helped us to construct a profile of the coastal areas in the provinces of Ferrara, Ravenna, Forlì-Cesena and Rimini. The profile takes into account the following parameters: wind, wave activity and currents. concerning the different themes are listed in the following tables.

Type	data
Marine currents	Statistics related to intensity
Wind	Polar diagrams
Wave	Polar diagrams
Wave	Grid –forecasting critical events

Table 1 – Hydrodinamic fields.

Hydrodynamic data has also been validated and now they are published on the web-GIS.

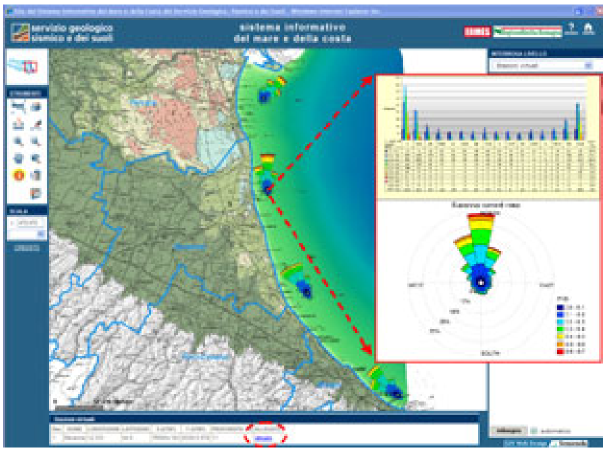

Figure 2 – example of hydrodinamic data available on web-gis; in datail wind polar diagram and bar-chart of the Ravenna coast

A second example of SIC implementation concerns Sea Use. Coastal zone integrated management and spatial planning for coastal and sea areas both require in-depth knowledge of all activities relating to these areas and the potential for resource exploitation. The creation of a sea-use database is a long and arduous task, involving many different regional and extra-regional bodies.
Many offices and bodies were contacted starting from Emilia-Romagna region fishery, tourism and infrastructure departments, the Institute of Marine Hydrographics, Eni SPA – exploration and production division – Unità geografica Italia,

ISMAR-CNR – National Council Research (Bologna, Italy).
What arose from this study is the fact that much of the data needed to create a sea-use databank is not already available or would require lengthy processing. The main data collected so far are found in the table.

Type	data
Submarine sand deposits	Dimension of the stocks useful for nourishment
Submarine sand deposits	Location of extraction
Concession boundary	Marittime areas for fish and aquaculture
off-shore structures	Eni's plans
Restricted areas	Anchoring Prohibited, Fishing Prohibited

Table 2 – Sea Use fields.

THEMATIC MAPPING

One of the most important tools supporting spatial planning are thematic maps which described the most relevant features characterising the state of the coast and the vulnerability levels of coastal environments.
Keeping in mind that the region's coastal area is characterised by a high anthropic pressure which has pushed urban areas right up to the coastline, it was decided that the analysis should focus on three critical tasks: coastal erosion, rising sea-levels and growing salt levels in aquifers.
It was decided to up-date the maps using the most recent aerial images over the coast dated to 2005, to evaluate the state of the region's coastline and the accompanying statistical analyses indispensable to spatial planning and management.
The qualitative and quantitative description of the physical features of the Emilia-Romagna coastline, required in updating existing records, are taken from two main cartographical sources: "coastal geomorphology" (CGC) and "land use in coastal areas" (LUC) referred to 2005.
The production of these maps involved georeferenced and orthorectified photo-interpretation techniques for GIS, the RER-Coastal Flight 2005, and altimetric and bathymetric dataset for the Emila-Romagna coastline. The general orthophotomosaic presents a level of accuracy of planimetric positions referenced to CTR 1:5.000 equal to less than 3 metres. Estimates suggest that the average margin of error in polygonal traces is numerically less than 2 pixel (<2m).
The mentioned cartography allowed several analysis and results needful in the vulnerability analysis.

Land-use modification was examined in three time periods: 1943-1982; 1982-2005; 1943-2005. Urban expansion and anthropisation in general has triggered changes in beach systems, causing a progressive diminishing of dunes and a huge growth in beach exploitation, with recreational buildings and seafront structures being constructed all over the area. This has obviously had a great effect on the coastal environment and beach erosion.
The main geo-indicators, analysed across the region as a whole and taken from CGC 2005, were:
Shoreline 2005 that was also used to update the shoreline variation analysis which began in 1943;
Beaches; three factors were considered in this regard: use, width and altimetry.
Dunes were analysed in several ways, including their distribution along the coast, level of maturity (active dune, semi-stable, stable), continuity (possible presence of openings) and altimetry.
Coastal defences play an important role in the coastal system, interacting with the coast's morphological processes and creating new marine ecosystems. About this theme the state of protection and different typology was analysed.

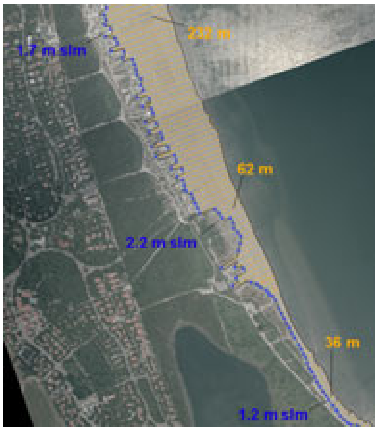

Figure 3 – example of the analysis undertaken for the beach: the orange transect measure the width whilst the blue dots show altimetric values.

VULNERABILITY ASSESMENT

The last step of the project was aimed at the application of regional guideline ICZM at the local scale (Ferrara's Territorial Coordination Plan). For this porpuse a detailed vulnerability assessment has been carried out with particular attention to the evaluation of the most critical factors such as coastal erosion, flooding and salt water intrusion of the aquifers. Ferrara coastal area lies in the Po delta coastal plain, characterized by low topography with large areas below sea level, intense morphodinamic evolution and a high level of human pressure and turistic exploitation of the beach. Most relevant data have been analised and combined in GIS by using spatial multiple criteria analysis. For each critical factor, vulnerability monitoring indexes has been identified as listed in

Critical factors	Vulnerability indexes
Coastal erosion	Beach width Beach elevation Coastal slope Shoreline accretion/erosion rate Subsidence rate Artificial defence
Flooding	Topography Subsidence rate Wheather condition (sea state) Sea level rise
Salt Intrusion of aquifers	Geological setting Hydraulic parameters Resistivity Aquifers exploitation

the following table.

Table 3– main vulnerability indexes identified for Emilia-Romagna coastal area

Such a parameters was than used to process vulnerability classification that has been outlined in several thematic maps (fig. 4) which show the most critical zones of Ferrara coast in respect to the different critical factors.
All these cartographic-tools were applied to analyse the coherence between the various planning choices and the state of the territory.
For doing this an interaction matrix between vulnerabily analysis and plan objectives was created up to identify conflicts and to suggest corrective actions.

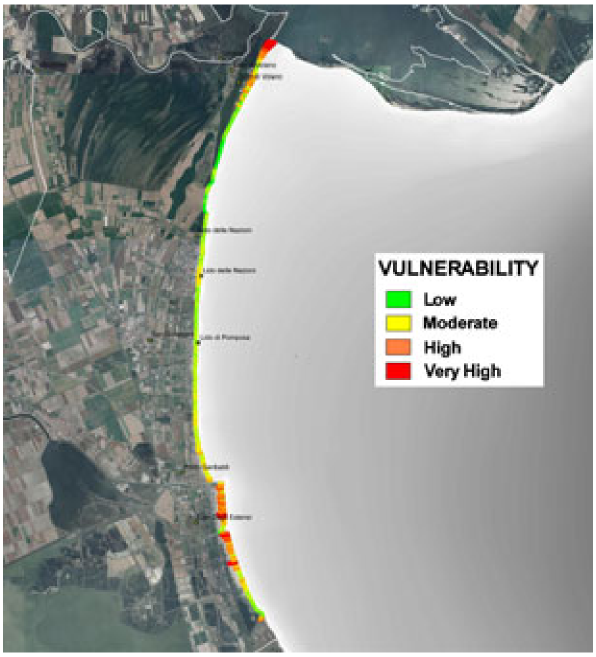

Figure 4 – Example of sea-level rise and flooding Vulnerability Maps .

CONCLUSIONS

The Coast and Marine Information System created by Emilia-Romagna region to support ICZM project is now implemented with several catography and tools more oriented to spatial planning. New dataset were implemented, the knowledge framework has been largely improved and properly cartography supporting vulnerability assesment was developed. The Plancoast project allowed even to use the cartography for the evaluation of coherence between the various planning choices and the state of the territory, suggesting new interventions or corrective actions. The experimented approach applied to Ferrara's Territorial Coordination Plan fournished appreciable results and it can be exported to the other provincial plans.
Besides we underline the importance of the Web-Gis tool created to support data sharing, that is one of the fundamental target of ICZM strategy.

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COASTAL APPLICATIONS OF LIDAR IN CATALONIA

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KEY WORDS: laserscanning, DTM, coast

ABSTRACT

The Institut Cartografic de Catalunya has completed in 2008 the first airborne laser scanning coverage of the Catalan coast with a point density of 0.4 points/m^2. It is planned to repeat the survey of the coast every year. For some areas older data is also available. With the new lidar equipment, it is possible to complete the coast survey, around 450 km, in only 4 flight sessions. Examples are given of the application of these data to beach change evaluation and detection of buildings in protected areas. Beach change evaluation includes measurement of sand volume change, shoreline displacement and change of the beach surface.

INTRODUCTION

Coastal areas concentrate most of the population and the economical activities in our region. Tourism is one important economic activity on this area but many other industries concentrate in our coasts. These areas are affected every year by storms whose effects range from sand displacements to damages to properties or even lost of human lives. Defences have been installed in many beaches to protect the sand but the net effect of the natural transport on most of the beaches is shoreline erosion, probably due to a widespread reduction of the sediments supply from the rivers because of the urbanization of many areas in the river basins, presence of dams and river channelling.

Tourists want to find beaches in good conditions for the bath and the authorities expend a lot of money to regenerate beaches after the storms. In Catalonia the rate of tourists per km of beach is the highest in Spain reaching 21,464 tourists/km in 2006, (Ministerio de Medio Ambiente, 2007). Coastal erosion and the probable rise of the sea level due to global warming threaten the coast, being the delta of the Ebre River the most vulnerable area in our region. Other threatens that could affect us are storm surges and tsunamis. Lidar can provide a fast response after major events.

Systematic monitoring is required to quantify the evolution of the coast. In the USA, the USGS, NASA and NOAA are collaborating to monitoring the coast with lidar since 1995. Lidar has many advantages over photogrammetry in these areas. It is an active sensor that can be operated day and night and the low texture of sand does not reduce lidar accuracy. The presence of water difficults photogrammetry because it is not possible to measure stereo points on the sea surface and stereo models with large areas covered by water can present deformations due to bad distributions of tie and control points. Lidar is very fast and allows getting models of a region shortly after the flight, showing an almost instantaneous “picture” of the situation each time it is flown. As it is cheaper, surveys maybe repeated periodically. The Spanish Environment Ministry (MINISTERIO DE MEDIO AMBIENTE, 2008) recommends repeating surveys 4 times a year in beaches not in equilibrium and every one or two years after when they are in equilibrium but the most common survey technique is still photogrammetry.

There are two kinds of lidar systems useful in coastal areas: topographic lidar and bathimetric lidar (Ruiz, 2008). In topographic lidar systems near infrared lasers are employed and light of this frequency doesn’t penetrate water. Bathimetric lidars employ a green laser, which in clear waters can reach up to 50 m depth. Current bathimetric systems combine both sensors and can survey simultaneously the surface above and below the sea.

Law 22/1988 on the coastline defines the land-sea public scope. According to this law, the strip of land that has ever been reached by the sea is public domain and the public administrations must recover the ownership and adapt land uses to a “more natural” state. The European Community has given some guidelines on coastlines and sea environment policy. Coastal resources must be handled according to an integrated coastal zone management (ICZM) and decisions must be taken based on true data and information. Lidar data is one of the data sources on which authorities can rely to take informed decisions.

DATA

The Catalan coast was flown in 3 flight sessions during 2008, from October 16 to

November 3, with a topographic lidar Leica ALS50-II. There were 65 strips in total. Flight parameters are shown in
Figure 1.

FOV º	56
Scan rate (Hz)	22
PRF (Hz)	88000 MPiA
Above Ground Level (m)	2250
Speed (knots)	140-165
Strip width (m)	2393
Average point density (m^{-2})	0.37
Nadir point density (m^{-2})	0.25
Footprint diameter(m)	0.58
Precision in height (cm)	15
Precision in plan (cm)	32

Figure 1. Lidar flight parameters

The calculated laser points are affected by height offsets because of GPS errors, which are corrected in a strip adjustment that is standard at the ICC (Kornus et al. 2004). As control information served 22 transversal lidar strips, which have already been adjusted in an earlier project as well as 13 control areas, each comprising approximately 40 control points observed with differential GPS at an accuracy of a few centimetres.

As result of the adjustment, height offsets for each flight line are estimated as unknowns from three different groups of observations:

- Height differences between crossing flight lines
- Height differences between flight lines and control areas/control flight lines
- Heights of the control areas/control flight lines

For the first group at each crossing area of two intersecting flight lines a ground DTM is computed with a regular grid from the laser points for each strip. The height differences between corresponding grid points are statistically analyzed, outliers are eliminated and the mean height difference observation is calculated. The a priori weight of the observation is defined as a function of the calculated standard deviation. In case of control areas in the second observation group also a ground DTM is generated and the mean difference between the heights of all control points and the respective interpolated DTM heights is computed.

Altogether, 235 observations were used to estimate the height offsets of the 65 project flight lines. The statistics of the estimated residuals are listed in **Fehler! Verweisquelle konnte nicht gefunden werden.**. The last column refers to the check information (4 control areas and 12 control flight lines) and gives an idea of the achieved accuracy after the height correction, which is approximately 3 cm.

Observation Group	1+2	3 (control)	3 (check)
Number	201	18	16
Sigma [cm]	1.5	1.9	3.1
Max.[cm]	7.4	4.0	3.9
Min.[cm]	-6.8	-3.4	-5.5

Figure 2. Statistics of estimated residuals.

The statistics of the estimated height corrections in Figure 3 show that the height offsets caused by GPS errors vary from day to day, but can also vary significantly during a single flight session as happened on the 2nd day. If not corrected they would produce systematic height shifts in the final DTM in the order of 1-3 decimeters, far beyond the lidar point accuracy.

	Day 1	Day 2	Day 3	Day 4	Σ
Number of flight lines	7	22	23	13	65
Mean [cm]	8.5	15.6	0.4	-2.2	5.9
Sigma [cm]	2.2	5.2	2.8	2.3	8.4
Max.[cm]	11.1	24.8	4.3	1.3	24.8
Min.[cm]	5.0	5.2	-5.6	-6.0	-6.0

Figure 3. Statistics of estimated height corrections

APPLICATIONS

This accurate data has many applications. Some of them are the following:

- Detailed digital terrain modelling of floodplains for mapping and risk analysis.
- Change monitoring: Volume computation of sand movements and shoreline change
- Detection of buildings in protected areas.
- Cataloguing of coastal defences and man-made structures.
- Dunes and beach morphological classification
- Development and emergency planning
- 3D models for landscape analysis, environmental impact, wind propagation, etc.

Floodplain areas require increased accuracy for contouring and are easily surveyed with lidar. Delta de l'Ebre was firstly flown in 2004 with an Optech 3025. Flooding risk models and maps are currently being elaborated from these data

In (Ruiz & Kornus, 2002 and Ojeda et at. 2004) one example of change monitoring was shown. On that year, a storm removed a lot of sand from the emerged part of the beaches in Barcelona. They were surveyed shortly after the storm and, later, after the artificial regeneration of the beach and volumes of displaced sand and changes in beach surface were computed (f

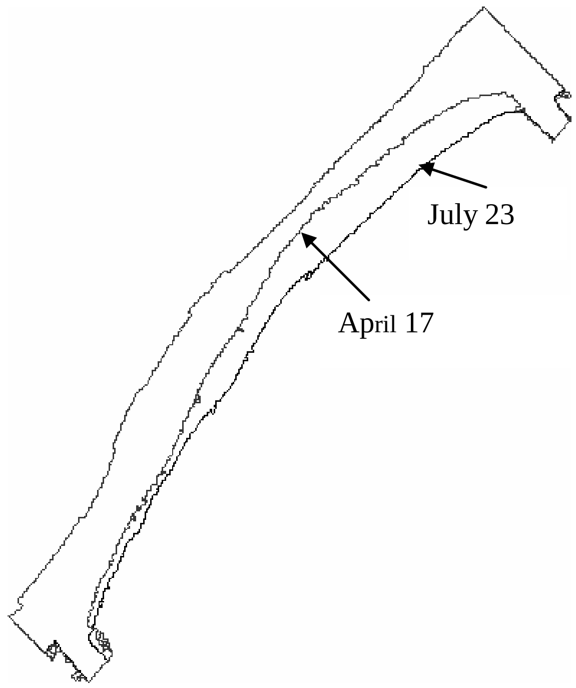

Figure 4. Difference between DTM from 2 epochs, Bogatell beach, Barcelona.

Figure 5).

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Between December 26 and 29, 2008 a strong storm with winds from the East produced damages on the beaches and harbours of Costa Brava. Buoys measured waves of almost 9 m in front of Roses Bay. Blanes and Palamós harbours resulted damaged. The coast from Barcelona to Lloret de Mar was surveyed again on January 17 and 28, 2009 with lidar and digital aerial photography taken with a DMC camera. The change evaluation is currently being done.

Detection of buildings is a standard tool in lidar points' classification software. Once the ground model has been edited by an expert operator, it is possible to classify points higher than the ground as vegetation and, between them, to choose automatically those that could belong to a building roof and so detect those buildings lying inside a protected area. The main difficulty to perform this detection is that ground classification must be very accurate and badly classified cliffs can be misclassified as buildings.

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PLANNING RESPONSES FOR NATURAL HAZARD AND CLIMATE CHANGE IMPACT REDUCTION

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KEY WORDS: Natural hazards, climate change, adaptation, spatial planning

Climate change adaptation has entered regional policy in Europe recently and is quickly growing in importance. It is certain that climate change assessments are to consider current extents of potential natural hazards and combine those with relevant scenarios. Projects related to natural hazards, climate change and regional development conducted under the European Spatial Planning Observation Network (ESPON) have supported the development of risk oriented policy recommendations (http://www.gtk.fi/projects/espon) and the Territorial Agenda of the European Union. Regional projects have been more concrete in stakeholder communication and have led to concrete decision making, for example the award winning Baltic Sea Region's INTERREG IIIB projects SEAREG[1] and ASTRA[2].

The scenarios developed under these projects comprise sea level rise and changing flood prone areas, salinization of aquifers and drought impacts, which were analyzed in interdisciplinary cooperation. Both projects have also only found entry into the 4th IPCC report and the Green Paper of the European Commission on Adapting to Climate Change in Europe. As a result of these projects and other national activities, cities in Finland have now started to take concrete actions and decisions to mitigate the potential impacts of natural hazards and climate change.

Within the frame of the Baltic Sea Region Programme 2007-2013 project BaltCICA[3] the important results achieved in the SEAREG and ASTRA projects shall be further developed into concrete adaptation measures - with a clear implementation perspective in cities and municipalities in the Baltic Sea Region. The BaltCICA project focuses on an implementation on structural, organizational and institutional level, also taking into account on the costs and benefits of adaptation measures.

The above mentioned projects have shown that not only the careful selection of hazard and climate change impact scenarios, but especially the identification of communication channels are most important factors in the science stakeholder dialogue. For example, misunderstandings in the definition and applicability of the terms *natural hazard*, *vulnerability* and *risk* can lead to hindrances in decision making processes. Risk concepts are complicated and their application in spatial planning has to be analyzed most carefully. In the presented cases was proven to assess potential risks by analyzing hazards and climate change effects in simple overlays on land use maps, rather than plotting complicated risk schemes.

[1]Sea Level Change Affecting the Spatial Development of the Baltic Sea Region – http://www.gtk.fi/projects/seareg
[2](Developing Policies and Adaptation Strategies to Climate Change in the Baltic Sea Region – http://www.astra-project.org
[3]Climate Change: Impacts, Costs and Adaptation in the Baltic Sea Region – http://www.baltcica.org

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A MULTITEMPORAL ANALYSIS FOR COASTAL HAZARD ASSESSMENT BY INTEGRATING PHOTOGRAMMETRIC TECHNIQUE AND DGPS FIELD SURVEY: THE CASE OF SELE PLAIN (SOUTHERN ITALY)

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KEY WORDS: beach profiles, photogrammetric analysis, coastal change, Sele plain.

ABSTRACT

The coastal changes between Sele mouth and Agropoli town, southern Italy, was evaluated by using the aerial photography of 1944, 1955, 1984 and cross sections, spacing 200m, surveyed by Trimble R6 GNSS in 2008. In particular, by using the Leica Photo System Project Manager of Erdas software and ArcGis software, it has been possible to reconstruct beach cross sections for the different considered periods. The comparison of cross sections highlighted the areas affected by erosion and the rate of the phenomenom. This information allowed us to define the erosional hazard in the study area.

INTRODUCTION

The Sele Plain (Campania region, southern Italy) comes from the aggradation of a Plio-Quaternary depression located along the rifted inner margin of the southern Apennine Chain. It is about 400 kmq wide and owes a triangular shape,

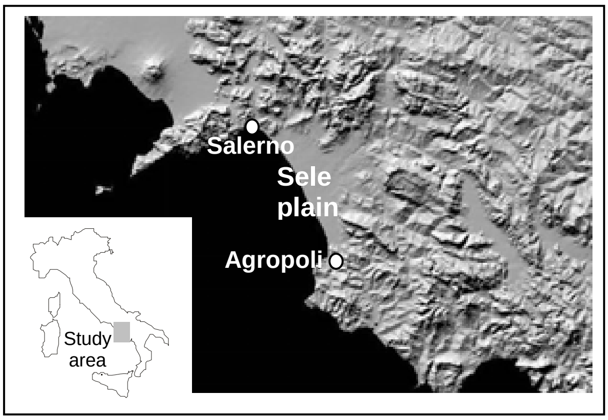

Figure 1 – Location map of the study area.

defined seawards by a straight sand coast stretching between the town of Salerno and Agropoli and closed landwards from Lattari and Picentini Mts. to the N-NW; Alburni, Soprano-Sottano and Cilento Mts. to the SE. The boundaries of the plain are defined by NW-SE and NE-SW trending scarps, active during Early and Middle Pleistocene. The most internal portion of this structural gulf was gained definitively by continental condition thanks to the huge phases of clastic sedimentary aggradation (up to 2000 metres, the Eboli Conglomerates), which accompanied the Quaternary subsidence events. Further seawards, there is the strip of plain that formed during the Last Interglacial (Tyrrhenian stage, OIS 5). It forms terraces between about 25 and 15 m a.s.l. and shows three orders of beach-dune ridges that interfinger at their back with lagoonal and fluvio-palustrine deposits. Between the Tyrrhenian ridge and the present shoreline, a last strip of plain occurs, which is not more than 5 m a.s.l. elevated. This strip was accreted during the Holocene. It include a composite sandy ridges Laura and Sterpina (I and II) which is partly exposed along the present coast and disappears inland under a muddy, substantially flat depression (Brancaccio et al. 1987; Brancaccio et al., 1995; Barra et al. 1998).

Actually the last part of the plain is elevated only few metres a.s.l (from 0 to 4-5 m a.s.l.). Furthermore, this coastal part has been interested from ponds and marshes until to the drainages operated in Borboun Epoch and during the first half of the 1900. A dense series of drain-channels, connected through collectors to water scooping machine, allows to the actual agrarian use of this depressed territory. The beach, that margins it seaward, fixed by a pinewood planted in the years 1930, is not much wide and relatively steep, because of the tendency to the withdrawal of the last decades; tendency that has produced berms that attacks the coastal ridge deposits. This tendency is more marked, because the principal rivers of the plain (Sele, Tusciano, Picentino) present anthropic riverside and because of the presence of the dam on the Sele river.

The location of the shoreline and its change through time is fundamental to coastal scientists,

engineers and managers (Douglas & Crowell, 2000) mainly after the recent estimates of future sea-level rise based on climate model output (Wigley & Raper, 1992) that suggest an increase in global eustatic sea-level of between 18 and 59 cm by 2100 (IPCC, 2007).
One of the most important applied problems in coastal geology today is determining the physical response of the coastline to sea level rise, to the high occurrence of storms (Kallen et al., 1997; Lambeck et al. 2001; Lambeck et al., 2004; Antonioli & Silenzi, 2007), to the reduction of the bottom transport to the sea floor. Predicting shoreline retreat, beach loss, cliff retreat, and land loss rates is critical to planning coastal zone management.
The quoted literature highlights the utmost attention of the scientific world to definition of historic shoreline variation at Sele plain. These studies highlighted the tendency to the recession and the erosion of the recent dune ridge (Cocco & De Magistris 1988; Cocco & Iuliano, 1999; D'Acunzi et al., 2008).
In the present paper the identification of the areas that could be affected by erosion-accretion phenomenon was based not only on the shoreline variaton but also on granulometric analysis and on comparison of the topographic profiles of beach system at different time. In summary, the present research was focused on the following main steps:

- Acqusition of aerial photography of 1944, 1954, 1984;
- Generation of Digital Terrain Model (DTM) using the Leica Photogrammetry Suite Project Manager available in the Erdas framework;
- Extraction of beach profiles by DTMs;
- Analysis of beach profiles surveyed in 2008;
- Comparison of beach profiles and identification of the areas subject to accretion-erosion phenomenon.

DATA ACQUISITION AND ANALYSIS

Shoreline change between the Sele mouth and Agropoli Town, relied on the comparison of beach profiles, was assessed from 3D model of coastal area of scanned aerial photography of 1944, 1955, 1984 and on field data surveyed in 2008.
Aerial photographs are distorted and must be corrected before they can be used to determine a shoreline. Common distortions include radial distortion, relief distortion, tilt and pitch of aircraft, and scale variations caused by changes in altitude along a flight line (Boak and Turner, 2005). To solve these problem the software Erdas rel. 9.1 was used. It allowed us to correct the distorsions and to obtain aerial photos usable as adequate sources from where to obtain ancient shoreline positions and beach morphology.

At this aim three main steps were followed:

- scan of aerial photography of 1944, 1954, 1984;
- interior and exterior orientation of aerial photographies
- generation of Digital Terrain Model (DTM) using the Leica Photo System Project Manager of Erdas software rel. 9.1

The aerial photographies were acquired at resolution of 800 DPI. The interior orientation was defined by using the image position of four fiducial marks (mean error=0.02 mm) and the focal length parameter. The problem related to the unknown parameters, necessary to define the exterior orientation, was solved by using the block adjustment photogrammetric technique. At this aim, about 40 Ground Control Points and 15 Tie Point were used for each aerial photographies stereo pairs.

Year	***Number of aerial photography***	***Number of GCP***	***Number of Tie Point***
1944	10	150	160
1954	7	140	150
1984	6	120	130

Table 1 – Number of GCP and Tie point used to assess the exterior orientation.

The static Global Position System (GPS) method was used on May 2008 to detect the shoreline and the beach morphology along 27 transects perpendicular to the coast line, spanning distance of 200 m each other, between the stable dune crest and the bathymetric of 0.5m. Along each transect a number of 3 – 5 samples of sediment were collected in correspondence to the dune scarp, storm and ordinary berm, foreshore and of 0.5 m isobath.
The comparison of beach profiles, drawn using the algorithms available in the 3D extension of ArcGis, allowed us to distinguish an unstable zone located between the Sele mouth and the Isola localitiy and a stable zone between the last locality and the Agropoli town.
The unstable zone, located between the Sele mouth and Isola localities (fg.2a) is characterized by topographic profiles showing erosion condition as testified by the correspondence of break-slope to storm berm with the stable dune in phases, partially eroded (fig.2b).

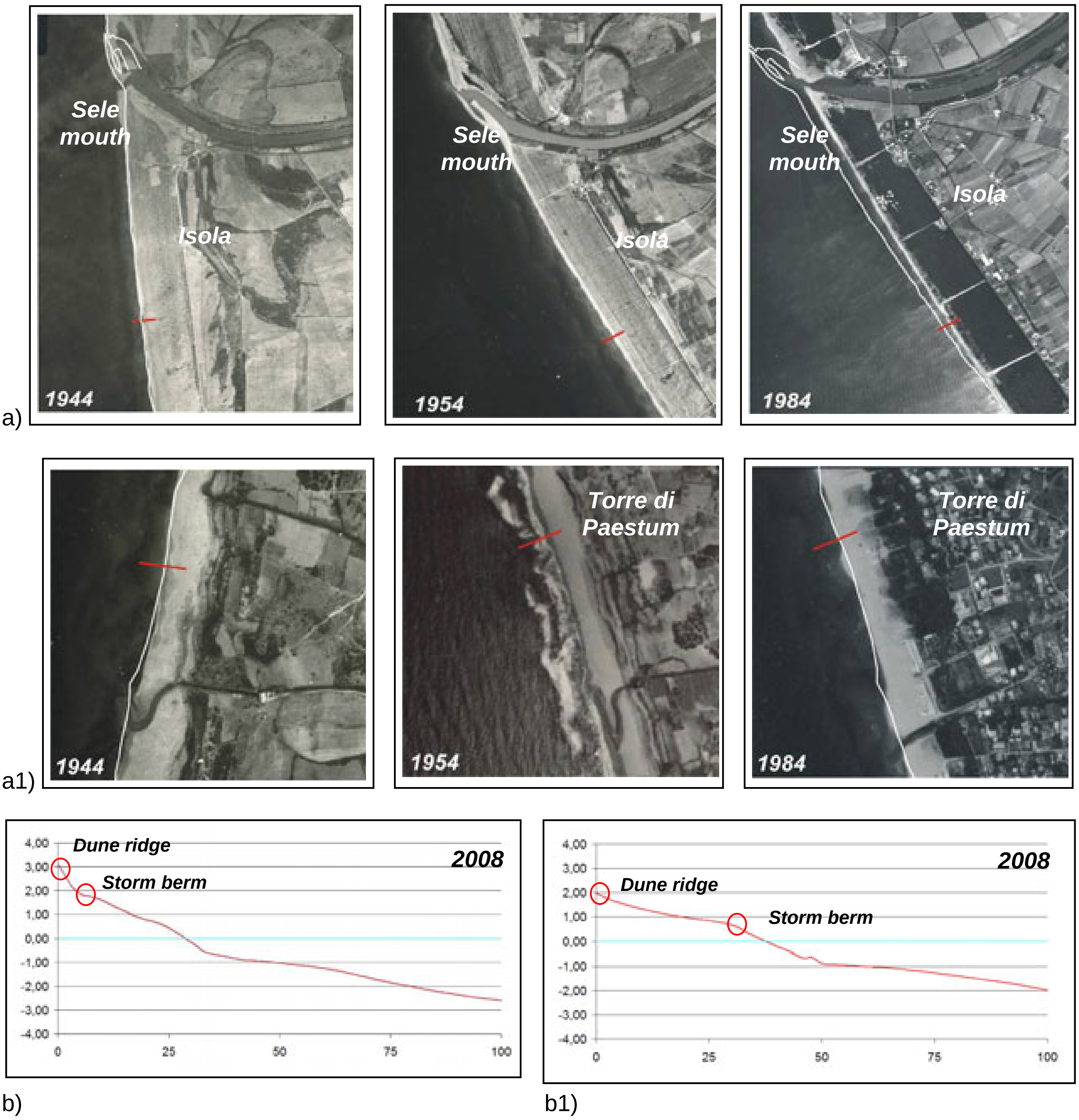

Figure 2 – Comparison of shoreline variation near Sele mouth (a) and Torre di Paestum (a1) between 1944 and 1984; the white line shows the 1954 shoreline. b) example of topographic profile (red line) of unstable (b) and stable (b1) beach system surveyed in 2008.

A mean value erosion of 1.3 m/year and a beach erosion of about 50 m typified this area.
This condition is also confirmed by the granulometric analysis characterized by a poor sorting and bimodal distribution of sediment particle size.
The stable areas located between Isola localities and Agropoli Town (fig.2a1) were characterized by topographic profiles, with evident break-slope of storm dune and ordinary berm, moreover the granulometric analysis showed a good sorting and an unimodal distribution of sediment particle size (fig.2b1) (Frihy & Lotfy, 1997; Bellotti et al., 2004).

DISCUSSION AND CONCLUSION

The comparison of beach profiles allowed us to recognise the different dynamic conditions characterizing the emerged beach and to distinguish the stable areas from those in erosion.
In the last 60 years, the beach system showed an erosion of about 50 m in the unstable located between the Sele mouth and the Isola localities. It is probably due to both, the reduction of the rates of Sele sediment supply and the massive growth of the urbanized areas.

ACKNOWLEDGEMENTS

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PHYSICAL PLANNING INFORMATION SYSTEM (PPIS) AS A TOOL OF SPATIAL MANAGEMENT IN THE PRIMORSKO-GORANSKA COUNTY

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KEY WORDS: Physical Planning Information System (PPIS), spatial databases, decision-making, spatial management.

INTRODUCTION

The obligation of putting in place and developing a Physical Planning Information System (PPIS) of the Republic of Croatia was formally established with the coming into force of the Physical Planning and Construction Act of 1 January 2008. [1]

Owing to its previous successful application of geo-information technology in spatial planning, the Institute of Physical Planning of the Primorsko-Goranska County is an active participant in setting up the PPIS as a tool in planning, monitoring and managing space, despite the fact that the Act fails to clearly define the procedures and contents to be carried out in the PPIS, thus making it more difficult to set up this information system. The Institute has built the required set of GIS databases of spatial development documents and is, accordingly, developing an information system in the field relating to spatial development and planning documents at the Primorsko-Goranska County level.

PPIS GOALS AT THE PRIMORSKO-GORANSKA COUNTY LEVEL

The primary goal in setting up a PPIS at the Primorsko-Goranska County level is to ensure easy access to the public of data in spatial development and planning documents, and to make spatial planning and development databases accessible to local self-government units and government administrative bodies, as well as to private and legal interested persons in accordance with their authorisation to access data.

The PPIS involves the following activities (listed according to priority in realisation):

- providing the public with information regarding spatial development and planning documents through the further development of the County WebGIS browser,
- merging the information system for the implementation of physical planning documents with the PPIS,
- merging the marine domain GIS with the PPIS,
- spatial management – drawing up physical planning documents and environmental protection documents,
- monitoring the condition of and phenomena in space and the environment – compiling Reports
- managing County assets – its network of educational, cultural, sports, health-care and welfare facilities
- managing protected areas, and natural and built resources,
- granting concessions for the use of natural resources.

An essential precondition to building the PPIS is designing the databases of physical planning documents of municipalities and towns. Initiated in early 2003, this project is expected to end in 2009.

PREVIOUS ACTIVITIES IN GIS DEVELOPMENT IN THE PRIMORSKO-GORANSKA COUNTY

GIS development in the Primorsko-Goranska County began already in 1995 in the field of spatial planning. GIS technology has been accepted as a way of handling spatial documentation and monitoring the condition of the County's space by the County authorities and County Assembly.

Sustained GIS application and the building of GIS databases has resulted in a number of projects that are important not only at the County level but at the national level and in the extended region, as well. Only the most important projects are listed below:

Adriatic GIS database

The Ministry of Environmental Protection and Physical Planning had commissioned the County's Institute of Physical Planning to design an analytical basis for setting up a GIS for the coastal zone of the Croatian Adriatic. The system was based on data from spatial documents of all Adriatic counties. A 1: 100,000 scale was applied in graphic presentation. The indicators collected are used in designing the Spatial Plan for the Adriatic Areas of Special Features, in drawing up a Spatial Status Report for the Republic of Croatia and a Program of Measures for Improving the Spatial Status of Croatia, and in making amendments to the Strategy of the Republic of Croatia. This system is in use in the Ministry and in the Institutes of Physical Planning of all counties.

County GIS database

Since 1995, analogue data have been collected for the entire Country for the purpose of elaborating a County Spatial Plan [2]. A database has been constructed containing more than one hundred thematic layers regarding the existing and planned spatial status. The County GIS Database contains data on:

- the territorial area of towns, municipalities and statistical settlements,
- population numbers by settlement,
- the area covered by spatial documentation and environmental impact studies,
- the geodetic network of maps,
- sites of cultural and natural heritage,
- water-protection zones,
- protected coastal-zone areas
- the natural properties of soil, air, the sea and water,
- the basic infrastructure network of roads, railways, the electric-power grid, concessions, etc.
- waste disposal sites, built constructions, and many other different data.

The database is updated with the data available and is used in drawing up Spatial Status Reports and Environmental Status Reports, as well as in developing new projects at the County level.

GIS database of physical planning documents of municipalities and towns

The Institute for Physical Planning collects spatial plans and town-planning schemes in their original digital form. This is typically an AutoCAD file that serves to plot maps in compliance with the Regulations on the Contents and Scales of Cartographic Presentation, Obligatory Spatial Indicators and the Standard of Spatial Planning Studies [3]. For the purpose of setting up a PPIS, the construction of a GIS database was initiated. This database is based on all graphical data and on specific textual data taken from the physical planning documents of municipalities and towns.

The GIS database of physical planning documents of municipalities and towns contains data on:

- area usage on a 1:25,000 scale,
- infrastructure,
- conditions of using and protecting space,
- construction areas on a 1:5,000 scale,
- general data (social activities).

The database is constructed using a singular methodology, criteria and data patterns (data model). It is applicable at all levels of spatial planning, and it is used in making spatial analyses and reports, and for rapid searching and plotting maps regardless of administrative boundaries.

Once data for all municipalities and towns have been entered, the cycle of initial entry of data from physical planning documents of municipalities and towns will be completed. The databases constructed have been built into the PPIS, where they are ultimately intended to be used as a basis for issuing construction permits.

THEMATIC FIELD	TYPE	CATEGORY	ATTRIBUTES
TRANSPORT (lines)	Road	Motorway	Level of importance: state
		Highway	Corridor breadth: (m)
		Other roads	Level of importance: state, county, local, unclassified Corridor breadth: (m)
	Rail	Rapid trans-European railway	Level of importance: state, county, local Corridor breadth: (m)
		Main arterial railway	
		Auxiliary arterial railway	
		Class I railway	
		Class II railway	
		Special-transport railway	
		Narrow-gauged, for tourism purposes	
		Cable railway	
	Maritime	Sea route	Level of importance: international, internal
		Navigable channel	
	Air	Air route	Level of importance: international and domestic, domestic (internal)
	Pedestrian	Seaside promenade	
		Bicycle trail	
		Hiking trail	
TRANSPORT STRUCTURES (lines)	Road	Bridge	Level of importance: state, county, local
		Tunnel	
	Rail	Bridge	

Figure 1 – An example of part of the database on Infrastructure in the Physical Planning Document of municipalities/town – line facilities.

Marine domain GIS database

For the purpose of managing the marine domain, the Administrative Department of Maritime Affairs, Transport and Communications has set up a Marine Domain Database. This database contains data on the established boundaries of the marine domain, areas for which ascertainment procedures are still pending, the names of concession holders, cadastre and land-registry plots, and detailed geodetic groundwork.

WEB-GIS browser – Internet Web environment www.gis.pgz.hr

A WebGIS browser has been developed to enable PPIS data to be easily used from any computer and regardless of equipment. This browser enables the visualisation of selected data from the physical planning documents of municipalities and towns. These data refer to built and unbuilt construction areas (settlements, business and tourism zones, zones for sports and recreation, etc.), agricultural and wooded areas, areas reserved for infrastructure corridors, as well as data on areas for which the elaboration of town-planning schemes or detailed plan are mandatory. The browser contains all geodetic maps available for the entire Primorsko-Goranska County (1:200,000, 1:100,000, and 1:25,000 scale topographic maps; the basic 1:5,000 scale map of Croatia, as well as 1:5,000 scale aerial images and digital ortophotos). The WebGIS browser is a component part of the County's information system, and it is designed to receive new thematic GIS layers from any of the County's administrative departments.

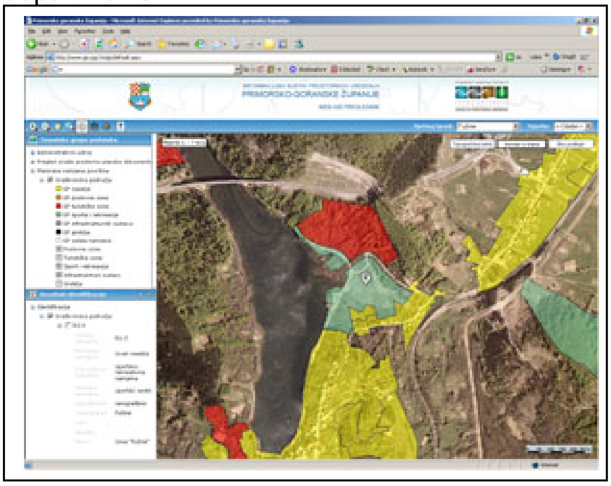

Figure 1 – An example of using the WebGIS browser – PPIS of the Primorsko-Goranska County.

CONCLUSION

With its coming into force, the Physical Planning and Construction Act has provided a legal framework for setting up a Physical Planning Information System of the Republic of Croatia, consistent with EU legislative regulations. Although legal preconditions have been created to putting a PPIS in place, neither have the procedures and contents to be carried out in the PPIS nor the quality and format of data required for data distribution been defined, thus making it more difficult to put the system in place. For this reason, GIS technology is still not used to any greater extent as a tool to increase the accessibility of spatial development and planning documents to the interested members of the public and to private and legal persons, in accordance with their level of authorisation.

The Primorsko-Goranska County is a region that has recognised the importance of developing and using GIS technologies in spatial planning and spatial management. A well-designed and permanent spatial planning database has been created for the County that serves for the further development of the Physical Planning Information System of the Republic of Croatia at the county level.

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Topic – Soil conservation

THE EARTH'S SKIN IN CATALONIA. THE SOIL MAPPING PROGRAMMES IN THE INSTITUT GEOLÒGIC OF CATALUNYA.

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KEY WORDS: Soil mapping programme, soil information, Geoworks of Catalonia, Geomaps of Catalonia.

INTRODUCTION

The "Institut Geològic de Catalunya" (IGC) was established in December 2005. Among many other functions it was planned that the IGC would be responsible to carry out different activities directly related to the knowledge of the soils in Catalonia. In particular, the IGC must give technical advise to the Government of Catalonia in this field.

In order to perform this task, the IGC has to execute, in collaboration with other organizations and/or private companies when needed, different works related to soil mapping, land evaluation and soil protection

It is in this context that the IGC has decided to initiate a soil mapping project, as the best strategy to generate, store, process and spread the soils information of Catalonia.

The main aims of this project are:

- Soil mapping of Catalonia (scales 1:25.000 and 1:250.000)
- Integration of the soil data in the structure of the IGC databases
- Research (digital mapping, soil protection…)
- Popularization of soil information

THE SOIL MAPPING PROGRAMMES IN THE IGC

The soil mapping programmes in the IGC try, first of all, to carry out the soil map of Catalonia to the 1:25.000 scale.

This map is going to be made up of 304 maps (fig. 1), according to the official sheets of the topographical map.

In parallel, at the beginning of the program, it is also intended to obtain the soil map of Catalonia to the 1:250.000 scale. This product can be use as a guideline to predict and estimate the soil types that can appear on the different areas of Catalonia where soil information is not available so far. Furthermore the implementation of this map will enable to fit the production planning for the soil map to the 1:25.000 scale.

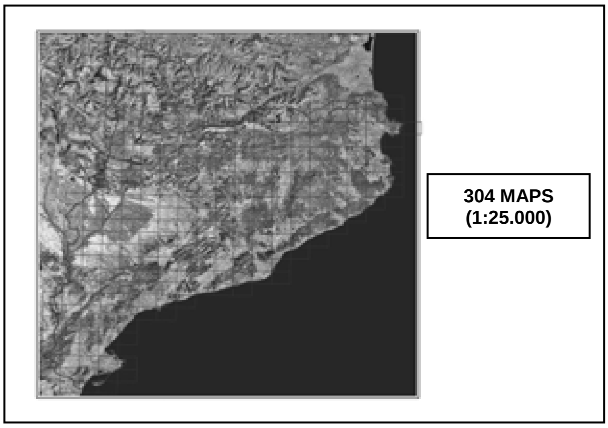

Figure. 1. Soil mapping programme (1:25.000) in the IGC (official sheets of the topographical map)

On the other hand, the IGC wants to participate in new projects and strategies related to earth sciences in general and to the soil science in particular, always involved in the policies of the European Community. In that respect the IGC is trying to be ready to give answers by establishing some memorandums of agreement with different entities and organizations related to these topics (Administration, Universities, Academies, private Companies).

THE STUDY AREA

Catalonia is a region located north-east of the Iberian Peninsula. It has a total area of 32.106,67 Km2 and a population of seven million. The climate is dry Mediterranean, with mild winters and hot summers. The mean altitude is 700 m above sea level, although it ranges between 3.404 m in the Pyrenees and sea level; this makes that 70% of the territory presents a slope steeper than 10%. This characteristic is directly related to land uses: forestry (70%), agriculture (29%), urban (6%) and others (5%).

From a physiographic point of view, Catalonia can be divided in three areas: the Pyrenees, the

Mediterranean system and the central depression. (Fig. 2)

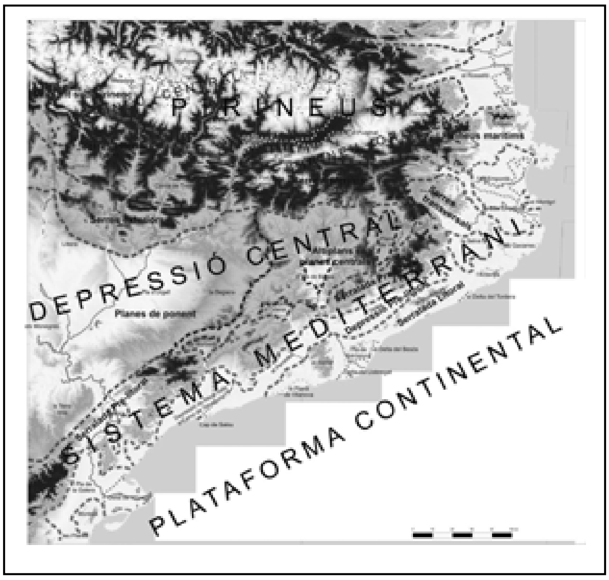

Figure .2. Physiographical areas of Catalonia

The Pyrenees are made up of a series of mountain chains ranging, in a parallel way, from west to east. They are characterized by high elevations, wild landscapes and dryness.

The Mediterranean system consists of two complex mountain chains ranging, in a parallel way, from north-east to south-west. They present a long a narrow valley in between. The mountains range from 1700 m in the inner chain to 500 m in the outer one. The valley is thickly populated and very rich from an agricultural point of view.

The central depression is formed by flat or almost flat areas in between the Pyrenees and the Mediterranean system. It presents young and soft parent materials where rivers have excavated big valleys and erosion basins.

METHODOLOGY

The 1:25.000 and 1:250.000 soil maps of Catalonia are going to be carried out by the IGC with the support of private companies. To that effect, the IGC has created a soil group that is going to perform the planning, the supervision and the acceptance of the different studies. Furthermore, the IGC has appointed a Correlator that is responsible for:

- Analyzing the schedule presented by the consultant at the beginning of the studies and to establish the frequency of the meetings.
- Checking the fieldwork of the consultants
- Take the minutes in the meetings where the different problems, solutions and agreements will be gathered, as well as ensuring their fulfilling.
- Recognizing, establishing and naming new soil types to keep up to day the soil catalogue
- Supervising the legends proposed by the consultant, correcting any inadequacy or ambiguity.
- Checking the quality of the final report, that must include a technical memory and the map, as well as the implementation of the database.

At present, roughly 25% of Catalonia has been mapped, to the 1:25.000 scale, by technicians of the Agricultural Department. These maps can be considered taxonomically and cartographically detailed, and have been carried out basically in agricultural areas. (Fig. 3)

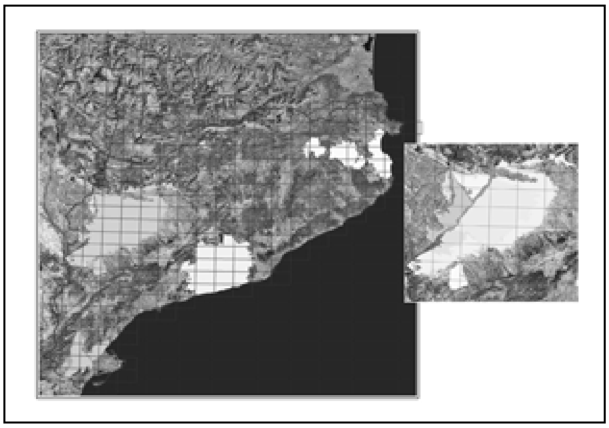

Figure 3. Soil map (scale 1:25.000) of Catalonia. Information contributed by the Department of Agriculture (1.984-2.007)

With the purpose of facilitate the mapping process to the external companies (gathering of background information and previous reports of the study areas, hiring of qualified technicians, asking for permission to dig the profiles…), it has been thought that the municipalities (946 in Catalonia) are the best work units when considering soil studies to the 1:25.000 scale, and that the "*comarques*" (41 in Catalonia) are the best when considering soil studies to the 1:250.000 scale. In this way, more companies, usually of small to middle size, can participate of the project because they can adapt their characteristics to the requirements of the programs.

TERMS OF REFERENCE AND OTHER TECHNICAL SPECIFICATIONS

The terms of reference are based on those established in Soil Survey Manual (SSS, 1.993). The nomenclature that is been used for soil description was gathered in the "*Sistema de información edafológica agronómica de España (SINEDARES)*"(CBSA, 1983), although it has been modified and enriched in order to be adapted to this type of detailed and systematic cartography.

The soil maps to the 1:25.000 scale presents a site intensity of 0,5/cm2 of the final map (16/100 ha) , in agricultural lands, and 0,25/cm2 of the final map (8/100 ha), in forest areas. The rate of dug pits to other type of soil exposures (mini pits, augers, road cuts…) is 2:5 in agricultural lands and 2:10 in forest areas. These figures try to keep an appropriate and homogeneous quality for the maps.

As a general rule, the soil map of Catalonia applies a free survey methodology. The pits are distributed according to the aerial photographic interpretation, in representative areas. The coordinates of these positions are integrated in the geodatadatabase.

The pits are dug out, when possible, by mechanical ways and to a depth of 2 m, unless lithic or cemented horizons are found. They are filled trying to conserve the natural order of the different horizons, this is why the epidepon is separated from the rest of the soil material during the excavation.

Once the pit is prepared for description, some digital photographs must be taken of the surroundings, of the profile and of special features and characteristics that can be observed during the process. This photographs, properly identified and classified, will be an important part of the documentation required by the IGC.

Soil description and sampling must conform to the terms of reference established in the “Guidelines to elaborate the Soil Map of Catalonia”. These guidelines are based on those developed years ago by the DAR, and have been updated after the promotion of the mentioned memorandum of agreement DAR-IGC.

Sampling must take into account all horizons in the profile, although each sample is going to undergo and individual treatment. The samples, placed into plastic bags and perfectly identified, are sent to the laboratory where are going to be analyzed according to the Official Soil Analysis Methods of the Spanish Ministry of Agriculture. Although the contracted laboratories present all the international standards of quality, during the survey some samples are collected in order to proceed to additional quality controls. The IGC is going to prepare a soil bank with the purpose to store all the soil samples gathered during these surveys.

Soil information for the representative pedons is completed, when needed, with other chemical analyses. Furthermore some physical properties and characteristics or the soils (bulk density, hydraulic conductivity and infiltration) are also determined because they are the basis for most of the interpretations required by the map users.

The taxonomic unit for the soil map of Catalonia (scale 1:25.000) is the serie (Soil Taxonomy, 1.999) since it is considered the most interesting for detailed surveys. IGC and DAR are bringing the Soil Series Catalogue of Catalonia up to day. This catalogue is based on the one developed by the DAR in 1993 (Herrero et al., 1993). The correlation system is Soil Taxonomy System (SSS, 1.999), although all the series are also classified according the soil units of the World Reference Base (WRB, 2.006)

The basic map units are consociations of soil series, although complexes of soil series are also allowed if it is justified by the patterns of soils distribution. All the mapping units must be checked in the field.

The legend is organized taking into account the physiography and geomorphology of the area; the homogeneity of the map units (Consociations, complexes…), and the development and limitations of the soils. The different phases that appear in the map are also organized according to their limitations to the use.

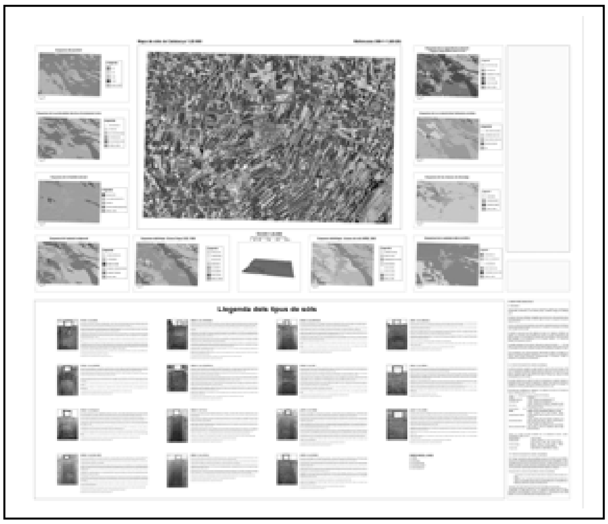

Figure 4. Sheet 65-29 of the soil map of Catalonia

All the information gathered and generated during the different soil surveys must be integrated in the IGC database. In this way, storage, processing, analysis, recovery and presentation of the information is enormously facilitated.

The thematic information is stored in a database (Microsoft ACCESS) developed by the

IGC. This database presents different tables containing information related to the soil profiles, analysis, soil exposures, legends…Geographical information (soil maps, pit sites, other soil exposures) are digitized as shapefiles (ESRI).

All the geographical information used as a reference (aerial photographs, topographic maps and ortophotos to different scales) belong to the “Institut Cartogràfic de Catalunya (ICC)”.

In the near future, it is planned that all this information is going to be integrated in the general database of the IGC. In this way, access to this information on the internet is going to be faster and easier.

With regard to the Soil Map to the scale 1:250.000, it has been established a site intensity of 1/cm2 of the final map (1/625 ha), in agricultural lands, and of 0,5/cm2, in forest areas. The taxonomic unit is the sub-group (Soil Taxonomy, 1.999) since it is considered the most appropriate for this scale. The basic mapping units are the associations of sub-groups. The legend is organized taken into account the phisiography and geomorphology of the area and the development and limitations of the soils. All the information gathered and generated must be integrated in the IGC database.

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LAND USE DYNAMICS AND SOIL CONSUMPTION IN ITALY

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KEY WORDS: land cover changes, reference geographical systems, soil consumption.

INTRODUCTION

Since Corine Land Cover Change 1990-2000 was made available by the European Commission, the analysis of land cover changes has been typically restricted within administrative boundaries, e.g., municipality, regional or national boundaries.

However, administrative boundaries do not provide a suitable basis to organize the analysis of land cover changes. In fact, the comprehension of land cover dynamics can be significantly improved by considering physio-graphical, ecological and landscape aspects of territory.

In line with the above considerations, the paper claims the need to rationalize and describe the land cover dynamics by considering geographical systems.

The study area is the Italian territory. The purpose is to provide a useful tool to help formulating hypotheses which are specific to the main geographical systems in Italy. The predictable impacts of the land cover changes on the relevant resources and their functions should give attention to the geographical component of the different trends.

DEFINITION OF THE REFERENCE GEOGRAPHICAL SYSTEMS

Defining the reference for geographical systems is a challenge task. In fact, reference geographical systems should provide suitable answers to different requirements: (i) should be relevant and pertinent to the national level of analysis and (ii) should be simple and inter-subjective (i.e., corresponding to substantial trans-disciplinary differences, by convergence of evidence).

Soil Regions and *Sub-Regions* defined within the framework of the Italian Eco-pedological Map (Rusco, E., et al, 2003) can provide suitable basis to meet all of the above requirements.

Soil Regions and *Sub-Regions* are mapped according to the European Manual of Procedures (Finke, P., et al., 1998). *Soil regions* are defined as large areas with commonalities in geologic, morphologic and climatic factors, which are responsible for soil differentiation.

For the purpose of this work, the soil Sub-Regions of the Italian Eco-pedological Map were aggregated into 13 reference geographical systems (see Figure 1).

A - High mountain of the Alps
B - Medium mountain of the Alps
C - Low mountain and hills of the Pre-Alps
D - Mountain of the Apennine and islands
E - Low mountain and hills of the Apennine and islands
F - Coastal hills of the Apennine and islands
G - Hills, mountains and plateaux of volcanic land
H - Valley floors of the Alps
I - Po River high plain
L - Po River low plain
M - Intra-mountain valleys of the Apennine
N - Alluvial plains
O - Terrace plains

Figure 1 – List of the 13 reference geographical systems.

ANALYSIS OF LAND COVER CHANGES WITHIN THE REFERENCE GEOGRAPHICAL SYSTEMS

Analyzing land cover changes is a rather challenging activity. As a consequence, we define a simplified land cover legend by aggregating and re-classifying the Corine Land Cover classes (see Figure 2).

Aggregated classes	**CLC classes**
Forests and shrubs	3.1; 3.2 (class 3.2.1 excepted)
Natural grassland*	3.2.1; 3.3; 4
Heterogeneous agricultural areas	2.4
Arable land and pastures	2.1; 2.3
Permanent crops	2.2
Artificial surfaces (continuous urban fabric excluded)	1.1.2; 1.2; 1.3; 1.4
Continuous urban fabric	1.1.1
Water bodies	5

*Figure 2 – Simplified legend for land cover changes analyzing. *open spaces with little or no vegetation and wetlands included.*

The geographical analysis of land cover changes has been carried out by intersecting the two information layers concerning:

- Corine Land Cover Change, re-classified according to the simplified legend
- the reference geographical systems.

RESULTS AND DISCUSSION

Figure 3 shows the specific incidence of the main land cover dynamics within the different geographical systems we studied. For each reference geographical system, the land cover changes are represented as the percent variation of areas calculated dividing by the total area (see Figure 4).

At the national scale, the interacting driving forces that control the land cover dynamics are strongly polarized with respect to physio-graphical, ecological and landscape aspects. Type and intensity of land cover changes are specific to the different geographical systems.

Typical examples are:

- the growth of forests and shrubs is mainly in the mountain land (75% of the total), within which the contribution of the Apennine lands (+59%) is more relevant than the one of Alps (+16%); new forests originates in cultivated land (about 60%) and natural grassland (40%);
- among the new urban areas: (i) 65% are in the plains (which are 30% of the Italian territory), (ii) 16% are in the hills and volcanic mountain land (which are 21% of the Italian territory), and (iii) about 20% in the mountain land (which is 49% of the Italian territory).

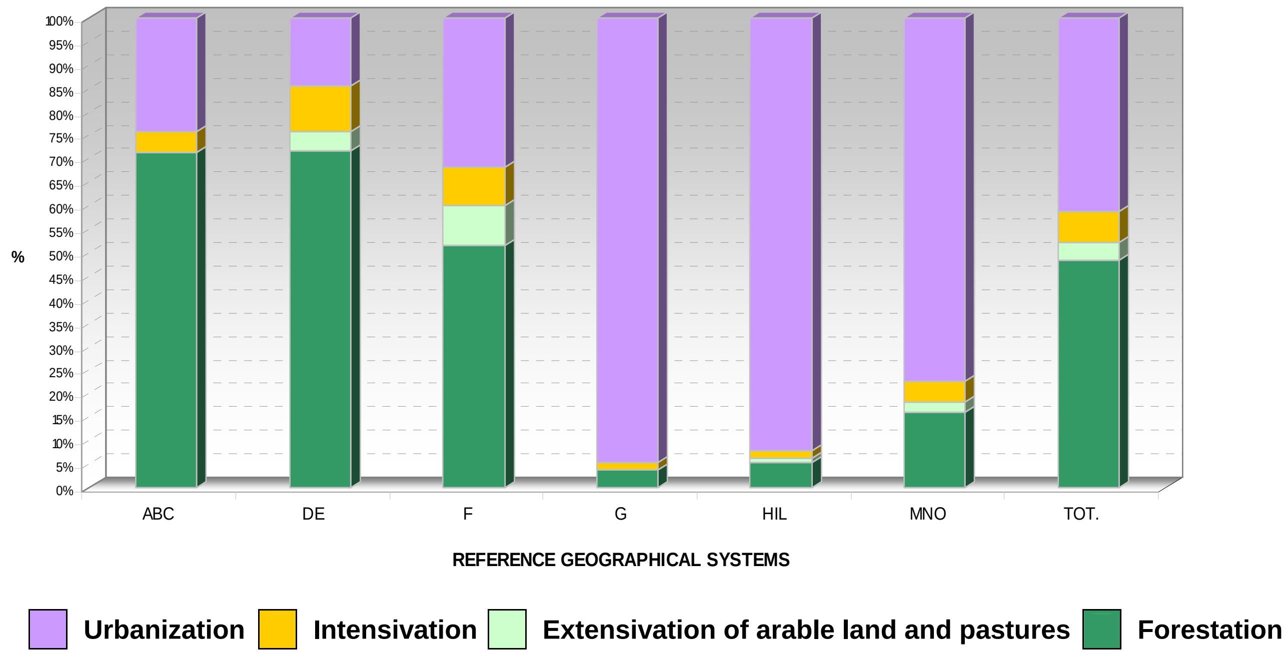

Figure 3 – Specific incidence of the main land cover dynamics within the different geographical systems.

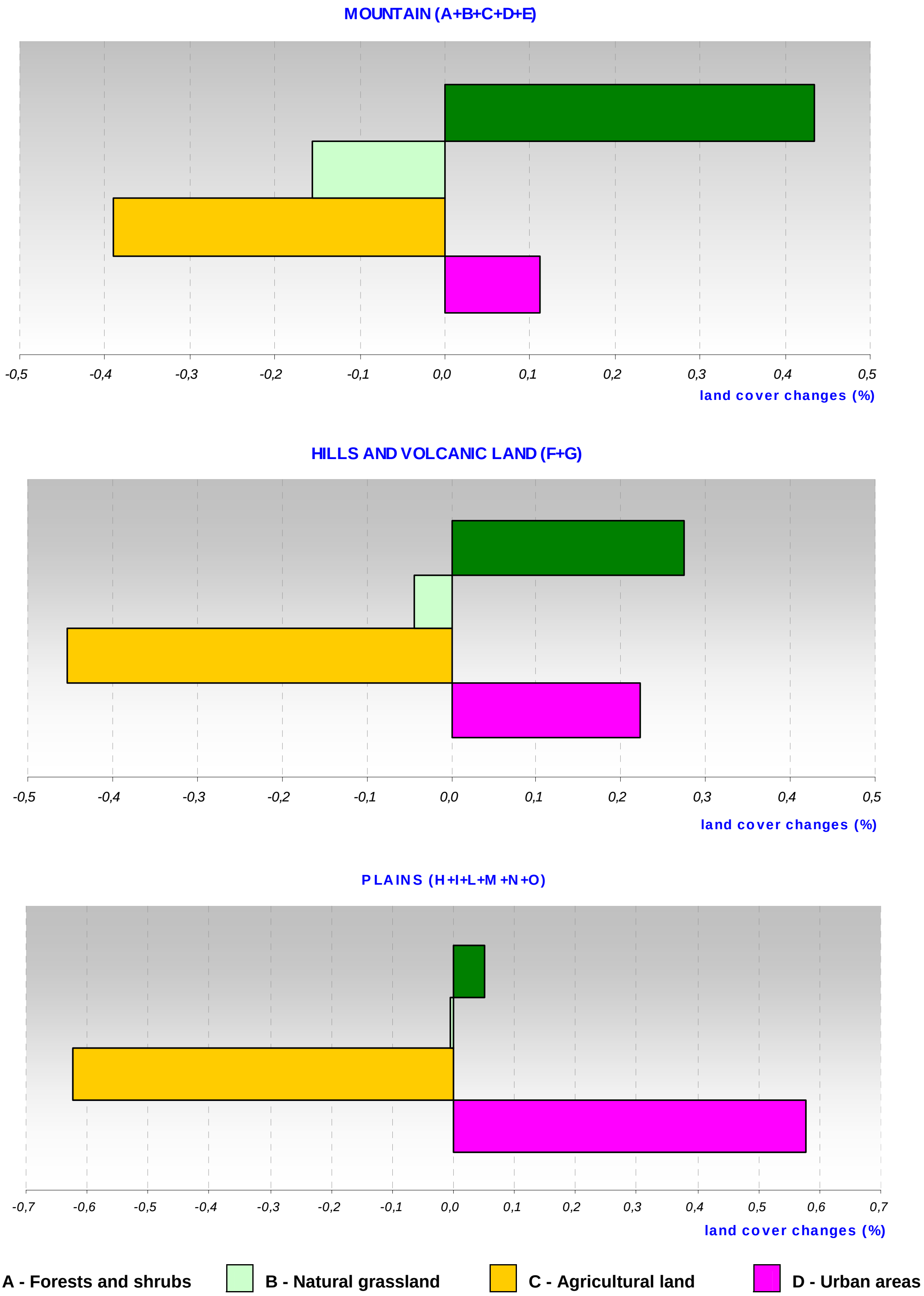

Figure 4 – Land cover changes as the percent variation of areas calculated dividing by the total area.

CONCLUDING REMARKS

The present work demonstrates that the interacting driving forces that control the land cover dynamics are specific to the different geographical systems.

The geography of land cover changes is strongly directed and structured according to geographical systems. As a consequence, it is not appropriate to restrict land cover analysis within administrative boundaries.

In line with these considerations, we are knee to think that is worth defining local development and resource conservation policies only by considering geographical structure of territorial changes.

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SOIL PROTECTION. TOWARDS INTEGRATION AMONG REGIONAL THEMATIC STRATEGIES

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KEY WORDS: soil protection, land planning, environmental, agricultural policies

INTRODUCTION

The Congress "Soil Protection. Towards integration among regional thematic strategies" was held in Bologna, 27-28 November 2008. It was organised by Regione Emilia-Romagna as a joint initiative of the Bavaria, Catalonia and Emilia-Romagna Regions, among the activities of the "Working Group on Soils". It represented the contribution of the "European Regions for Earth Science" to the International Year of Planet Earth.

Soil degradation is a serious problem in Europe. It is driven or exacerbated by human activity such as inadequate agricultural and forestry practices, industrial activities, tourism, urban and industrial sprawl and construction works. These activities can have a negative impact, when they prevent the soil from performing its broad range of functions and services to humans and ecosystems. This can result in loss of soil fertility, carbon and biodiversity, lower water-retention capacity, disruption of gas and nutrient cycles and reduced degradation of contaminants.

Provisions in favour of soil protection are spread across many areas. Single strategies can have positive effects on the state of soil. However, to the extent that existing strategies often aim to safeguard other environmental media, we can not take it for granted that they constitute a coherent soil protection policy. This means that, even if exploited to the full, they could be far from covering all soils and all soil threats.

Therefore, four sessions were arranged along the Congress: (i) Workshop on the Thematic Strategy for Soil Protection, (ii) Land planning policies: impacts to soils; (iii) Environmental policies: impacts to soils; (iv) Workshop on Agricultural policies and soil management.

Workshop on the Thematic Strategy for Soil Protection

The Commission adopted a Soil Thematic Strategy (COM(2006) 231) and a proposal for a Soil Framework Directive (COM(2006) 232) on 22 September 2006 with the objective to protect soils across the EU. The Strategy and the proposal have been sent to the other European Institutions for the further steps in the decision-making process.

The Opening Speech was made by Luca Montanarella, from EC Joint Research Centre. Five invited speakers contributed: (i) The role of Geological Services in the Soil Thematic Strategy, by Patrice Christmann, from *EuroGeoSurveys;* (ii) German Soil Protection Act (and the corresponding Bavarian regulations), by Bernd Schilling, from Bayerisches Landesamt für Umwelt; (iii) Italian and regional legislation, by Igor Boni, from Institut for Plant and Environment (IPLA S.p.a.), Torino; (iv) Towards the energy planning of municipal districts, by Leonardo Setti, from Bologna University and (v) Soil and Climate Change, by Vittorio Prodi, Vice-president of the European Parliamentary Commission on Climate Change.

At the Round Table "Positions and comments on the Thematic Strategy for Soil Protection", chaired by Vittorio Prodi as Soil Thematic Strategy rapporteur, Andrea Giapponesi (Regione Emilia-Romagna), Bernd Schilling (Bavaria Region), Patrice Christmann (EuroGeoSurveys), Ferruccio Melloni (Reno River Basin Authority), Guglielmo Garagnani (Reno-Palata Land Reclamation Syndicate), Gaetano Finelli (Castello di Serravalle Municipality), Luca Montanarella (EC Joint Research Centre) participated.

The works of the session were concluded by the Chairman Marioluigi Bruschini, Territorial Defence, Soil and Coastal Defence, Civil Protection Ministry, Regione Emilia-Romagna.

LAND PLANNING POLICIES: IMPACTS TO SOILS

Soil performs a multitude of key environmental, economic, social and cultural functions, vital for life. Land use policy can play an important role in protecting soils, by limiting soil sealing, using construction techniques that allow maintaining as many soil functions as possible and ensuring that soil characteristics are taken into account in decisions concerning allocation and use of land.

The Opening Speech “Public govern of the land and soil protection in Regione Campania” was made by Antonio di Gennaro from Risorsa s.r.l. Naples. Many invited speakers contributed: Ugo Baldini (CAIRE), Nicola Dall’Olio (Provincia di Parma), Eriuccio Nora (Provincia di Modena), Barbara Guandalini (Regione Emilia-Romagna), Paola Altobelli (Provincia di Bologna), Stefano Agostoni (Regione Lombardia), Paolo Giandon (Regione Veneto), Francesco Malucelli (Regione Emilia-Romagna), Raffaella Bedosti & Francesco Sacchetti.

The works of the session were concluded by the Chairman Paolo Mattiussi, Head of Service for Land Planning, Regione Emilia-Romagna.

ENVIRNMENTAL POLICIES: IMPACTS TO SOiLS

Main issues: Integrated Pollution Prevention and Control (IPPC Directive); Inventory and remediation of contaminated sites; Sewage Sludge Directive; Thematic Strategy on Waste Prevention and Recycling, to ensure that maximum benefit is reaped from the reintroduction of nutrients; Assess possible synergies between measures aiming at protection and sustainable use of soil and measures incorporated in river basin management plans under the Water Framework Directive; Soil and climate changes interactions.

The Opening Speech “Segregation of subareas with elevated geogenic pollutants and their effects on the utilization due to the German Soil protection Act” was made by Bernd Schilling from the Bayerisches Landesamt für Umwelt. Many invited speakers contributed: Monica Guida (Regione Emilia-Romagna), Domenico Preti (Reno River Basin Authority), Eugenio Lanzi (Regione Emilia-Romagna), Patrice Christmann (EuroGeoSurveys), Nazaria Marchi (Regione Emilia-Romagna), Paolo Giandon (Regione Veneto), Laura Billi (ARPA Emilia-Romagna), Claudia Ferrari (Regione Emilia-Romagna), Sergio Baroni (Provincia di Ravenna), Stefano Brenna (Regione Lombardia).

The works of the session were concluded by the Chairman Lino Zanichelli - Ministry for Environment and Sustainable Development, Regione Emilia-Romagna

Workshop on Agricultural policies and soil management

Main issues: (i) Checking the contribution made to soil protection by the minimum requirements for good agricultural and environmental condition defined by Member States; (ii) Monitoring whether the need to protect soil is adequately taken into account in the Rural Development Plans for 2007-2013, and thereafter.

The Opening Speech was made by Camillo Zaccarini Bonelli – National Rural Network, MiPAAF. The Opening Speech “Common Agricultural Policy and soil protection in Catalunia” was made by Emilio Ascaso Sastrón from Institut Geològic de Catalunya and by Jaume Boixadera from Catalan Ministry of Agriculture. Many invited speakers contributed: Gabriele Rizzo (ARSSA, Calabria), Mauro Tiberi (ASSAM Marche), Barbara Lazzaro (Regione Veneto), Nicoletta Alliani (IPLA S.p.a,Torino) , Elio Passaglia (Università Modena e Reggio Emilia), Carla Zampighi (Reno-Palata Land Reclamation Syndicate), Marco Ligabue (Centro Ricerche Produzioni Animali), Giovanni Nigro (Centro Ricerche Produzioni Vegetali), Teresa Schipani, Gianfranco De Geronimo, Giampaolo Sarno (Regione Emilia-Romagna), Franco Zambelli (Regione Emilia-Romagna), Roberto Genovesi (Consorzio per il Canale Emiliano-Romagnolo).

The workshop was concluded by the Chairman Giancarlo Cargioli, Head of Service for Agri-food System Development, Regione Emilia-Romagna.

conclusions

The proceedings of the Congress and the posters are available at HTTP://WWW.REGIONE.EMILIA-ROMAGNA.IT/WCM/GEOLOGIA_EN/SECTIONS/MEETINGS_AND_SEMINARS/14_ABSTRACTS/2008_BOLOGNA_SUOLI.HTM

After the Bologna Congress further discussions have been going on within informal small sub-groups of the Working Group on Soils. We would like to take the opportunity of the present Eurogeo2009 in Munich to define priorities.

REGIONALIZING GULLY EROSION RISK FOR URBAN PLANNING

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KEY WORDS: gully erosion, urban planning, GIS

INTRODUCTION

Belo Horizonte is the fast growing capital of the Brazilian state Minas Gerais with today over five million inhabitants in the metropolitan area. The newly built highway to the international airport about 50 km north of the city is accelerating the urbanization of its northern periphery due to a fast connection to the city combined with tax reductions for industrial plants.

The city of Lagoa Santa in the northern periphery of Belo Horizonte is strongly affected by this trend, and the prices for real estates in its municipal area have been rising even before the new highway was finished. Still, Lagoa Santa is situated in a fragile environment, as the hills it is built on are of highly erodible siltite rocks and many gullies are threatening the infrastructure of the city.

It can be seen on old aerial photos that most of the large gullies already developed during the process of urbanisation when the topsoil was removed and the underlying saprolite not yet protected by pavement or buildings. The same circumstances often arise around unplanned settlements and (unpaved) roads that also tend to be associated with gullying.

As the city of Lagoa Santa will be expanding into its surroundings within the next decades, our aim is to generate a robust and simple method that helps to predict and thus minimise the risk of gully development during the urbanisation of the region. Our method is based on easily available data that are processed in a commonly used geographical information system (GIS) environment (ArcGIS). In this study, we first try to establish a method that is fitted to the already existing gullies near the center of the municipal area of Lagoa Santa. Later on, in a following study, this method will be applied to assess the risk of gullying for different future urbanisation scenarios of the region.

STUDY AREA

The study area lies in the Brazilian cerrado region around 20° latitude with an elevation between 650 and 920 m a.s.l.. The climate is tropical on high altitudes with humid warm summers and dry cool winters. The mean temperature varies around 20°C and the annual precipitation of 1400 mm falls nearly completely during the summer raining season between October and March.

The underground consists of Archaean gneiss/granite basement rocks dissected by swarms of basic dykes that are covered for large parts by Late Proterozoic carbonate sediments and (especially around the city of Lagoa Santa) siltites of the Bambuí Group. The relief is accentuated, with convex-concave hills ("mar de morros") on Archaean basement, carstic relief in the limestone area and old plateau surfaces interchanging with concave slopes on siltites.

Gullies are most common on crystalline basement rocks and on siltite sediments while being nearly absent in limestone areas.

METHODOLOGY

For gully hazard evaluation, a broad variety of methods exists:

There are physically based methods that are implemented as extensions of erosion modelling software (e.g. LISEM-Gullies (LISEM 2000) or WEPP (Flanagan and Nearing 1995)). These methods yield good results but need many detailed parameters as input.

Then, there are many studies that focus on local conditions for gullying (e.g. Ries and Marzolff 2001, Bacellar et al. 2005). Although they provide much information on the physical processes associated with gullying, they are difficult to regionalize for risk prediction in a large area.

Finally there are threshold based methods relying on a regression of critical slope and drainage area (e.g. Montgomery and Dietrich 1994, Vandaele et al. 1996, Vandekerckhove et al. 2000). These methods are more general, incorporating all local factors in only two coefficients that are found by performing a regression on the initial starting points of the gullies. Once these coefficients are found, gully erosion risk can be easily regionalized using a GIS.

In our case, all three methods faced problems:

- For a physically based model we did not have enough data.

- Informations on local processes associated with gullying were too specific to regionalize using a GIS.
- Threshold methods need the knowledge of the original gully starting points for calculating a regression on contribution area and critical slope. As most of the gullies in the area are old and large, it is very difficult or impossible to indicate their initial starting point due to forward / backward progression of the gully.

Finally, the method of choice for our study was a modified threshold model. We used the common equation

$$\mathbf{S_c = a\, A^{-b}} \qquad \text{(eq. 1)}$$

with S_c = critical slope, **A** = drainage area and **a** and **b** factors fitted to the local conditions of the study area. Behind this formula lies the concept that the initiation of gullies needs a certain amount of water (supplied by a large enough catchment area) and a high enough gradient that gives the water the power to incise a channel. The factors **a** and **b** are used to fit the model to the rest of the gully controlling factors such as rain intensity, soil physical properties and land use type. The regression is usually based on a dataset of starting points of existing gullies in the (homogeneous) study area. For an overview of studies using a regression to find the factors **a** and **b** in different environments see e.g. Vandaele et al. (1996).

As we do not know the starting points of the old gullies in our area, it is not possible to calculate a regression for our study. However, this might not even be desirable as the land cover in the study area is very heterogeneous including urbanized areas extending to various degrees into the catchments of gullies. Land cover being a very important factor, there might be no sensible regression fitting to the data of the whole area.

Moeyersons (2003) paid respect to this influence of the land use and calculated two different regression analyses for a study site in Rwanda: one for more or less undisturbed rural areas and one for areas where linear features such as contour trenches, ditches or roads artificially enlarged the catchment of the gully. He also found that for his study site on tropical ferralitic soils the drainage area threshold for gullying seemed nearly twice as large as for North American conditions reported by Montgomery and Dietrich (1994).

In our study, we took the coefficients **a** and **b** from Moeyersons (2003), as the basic conditions (e.g. tropical savannah climate, ferrallitic soils, granite or phyllitic underground) were similar.

Nevertheless, besides calculating the critical slope thresholds for gullying using coefficients from literature, we wanted to adapt the model better to our study area, especially incorporating the additional overland flow generated by sealed or compacted areas.

In the equation given above (eq. 1), the drainage area **A** is a substitute for the amount of water that arrives at a certain point and is available for gully incision. Although subsurface flow, piping and saturation excess overland flow often play an important role (see e.g. Bacellar et al. 2005, Augustin and Aranha, 2006), infiltration excess overland flow (so called Hortonian overland flow) seems to be the main force for gully erosion connected with urban features. The amount of infiltration excess overland flow is directly linked to urbanisation through increase of sealed area and flow concentration along roads.

Thus, we substituted the drainage area **A** in eq. 1 by the amount of infiltration excess overland flow generated by a heavy rain event. In a modern GIS environment (e.g. ArcGIS), this can be done by incorporating a weight raster while calculating the drainage area based on a digital elevation model (DEM). The weight raster was generated from a satellite image (RGB scene from Ikonos) of the area. This RGB image was classified using an unsupervised maximum likelihood classifier implemented in the software ERDAS Imagine which yielded five identifiable land use classes: high vegetation (eucalyptus plantations and cerrado), dense low vegetation (mainly grassland), sparse low vegetation (mainly degraded grassland), bare soil and urban areas (Fig.1). Agricultural areas are not common in the area due to accentuated relief that is only suitable for pasture. The classes “urban areas” and “bare soil” could not be separated clearly, having a similar spectrum on the RGB image that we used. The same is true for “high vegetation” and “dense low vegetation” which could often only be distinguished by the shadows of the trees. Choosing a majority filter for resampling the land use classes to the same cell size as the digital elevation model helped to reduce the misclassification error to some parts (Fig. 2).

We chose the weights according to the range of estimated infiltration capacities for different land use types: for natural savannah forest (cerrado), we assumed complete infiltration even of extreme summer rains as there are no traces of overland flow visible in the field. These rains can have intensities of more than 70 mm/h during 30 minutes (Viola 2006 in de Mello 2007). The observation of complete infiltration was confirmed by a double ring infiltrometer test which showed that lateritic topsoil under cerrado forest had an infiltration capacity clearly beyond this value. This was also related to the existence of huge macropores. Exposed subsoil or compacted areas had infiltration rates in the same order of magnitude as extreme rain events (around 60 mm/h). Where the saprolite was exposed, infiltration rates below 10 mm/h were observed. Although these infiltration experiments are not statistically significant, they can give a hint on the order of magnitude of generated overland flow.

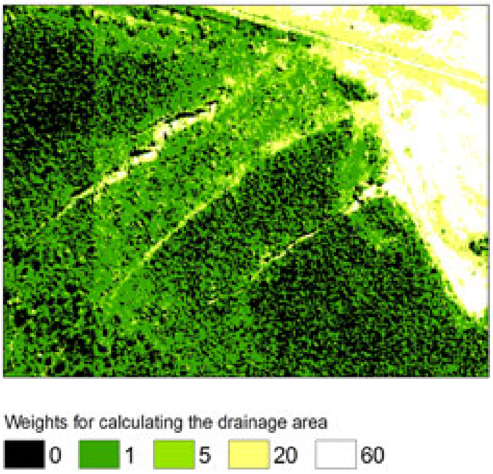

*Figure 1: Weights for the calculation of the drainage area **A** in eq. 1 generated using a maximum likelyhood classifier on a RGB Ikonos Image. Class descriptions are given in the text. For scale see fig. 3.*

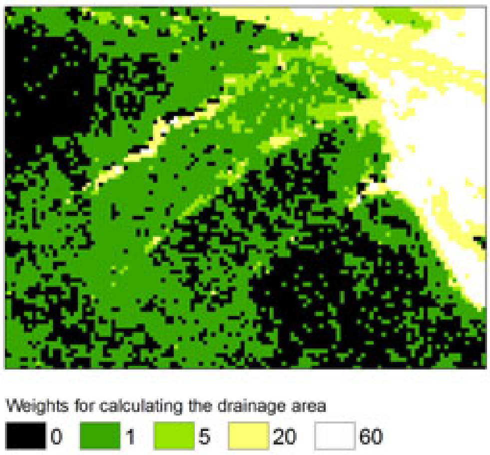

Figure 2: Classified image from Figure 1 after resampling using a majority rule. For scale see fig. 3

We chose the following weight for each land use class, indicating the amount of infiltration excess overland flow generated during a heavy rainfall with an intensity of 70 mm/h:

- Class 1: high vegetation (cerrado / eucalptytus): generated overland flow = 0 (complete infiltration)
- Class 2: dense low vegetation (mainly grassland): generated overland flow = 1 mm/h (infiltration rate in the same order of magnitude as the precipitation). This would be the default value if no weights were used for calculating the drainage area.
- Class 3: sparse low vegetation (degraded grassland): generated overland flow = 5 mm/h (slightly reduced infiltration rate due to crusting or compaction)
- Class 4: bare soil / compacted areas (often combined with class 5): generated overland flow = 20 mm/h (crusted and / or compacted soil)
- Class 5: urban area / completely sealed areas: generated overland flow = 60 mm/h (some infiltration in missclassified bare soil areas)

RESULTS AND DISCUSSION

A risk map generated by the combination of weighted drainage area calculation and the coefficients from Moyersons (2003) yielded better results than the application of the gully threshold method alone. For example, the active gullies in Fig. 3 could be well predicted by our modified threshold method incorporating the land use upstream but not by the classical equation using the factors from Moeyersons (2003) only. This was the case for many gullies associated with urban features in the study area.

While the method indicated most of the existent gullies in the area correctly, many times a gully hazard was indicated where no gully could be found. For this observation, mainly two causes could be distinguished:

- Gullies predicted in urbanized areas: in urbanized areas, gullies are often removed by canalizing the stream and filling the eroded valley. Once the urban infrastructure is fully installed, new gullies rarely develope due to the protection of the surface by pavement. This problem is adressed by adding an erodibility factor that classifies areas according to their vulnerability with respect to gully incision given a certain erosion force by overland flow.

- Gullies predicted along existent stable rivers: in this case, the drainage area is very large and thus generates an erosion hazard even for low slopes. A solution could be here to set a lower slope threshold, below which no gully risk will be indicated. Another possibility could be to use a higher coefficient **b** for equation 1. This would have the effect that slope is given more relevance for gully risk prediction compared to drainage area.

It can be argued that the weights chosen for the calculation of generated infiltration excess overland flow are only a crude estimate of the real situation. This can be improved by more on site infiltration experiments and more model runs using different values to optimize the method until the gullies in the study area are all well predicted.

As can be observed in Fig. 3, risk areas generated by our method area always grouped along a thin line of only one cell width. This is due to the algorithm implemented in ArcGIS that was used to calculate the drainage area. Nevertheless, the exact location of such a line is highly dependent on the local geometry and thus very sensitive to interpolation errors of the DEM. A solution to this problem could be to add a slight random noise layer to the DEM and recalculate the flow accumulation (=drainage area) around 100 to 1000 times as suggested by Burrough et al. (2000) to get an average distribution of the risk area. Refraining from this computing intensive option, one has to bear in mind while interpreting the linear risk areas that their exact location is uncertain and may vary considerably to the right or left, depending on local terrain irregularities.

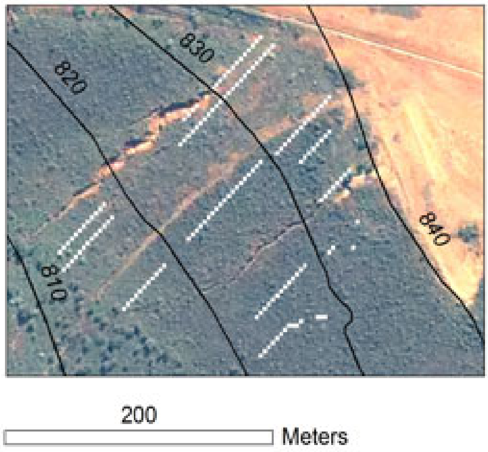

Figure 3: Topography and risk assessment of a gullied slope. The white lines indicate areas beyond the critical slope S_c *according to eq. 1 with* a *= 0,3* b *= 0,6 and* A *calculated using the weights fig. 2.*

CONCLUSION

Although our method for gully prediction seems very simple and is based on very rough estimates, it could improve the threshold method in cases where a regression on the coefficients **a** and **b** of eq. 1 is not possible or suitable. Instead of reflecting the properties of the study area (climate, geology, soil, land use) purely by adjustment of these two regression coefficients, we took the coefficients from a study area that was similar in three factors (climate, geology and soil) and incorporated the important factor land use directly and with a high spatial resolution into the equation. Even though important processes such as piping, interflow and saturation excess overland flow were not accounted for, we were able to reach a fairly good prediction of existent gullies in the study area. This result can be used for assessing the gully risk of future land use scenarios for a sustainable urbanisation of the region.

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EFFECTS OF ACIDIFICATION ON FOREST SOILS IN NORTH-EASTERN BAVARIA

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KEY WORDS: acidification, acid neutralization capacity, pH, sulfate.

Abstract

The effects of acidification were monitored at many sites all over Europe and measures to reduce SO_2 emission were successfully taken. But, despite the strong reduction of SO_2 emissions, the total acidic deposition still exceeds the “Critical Loads” at various sites. The north-eastern part of Bavaria is mostly very sensitive for acidic inputs. Therefore a thorough investigation of the current state of these soils was performed to obtain detailed information.

Besides water extracts, cation exchange capacities, base saturations and sulfate pools we also determined the acid neutralization capacity or buffering capacity of these soils. This enabled us also to gather information about the potential release of nutrients and heavy metals.

The acid neutralization capacities were very low in the organic layer and the topsoils, with a clear increase in the subsoil and bedrock. At many sites the base saturation was below 15% throughout the whole mineral soil profile indicating the severity of the acidification in this region. We could further observe that in the subsoils a large amount of sulfate is stored, which could be released in the upcoming years.

These results demonstrate that the ongoing exceedance of the “Critical Loads” by acidic depositions is not acceptable. The main focus should be laid on a decrease of NO_x deposition, but besides this also appropriate land use strategies need to be developed for sensitive and stressed areas.

Introduction

Deposition of acidifying compounds like SO_2 and NO_x caused acidification of soils all over Europe. The effects were monitored at many sites and measures to reduce SO_2 emission were successfully taken.

Despite the strong reduction of SO_2 emissions, the total acidic deposition still exceeds the “Critical Loads” at many sites. In the north-eastern part of Bavaria a large fraction of the soils is located over acidic bedrock. Therefore these soils are especially sensitive to further acidification. To assess the recent state of these soils the Bavarian Environment Agency determined in an EU-funded project, in cooperation with the Czech Republic, buffer capacities and sulfate pools of forest soils along the Bavarian-Czech border region. Soils of the mountainous region were heavily affected by deposition of acidifying compounds emitted by e.g. brown coal combustion around the 1980’ies.

The mountainous range in the border region serves as a topographical barrier. So the spruce forest in that region filtered out contaminants throughout all these years.

The surface and seepage water there still has elevated concentrations of pollutants, as found in previous investigations (Durca and Schulze, 1992). This can be attributed to the fact that many soils in that area have pH values of 4 and below. This causes damage to forests and impairs the quality of ground- and surface waters.

To provide the maximum efficiency of protection measures the Bavarian Environment Agency performed this study to assess the current state of these soils and to deduce the best protection strategies.

Methods

The acid neutralization capacity was determined for 519 soil samples of 91 sites in north-eastern Bavaria. Additionally, the acid induced release of nutrients and heavy metals was measured. This was done by pHstat analysis, where the sample pH is constantly kept at pH 3 for 24 h by adding minute quantities of HCl. We had to choose pH 3 as a quite large fraction of the samples already had pH values below 4.

Furthermore, a water extraction (1:10) was carried out to measure the water extractable fraction of nutrients and heavy metals. This served as a basis for comparison with the extracted fractions of the pHstat analysis, where the release in case of a pH decline to pH 3 was determined.

Additionally the water soluble and total pool of sulfate was measured. The total pool of sulfate was measured with NH_4F extraction and served as a basis for the calculation of the potential release of sulfate from the soil.

Besides these parameters we further determined the cation exchange capacity and the base saturation of the samples with an NH_4Cl extract.

To gain a coherent view of the situation in situ we also measured the oxalate and dithionate extractable metals. These results and the calculated “Critical Loads” for acidic deposition will be presented elsewhere.

The data was aggregated for each site for the organic layer, topsoil, subsoil and bedrock to enable regionalization and comparison between sites.

The regionalization of the parameters was done by kriging except for the acid neutralization capacity, because of the strong relation to the underlying bedrock. There we applied a substrate-related multiple linear regression with available parameters.

Results

In the mountain range in the eastern part of the investigated region nearly all profiles had base saturations below 15% or even below 5% up to a depth of 1m or more. This is a strong indicator that the acidification front had progressed deep into the soils.

The effects of acidification also became evident in the acid neutralization capacities. In the organic layer and the topsoil the remaining acid neutralization capacities (0.5-2.0 keq ha^{-1} cm^{-1}; Fig. 1, top) were much smaller than in the subsoil (3-10 keq ha^{-1} cm^{-1}; Fig. 1, bottom) and the underlying bedrock (5-50 keq ha^{-1} cm^{-1}). This demonstrates that especially the organic layer and the underlying topsoil are most sensitive to further acidic inputs. Furthermore, the basin areas had mostly larger acid neutralization capacities in comparison to mountainous regions close to the Czech border, which might have received a larger acidic deposition load (Fig. 1).

This larger deposition was also reflected in the stored amount of total sulfate, especially in the subsoil. We calculated the potential for additional sulfate release by subtracting the amount of water soluble sulfate from the total pool determined by NH_4F. For the topsoil we could only observe a slight increase of 25-50 mg SO_4 kg^{-1} with increasing values in the eastern part of up to 100 mg SO_4 kg^{-1} (Fig. 2, top). However, the total amount of sulfate in the subsoil strongly increased, especially in the mountainous regions in the eastern part. There the potential for additional suflate release ranged from 100 to over 500 mg SO_4 kg^{-1} (Fig. 2, bottom). This sulfate could be released during the next decades and may cause further acidification.

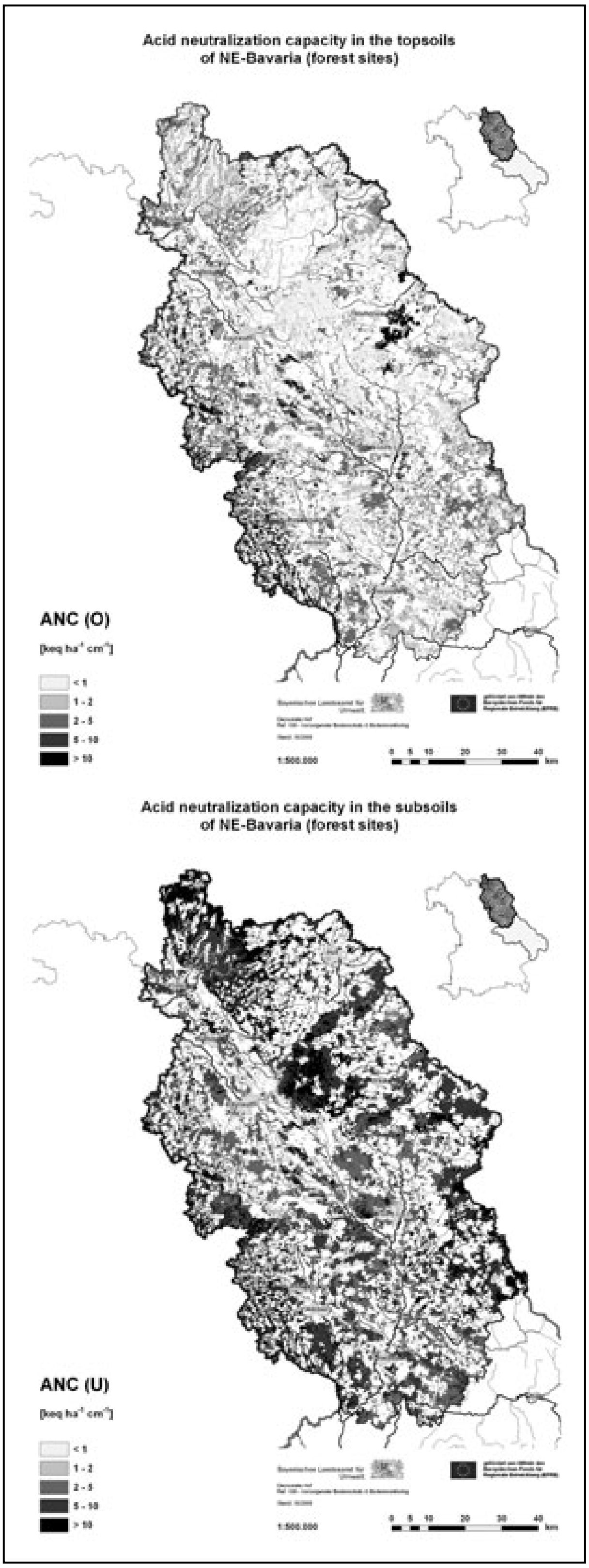

Figure 1 – Acid neutralization capacities of the topsoil (top) and the subsoil (bottom) in the investigated area in north-east Bavaria.

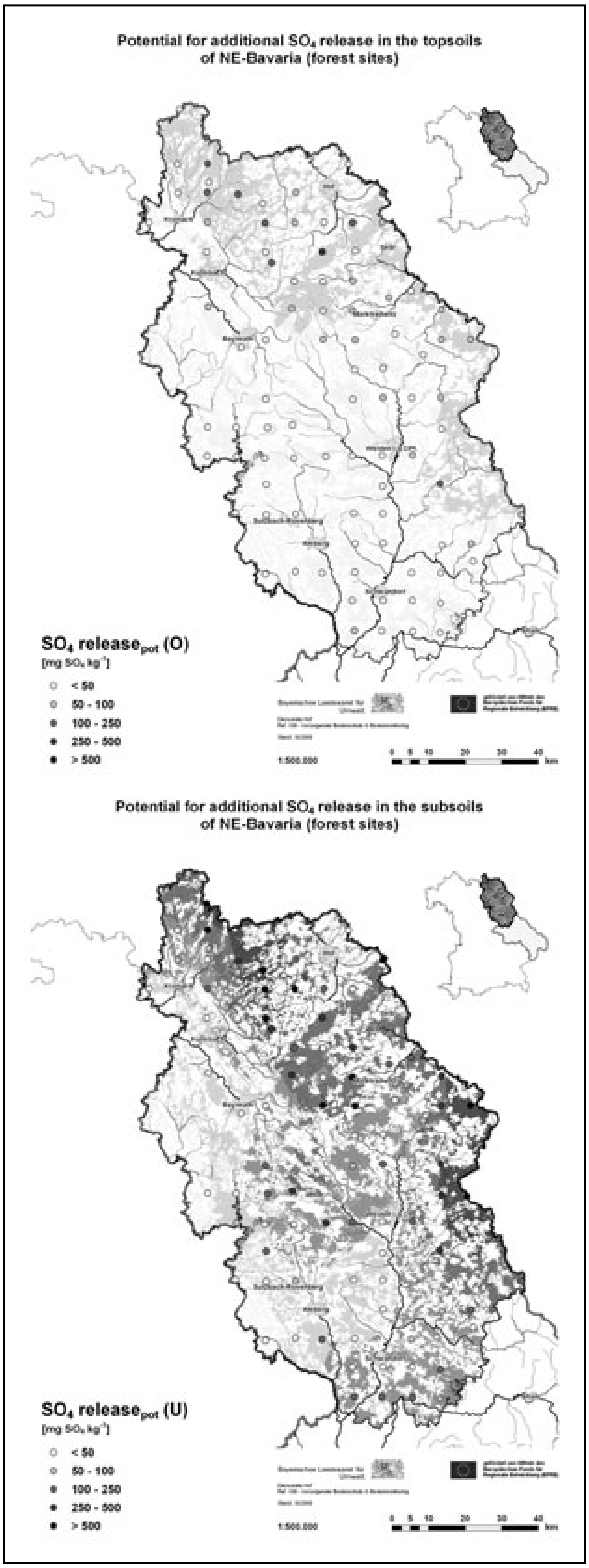

Figure 2 – Potential for additional sulfate release from the topsoil (top) and the subsoil (bottom) in the investigated area in north-east Bavaria.

The decrease in pH leads to an additional release of aluminium (Fig. 3, top). The largest Al-release was observed for soils with original pH values between 4 and 4.5. Soils with smaller pH may release less aluminium because it might have been already leached before. The fact that soils with pH values larger than 4.5 also release less aluminium seems contradictory (Fig.3, top), but only when neglecting kinetic aspects. In these soils aluminium is possibly still stronger bound to the soil matrix so that leaching would need more time than the 24 hours in the experiments.

We also observed the expected increase in heavy metal leaching. The strongest effect was observed for zinc (Fig. 3, bottom) which showed a clear increase when the pH of soils with pH 4.5 or lower were brought to pH 3. Also here we observed that soils with a larger pH did not show this effect, which probably results from kinetic aspects. On average the extracted amounts rose by a factor of 5 at most.

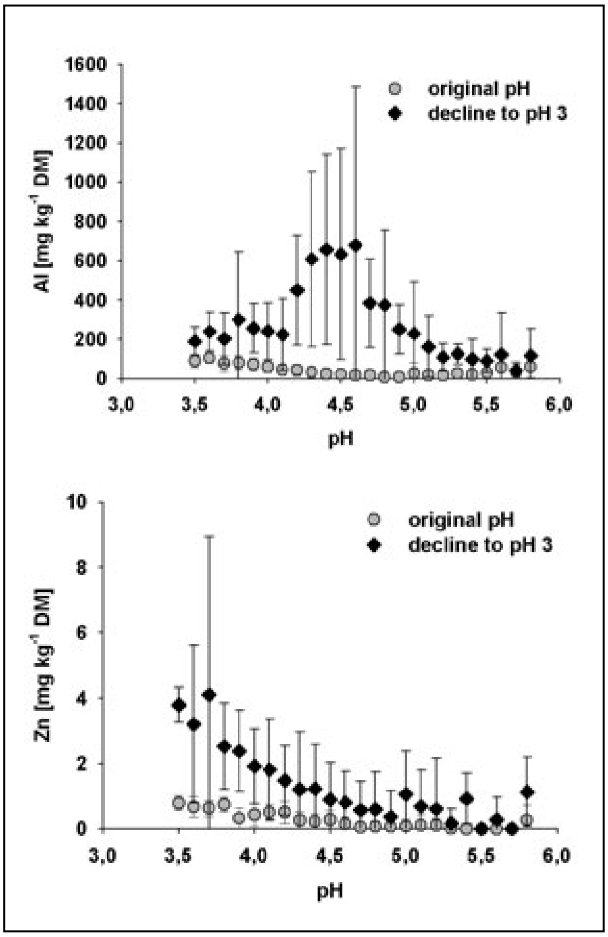

Figure 3 – Additonal release of aluminium (top) and zinc (bottom) from mineral soil in case of a pH decline down to pH 3 (medians with standard error).

Conclusions

A recovery from acidification can not be recorded for the forest soils of north-eastern Bavaria. With various measurements we have shown that the current state of these soils is still dramatic. Further efforts need to be made to protect these environments. A first step would be to reduce NO_x emissions analogue to the reduction of SO_2. In parallel suitable land use strategies need to be employed to areas which soils are highly sensitive for further acidic inputs to minimize negative effects for the environment.

Acknowledgements

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INVESTIGATION OF SUBURBAN AREAS AS A SUPPORT FOR LAND-USE MANAGEMENT

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KEY WORDS: Soil Function, Soil Evaluation, Suburban Area, Planning Processes, Environmental Audit, Subject of Protection:

ABSTRACT

In Bavaria soil testing was focused on arable land and forest regions mainly. Provision of soil information to town councils was neglected for a long time. The Bavarian Environment Agency started a pilot project in 2008 to investigate the surroundings of 3 municipalities. The results shall help to implement aspects of soil protection into urban planning.

INTRODUCTION

Soil is one of the most important environmental mediums of an ecosystem. It comprises a large variety of functions, for instance as natural habitate and living space for human beings, animals and plants, as controlling factor of the water and nutrient cycle, as filter and buffer as well as reservoir for different materials. Furthermore it provides information about the natural and cultural history.

The most crucial impact on soils is caused by land consumption. Natural soils are destroyed by changing them into settlement areas. By this, the soil does not fulfil its functions any more or only partially. Therefore negative influences on soils, which damage their natural functions and their role as an archive for natural and cultural history should be avoided as far as possible.

Soils fulfil those functions to different extents. For example, clayey soils retain heavy metals better than sandy soils and thus prevent or decrease groundwater pollution more effectively. These different soils and their properties shall be mapped in a suitable scale. This will give the local authorities information about soils that should be preserved and spared from soil sealing and soils, which are less important to be protected.

METHODS AND IMPLEMENTATION

In the past soil protection was not taken into account in urban planning. Since the amendment of the building law was enacted in 2004 the implementation of an environmental audit by constructing a building plan was required. Since then it is regulated by law that aspects of soil protection have to be taken into account. However, to consider soil protection detailed information is necessary, which often is not available yet.

The Bavarian Environment Agency is obliged to collect and obtain information about soil protection aspects, which can be implemented in the structural planning of suburban areas (Fig. 1). This was fixed in the Bavarian Soil Protection Program, which was enacted by the Bavarian Government in 2006. It contains the following considerations:

The evaluation of soil functions in suburban areas shall be intensified, because in the suburban areas most land development projects take place.

Local authorities shall receive support for evaluating soil functions. Therefore soil evaluating maps in different scales should be provided by the Bavarian Environment Agency. This enables the incorporation of soil protection into planning processes (BAYERISCHES LANDESAMT FÜR UMWELTSCHUTZ, 2005). Furthermore, this information should be the basis for developing municipal soil protection concepts.

Figure 1 – Suburban area of the city of Hof/Saale.

For these reasons the Bavarian Environment Agency started a pilot project with 3 exemplary municipalities, where the land development plans are going to be updated in the near future. In the periphery of these municipalities the Bavarian Environment Agency is conducting a large-scale soil evaluation to incorporate soil protection aspects in planning processes.

The following municipalities were selected for this pilot project: The city of Hof in Upper Franconia, the municipalities Kümmersbruck, Upper Palatinate and Moosinning, Upper Bavaria (Fig. 2). In relevant areas of the land development plan of these municipalities the soil will be mapped in a scale of 1:10.000. With these data, soil functions like the habitate potential for natural vegetation will be evaluated and classified. These classifications will be illustrated on maps. The content of the maps is restricted to soil related aspects, which are of relevance for land development plans. The classifications will be also compared with other existing data.

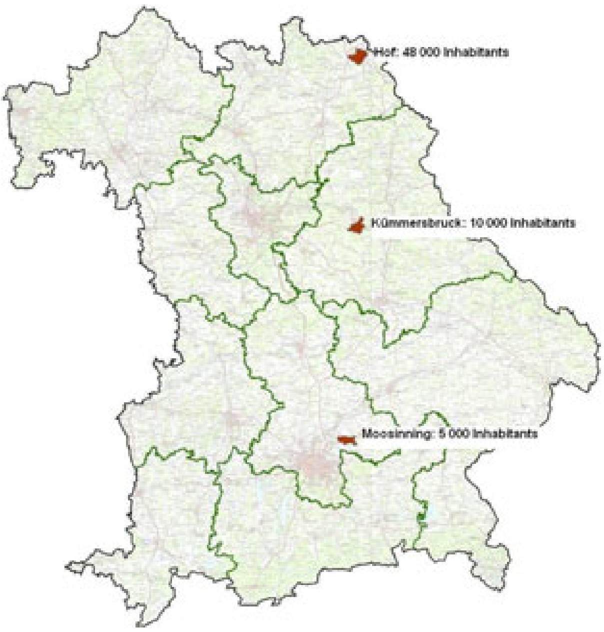

Figure 2 – Location of model municipalities.

Such data can be, for instance, geological, forest or agricultural data. This data validation shall point out whether the soil evaluation data are of sufficient accuracy to be implemented by the local authorities in the planning process.

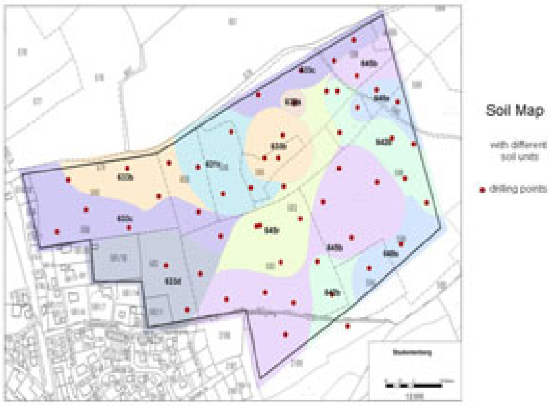

Figure 3 –Soil map with different soil units in the Northeast of Hof.

The large-scale soil survey was started around the city of Hof in summer 2008. The municipal planning office provided the areas around Hof which were affected by the land development plan.

In those selected areas the Bavarian Environment Agency surveyed the soil down to a depth of 1 m on a 100 x 100 m grid to document the current situation. The soil units in the resulting map were determined by considering the soil type, the substrate and the parent material (Fig. 3). To each soil unit a model profile with analytical data was assigned. Model profiles were created using data from the Bavarian Soil Information System and should represent typical properties of soils. These data are the base for the evaluation of the soil functions of a soil unit (BAYERISCHES GEOLOGISCHES LANDESAMT UND BAYERISCHES LANDESAMT FÜR UMWELTSCHUTZ, 2003). Figure 4, for example, shows the partial soil function "retention capacity of heavy metals". The map provides spatial information about areas of high or low adsorption of heavy metals. The evaluation of the different partial soil functions will be summed up to an overall evaluation. The overall evaluation shall inform the planning institutions about the requirements of soil protection in a comprehensible and applicable way.

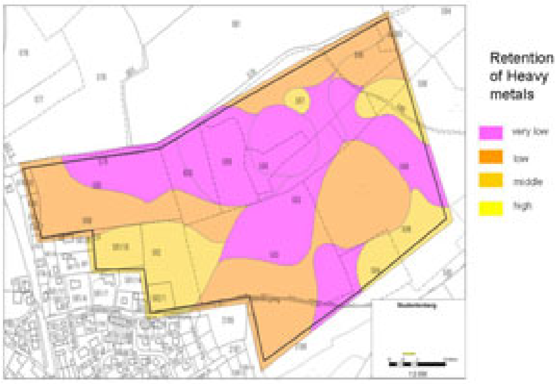

Figure 4 – Evaluation of the retention capacity for heavy metals (partial soil function) in the North-east of Hof.

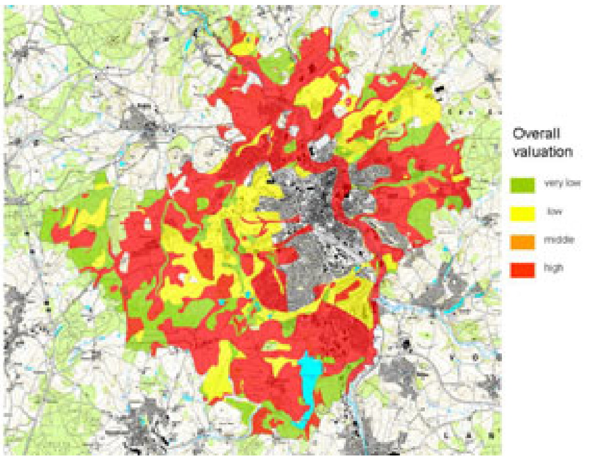

Figure 5 – Overall evaluation of different soil functions in the surroundings of the city of Hof.

FIRST RESULTS

The first results were presented to officials of the city of Hof. They were very interested in the different maps, which showed partial soil functions. The maps provide good supple-mental information for the spatial planning of a medium-sized city. Nevertheless, the officials prefer one map which contains only those crucial partial soil functions which need to be considered in land use planning. Figure 6 shows a first draft of such a map. It contains the distribution of very important soil functions which need to be protected ("Hot Spots of Soil functions").

PERSPECTIVE

The large-scale soil evaluations are integrated in the new land use plan of the city of Hof. During 2009 the peripheries of the municipalities Moosinning and Kümmersbruck will be surveyed. The soil maps will be compared with geoscientific, forest and agricultural data and maps. Products of mapping, evaluation and comparison will be different soil evaluation maps. Besides this, a recommendation note, which contains information about implementing soil protection aspects in land use planning, is intended. For the same objective, workshops will be held for planning agencies and authorities.

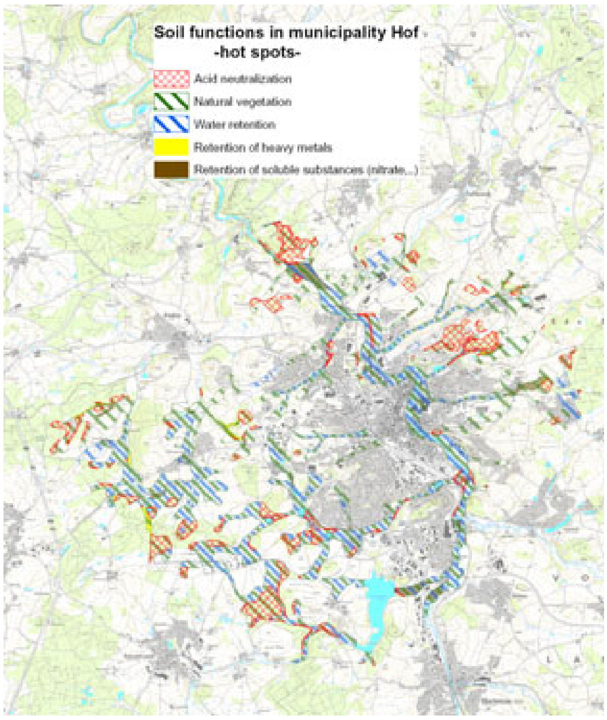

Figure 6 – "Hot Spots" of different soil functions in the surroundings of the city of Hof.

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RAINFALL EROSIVITY INDEX ESTIMATION IN THE HIGH ATLAS RANGE AND HAOUZ PLAIN (MOROCCO)

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KEY WORDS: erosivity; regional relationships; isoerodent map; Morroco ten words as a maximum.

INTRODUCTION

One of the most commonly used models to study water soil erosion is the Revised Universal Soil Loss Equation (RUSLE, Renard et al. 1997; Foster 2004), an empirically based model based on the Universal Soil Loss Equation (USLE, Wischmeier and Smith 1978). It is designed to predict long-term average annual soil loss from field slopes under a specific land use and management system, based on the product of rainfall erosivity (R), soil erodibility (K), slope length and steepness (LS), surface cover and management (C) and support conservation practices (P).

Our objective in this study was to develop relationships between rainfall amount and the R factor in a Mediterranean environment (High Atlas of Marrakech and Haouz Plain, Morocco) using high temporal resolution data, as a first step in the application of a soil erosion model using the RUSLE methodology. This region is representative of other areas in this type of environment in terms of high spatial variability of rainfall, complex and steep topography, and limited availability of pluviographic data.

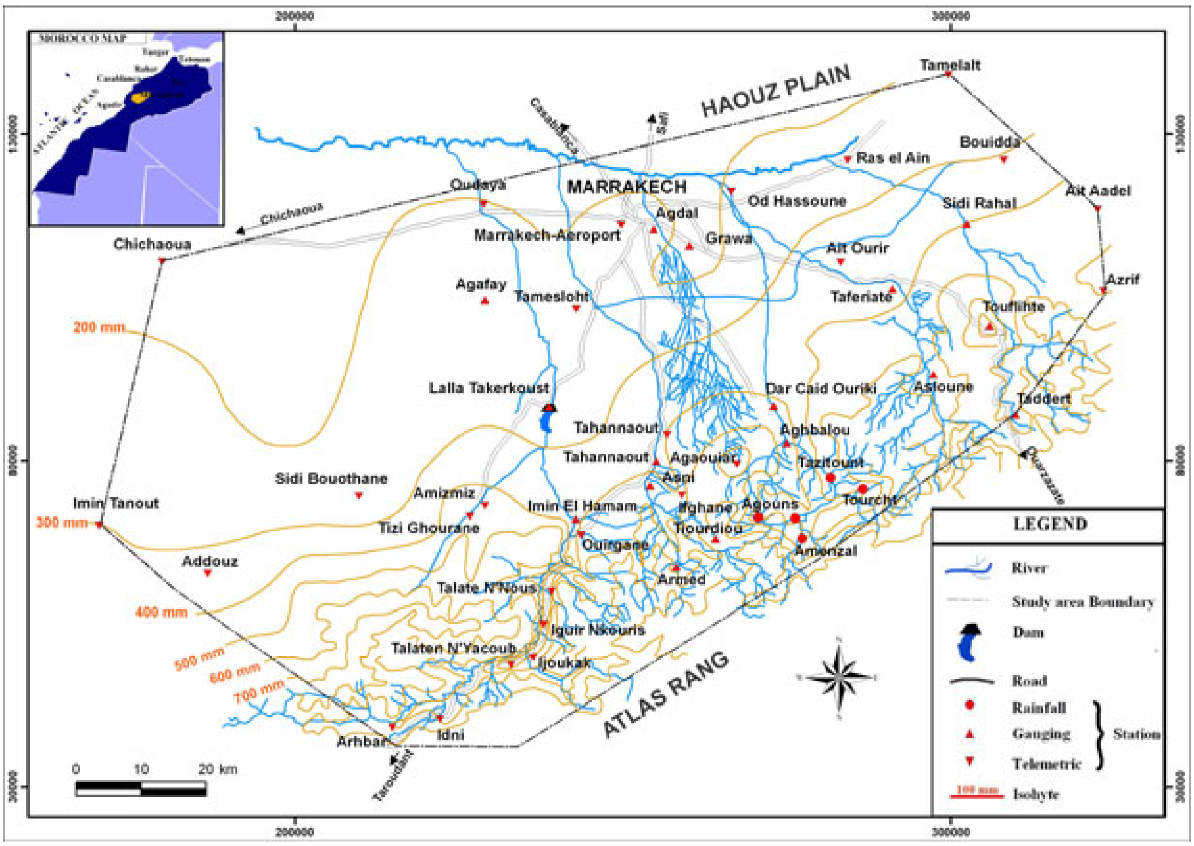

Figure 1 – Mean annual rainfall and the location of the 47 stations.

STUDY AREA

The study area is located in the northern slopes of the high mountain range called the "High Atlas" extending to the plain region called the "Haouz Plain". The study area covers 3500 km^2 of the left bank of the Tensift river including river basins of six tributaries, the R'dat, Zat, Ourika, Issil, Rheraya and N'fis rivers as shown in the study area map (Fig. 1). Elevations range from 500 m to 4167 m with a relief characterized by steep slopes and poor vegetation.

DATA AND METHODOLOGY

The dataset for this study (tipping bucket recording rain gauges, automated precipitation gauges, daily, monthly and annual rainfall) consisted of data from the 47 recording rain gauge stations collected by the Tensift Hydraulical Basin Agency (ABHT, Marrakech) for the years 1924 to 2006, inclusive. The mean annual rainfall and the location of the stations are shown in Figure 1.

Fully automatic rainfall gauges were used for the first time in Morocco, as input for developing spatially distributed estimates of the R-factor. The tide gauges data are automatically measured at 10 minute intervals, stored by a data-collection platform (DCP), and transmitted by radio frequency telemetry system (RFTS) to the network of computer base stations at the ABHT.

In this study, we chose the EI30 index to calculate erosivity as it has been widely used, therefore providing the best opportunity for comparison with other locations. Individual storm EI30 values were computed following the Revised Universal Soil Loss Equation (RUSLE, Renard et al. 1997) methodology.

The energy of a rainfall event is function of the amount of rain and all the component intensities for the event. The relationship between energy and intensity was described by Brown and Foster (1987) as:

$$e_t = 0.29\,[1 - 0.72\exp(-0.05\, i_t)] \quad (1)$$

where e_t is kinetic energy in megajoules per hectare per millimetre of rainfall (Mj ha^{-1} mm^{-1}) for time interval t, and i_t is the intensity in mm h^{-1}. The equation for computing energy for a rainfall event is:

$$E = \sum_t e_t p_t \quad (2)$$

where E is the energy for an event in Mj h^{-1} and p_t is the rainfall for time interval t in mm. The EI for an event is the product of E and the maximum 30 min intensity I_{30} for the event:

$$EI = E \times I_{30} \quad (3)$$

where I_{30} is in mm h^{-1} and EI is in Mj mm ha^{-1} h^{-1}. Storm rainfall amount P is expressed in mm. Rainfall of less than 13 mm and separated from other rain periods by more than 6 h were not included in the computation of EI unless as much as 6 mm of rain falls in 15 min (Wischmeier and Smith 1978).

The general approach used to estimate R factor values for areas without data required to calculate R can be summarized as follow:

(a) R factor values are calculated by the prescribed method (Wischmeier and Smith 1978; Brown and Foster 1987) for stations with recording rain gauges;
(b) a relationship is established between the calculated R values and more readily available types of precipitation data (i.e., daily; monthly or annual totals);
(c) the relationship is extrapolated and R values estimated for stations with the associated precipitation data;
(d) isoerodents are estimated by linear interpolation.

RESULTS AND DISCUSSION

Event erosivity index

EI and P data for individual rainfall events were obtained for 13 stations in the study region (Fig. 2).

Stations	Altitude	Annual rainfall (mm)	Erosivity Index (MJ mm ha^{-1} h^{-1})	Length of record	Events size
Agafay	479	255.0	521.5	2003-2006	52
Agdal	482	244.6	317.0	2005-2006	46
Aghbalou	1,070	423.7	520.5	1982-1999	67
Agouns	2,200	352.5	881.9	2003-2006	61
Amenzal	2,230	350.8	955.3	2003-2006	58
Armed	1,950	419.9	565.7	2003-2005	87
Asni	1,200	294.7	302.8	2004-2006	59
Grawa	512	176.7	249.3	2004-2005	45
Oukaimeden	3,200	622.5	1,897.7	2004-2005	108
Sidi Rahal	660	400.1	546.9	2003-2004	56
Tazitount	1,270	486.8	1,164.0	2003-2006	46
Tiourdiou	1,850	346.5	769.7	2003-2006	53
Tourcht	1,650	392.8	543.0	2002-2006	51

Figure 2 – Annual rainfall and Erosivity Index obtained for the locations studied.

Only the Aghbalou station includes a wide range of mean annual precipitation and intensities. The other locations have less than six years of registration, but the length of record is considered to be sufficient to characterize the relationship between P and EI. The linear regression of P and EI obtained shows a correlation coefficient of r^2= 0.69 (Fig. 3).

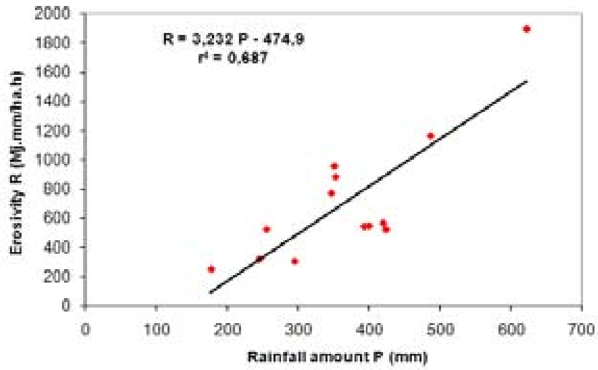

Figure 3 – Regression curves relating annual rainfall and erosivity for 13 stations.

Daily erosivity index

A data set of 12 rain gauge stations was used to estimate EI_{30} through daily rainfall data (Fig. 2).

The daily data from 8 pluviometric stations was used to calculate the EI30 index with this model. The results obtained are shown in Figure 4.

Regional rainfall vs. erosivity relationships

To obtain the R factor for all the stations chosen for this study, rainfall-erosivity relationships (Fig. 5) were determined by a regression analysis of the Fournier Index (F) and annual rainfall data from the stations used to calculate EI_{30} by the prescribed method. It was found necessary to separate the data into three groups as per the oroclimatic zone location of each station, in order to get better correlation coefficients.

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Stations	**Altitude**	**Annual rainfall (mm)**	**Erosivity Index MJ mm ha^{-1} h^{-1}**	**Length of record**
Asloune	1,155	478.0	740.6	1964-1997
Dar Caid Ouriki	900	467.7	619.9	1964-1997
Imin El Hamam	770	371.1	473.1	1969-1999
Lalla Takerkoust	636	251.2	303.7	1963-2005
Taddert du Rdat	1,650	442.6	550.6	1974-1996
Taferiate	760	372.1	575.6	1981-2005
Tahannaout 7512	925	393.1	475.5	1964-2005
Toufliht	1,465	717.3	1,314.6	1970-1997

Figure 4– Annual Rainfall and Erosivity Index obtained for the pluviographic stations studied

	Oro-climatic Stations	**Relationship**	**r^2**	**e**	**n**
1	Agafay, Agdal, Dar Caid Ouriki, Grawa, Imin ELHamam, Lalla Takerkoust, Sidi Rahal, Taferiat	(a) R = 1.235 P+ 59 (b) R = 4.918 F+ 114.65	0.75 0.64	136 220	8
2	Aghbalou, Asloune, Asni, Taddert (Rdat), Tahannaout (7512), Toufliht	(a) R = 2.483 P - 487 (b) R = 8.318 F - 170.71	0.99 0.96	276 375	6
3	Agouns, Amenzal, Armed, Oukaimeden, Tazitount, Tiourdiou, Tourcht	(a) R = 3.851 P - 666.2 (b) R = 20.85 F - 511.3	0.70 0.82	428 562	7
4	All stations	(a) $R = 0.3064\ P^{1.2783}$ (b) $R = 10.939\ F^{0.9315}$	0.65 0.40	321 410	21

r^2 = Coefficient of linear regression; n = Number of observations; e = Standard error of estimate,
R = Average annual rainfall erosivity (MJ mm ha^{-1} h^{-1}); P = Annual rainfall amount (mm); F = Fournier Index,
1 = Plain and piedmont region; 2 = Subatlasic region; 3 = High mountain region.

Figure 5– Regression equations relating annual rainfall or Fournier Index with erosivity

The correlation obtained at all stations is 0.65 using the annual rainfall amount and 0.40 using the Fournier Index. The highest correlation was found in region 2 (subatlasic area) with values of 0.98 (0.96 with F). However, the region 1 (plain and piedmont area) showed a correlation value of 0.75 (0.64 with F) and region 3 (High-mountains) a correlation value of 0.70 (0.82 with F). The high correlation in region 2, exposed to oceanic effects (rainy area), is explained by the homogeneity in topography and climatic parameters, whereas poorer the correlation obtained in high-mountain regions could be explained by the orographic contrast with high peaks and deep valleys and also by the long snow period. In region 1, the correlation is lower than in region 2 due to the integration of two different orographic areas (plain and piedmont) but still significant. The regression equations obtained (shown in Fig. 5) was applied to the rainfall map of the study area using GIS interpolation tools, thus producing the erosivity map (isoerodent map).

Isoerodent map

After application of these specific equations (Fig. 5) on the data sets according to the geographic locations of the rainfall stations, the erosivity data in the 47 stations chosen in this study were interpolated to generate the first version of the erosivity map in this region and in Morocco using high-resolution data (Fig. 6).

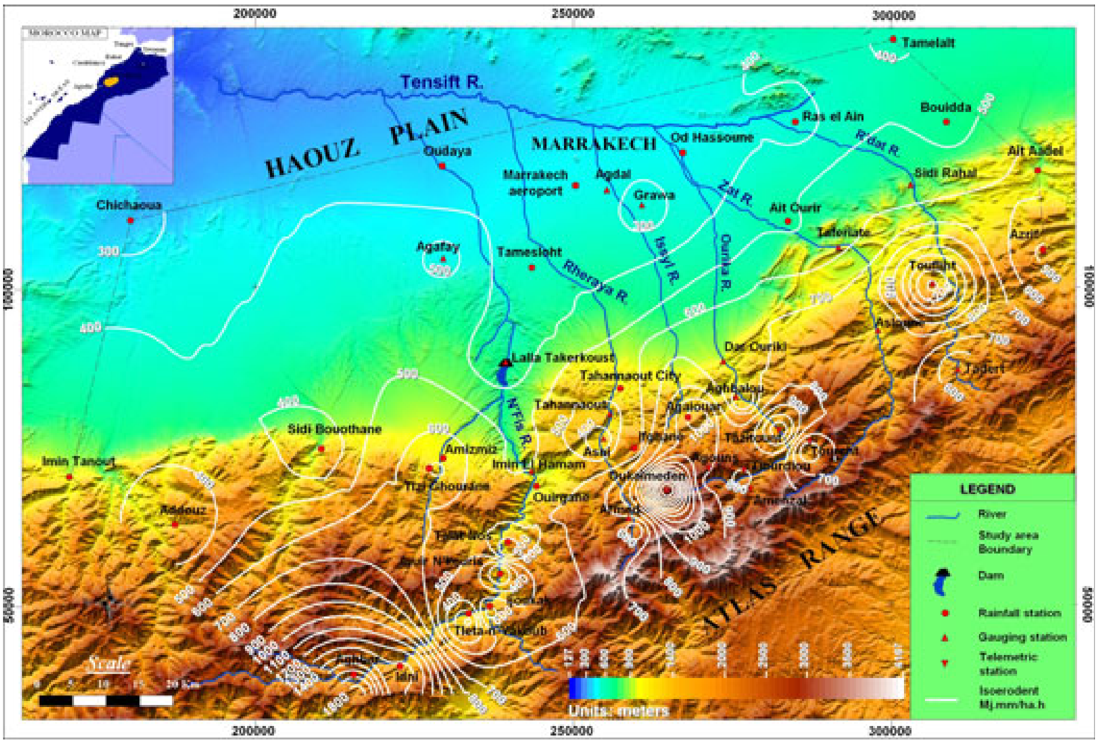

Figure 6– Rainfall erosivity map for the study region

In this semi-arid area, the annual rainfall erosivity map shows a range of 186 to 1,898 MJ mm ha^{-1} h^{-1} with an annual pluviometric values ranging from 177 to 717 mm year- 1. The region with the lowest values of erosivity is represented by the northern region (Haouz Plain), while the highest values are found in the southern region (the Atlas range). Many variations of erosivity inside the mountainous area related to the orographic context can be determined from the map. Regression analyses between the pluviometric and annual erosivity showed a correlation coefficient of r^2 = 0.70 (Fig. 7) and suggest that for this region, the geographic distribution of the annual erosivity is closely related to annual pluviometric values (annual precipitation depth).

SUMMARY AND CONCLUSION

The use of the Richardson al. (1983) method to calculate rainfall erosivity using hourly and daily precipitation data provides good results in our study area. The correlation coefficient obtained between observed and calculated EI_{30} was high (r>0.96). This step was required to derive regional

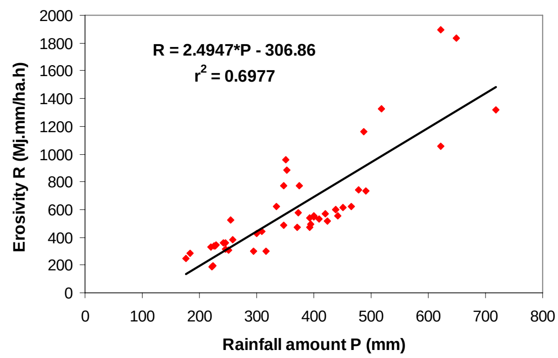

Figure 7– Regression curves relating annual rainfall and erosivity in the 47 stations studied

relationships for estimating the erosivity index from more readily available types of rainfall data (monthly and annual data). The result showed a correlation coefficient ranging from 0.65 to 0.98.

This can be helpful in the application of erosion prediction technology, such as the USLE or RUSLE, in areas where extensive breakpoint precipitation data are unavailable.

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EFFECTS OF FLOODING EVENTS ON YIELD AND SOILS OF AGRICULTURAL AREAS

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KEY WORDS: flooding, yield loss, flood retention reservoir, risk management, EPIC-Model.

Introduction

Again and again flooding events led to big damages in agriculture. Especially in flood retention reservoirs and polder, where the danger of flooding is rather high, an adapted land use is very important.
Therefore knowledge about the behaviour of plants and soils during flooding events is essential to avoid or reduce financial penalties for farmers.
Up to now there is a lack of investigations about effects of flooding on agricultural areas in use in Germany.
Therefore, the research project RIMAX (Risk Management of Extreme Flooding Events) aimed to characterize the effects of flooding on yield and soils of agricultural areas in a flood retention reservoir. These results should provide an instrument for the sustainable management of affected areas.

Materials and Methods

For the flood retention reservoir Winterbach in the catchment area of the river Rems, 50 km east of Stuttgart, a soil and land use map at 1: 5000 scale were generated. Within an area of 62 ha, more than 150 drillings have been carried out for the soil map. Important parameters like soil texture, pH, carbonate and humus content have been determined in the field. With this information, soil units have been defined and for each unit a soil profile has been built. Each layer of these profiles was sampled and analyzed in the laboratory. For the land use map the crops of 2006 of every field were determined, recorded and processed in order to create a soil map in GIS.

To quantify yield losses due to flooding two outdoor experiments with partly and completely flooded crops were performed. With this purpose in commercial pots of a diameter of 30 cm a drainage system has been implemented and the pots were filled with the native soil of the retention area (fig. 1). After that they were buried in an area on the university of Hohenheim.

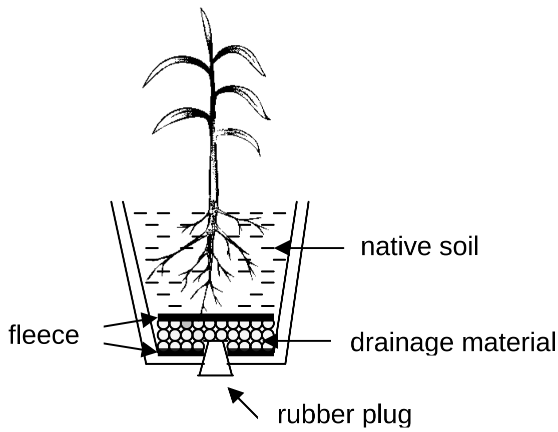

Figure1 - experimental setup

For the first experiment in spring 2007 oat plants for the partial flooding were seeded in the pots. The pots were inundated for 3, 7, 11 and 15 days in June and July. Depending on consumption the required water was added, so that at every time there was absence of oxygen for the roots. While flooding the holes on the bottom of the pots were closed with conical rubber plugs. For the treatments respectively three replications for the 4 durations were implemented and three pots as standard without flooding.
For the second experiment in winter 2007 winter wheat plants for the complete flooding treatment were seeded
Winter wheat was flooded for 1, 3 and 7 days in February, April and shortly before harvest in August by inundating the pots in big tanks filled with water.
During both treatments, the same fertilization program used by the local farmers was applied. While inundating, temperature, pH, oxygen of the water and redox potential of the soils were measured.
At harvest all parts of the plants were collected and oven dried for 48 h at 65 °C using labelled, perforated plastic bags. Kernels were dehusked, counted and weighted. With this results the yield per ha was calculated by extrapolating the area of the pots. The roots and shoots were also weighted

to quantify the aboveground and underground biomass.

Additionally to the field experiments simulations with the crop growth model EPIC were carried out. EPIC is a widespread, open source model to simulate crop growth. It was developed on the early 90's in Texas with a resolution of days and informations of more than 150 crops (Williams et al. 1990). Soil, weather and management data are minimum input parameter.

The flooding was simulated by adding irrigation volume and at the same time reducing the field capacity of the soil down to the minimum. Then, the exact flood height, like simulated by the hydrologists in the project, could be added. For every crop and every soil group of the retention area the simulation was performed and yield losses for the farmers were calculated. By using the analyzed soil parameters, plant data and field results model could be calibrated and validated.

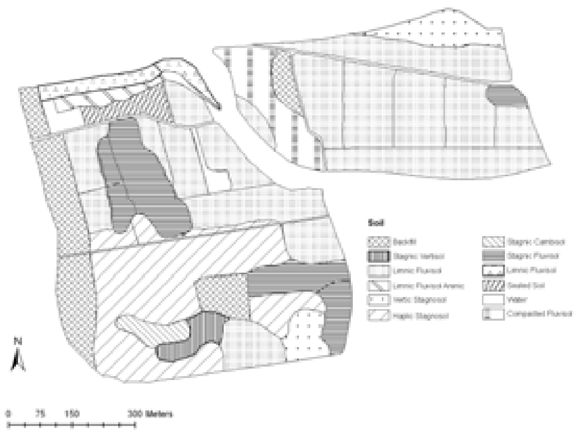

Figure 2 – Soil distribution in the retention area

Results and Discussion

1. Field

In the retention reservoir two soil groups are dominating: Stagnosols and Fluvisols.

The Stagnosols, developed out of slope material, are dominating in the southern part of the reservoir, whereas the fluvisols spread on both sides of the river. Beside these two main groups there are various sub groups (fig. 2)

The Stagnosols,strongly affected by water logging due to the high clay content, showed distinctive redoximorphic characteristics and are therefore restricted areas for agricultural use. On the other hand the Fluvisols are part of the most productive soils in Germany. During flooding events they received permanently sediment material rich in nutrients from higher parts of the catchment area.

Noticeable are the areas of disturbed soils that result from taking soil away for the dyke construction.

Regarding land use, there is a distinctive border between the arable land and the grassland. Whereas the arable land restricts especially on the Fluvisols that are more affected by flooding, grassland appears on Stagnosols on the border and higher parts of the reservoir. 76% of the whole area of the retention reservoir is under agricultural use. Here, extensive grassland with 42,5% takes the biggest part followed by oat with 12,7% and winter wheat with 12%.

2. Outdoor experiment

Results of field experiments and previous simulations showed that yield loss depends on a combination of factors. The most important are the affected culture, the duration(days), height(cm), and seasonality of flooding.

In autumn and winter plants are most resistant against flooding(SLfL 2005). At partly flooded crops in spring and summer like wheat, maize, and oat, yield loss fluctuates between 10% before the corn filling phase and 25% after the time of corn filling (fig. 3).

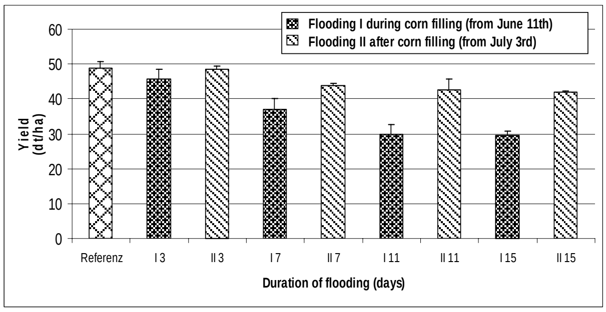

Figure 3 – Yield of partly flooded Oat

When the time of lack of O_2 in the root zone exceeds 2 weeks, yield loss reached up to 50%. For farmers this means a total loss, because the performed costs in combination with the follow up costs of harvest and drying exceed the revenues by yield.

During a total inundation, additionally to the lack of O_2 for the roots there is a lack of CO_2 for the shoots and therefore the damages are correspondingly higher – especially after the development of the grains. Investigations showed, that when complete flooding exceeds 3 days, corn cannot be used for food production by mould build-up.

3. Simulation
To get an overview of the damage of some cultures during a total inundation in relation to the time, fig. 4 shows the simulated losses by a 7 day flooding. The data in the grey cells show own and assessments of experts (SLfL 2005) because the model cannot consider the effect of rotting. Therefore, the model calculates for periods after corn filling without restrictions.

Corn	Grass	Oat	Winter Wheat	Sommer Wheat	Maize	Rape	Root crop
Yield loss in % during 7 days of flooding							
Jan.	-	-	10	-	-	10	-
Feb.	-	-	10	-	-	15	-
March	-	-	15	-	-	20	-
April	0	5	20	10	-	50	100
May	0	5	25	10	10	50	100
June	0	30	30	30	15	50	100
July	0	80	80	80	20	40	100
August	0	80	80	80	100	30	100
Sept.	0	-	-	-	100	40	100
Oct.	-	-	-	-	-	15	-
Nov.	-	-	10	-	-	15	-
Dec.	-	-	10	-	-	10	-

Figure 4 - Simulation results.

Root crops like sugar beet and potatoes are the most vulnerable crops. There is already a totally loss, when flooding exceeds 3 days. Comparing crops, differences between partly and totally flooded crops are not to big, provided that there is no influence in sediment deposition when the event takes place before the grain filling.

4. Soils
A further effect of flooding on agricultural areas is the effect on soils. Sediment deposition leads to an accumulation of particulate fixed matters in the retention reservoir. In this connection heavy metals and hard degradable organic matters play an important role. By flooding the changing redox potential influence the mobility and availability for plants of heavy metals (Du Laing et al. 2008).
During the experiments a permanent decrease of the redox potential was measured (fig. 5).

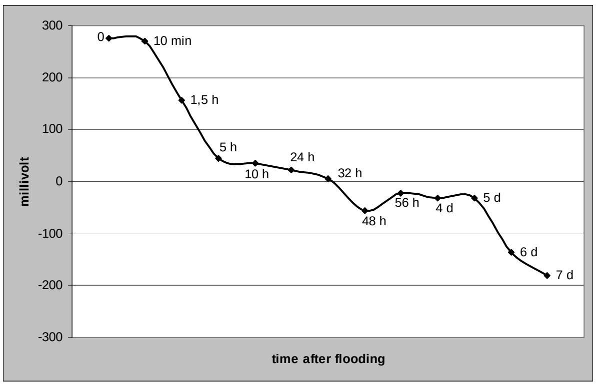

Figure 5 Redox potential in a Fluvisol during flooding

To estimate the effects of sediment depositions on soils and agriculture, the contamination of the catchment area as well as the retention area has to be determined.
To get an overview of the contamination, the results can be compared with the limits regulated by law (BBodSchV 1999).

Discussion

To develope a sustainable management concept for retention areas a lot of standpoints have to be considered.
In retention reservoirs, where the probability, that a flooding event occurs, is bigger than 5 years, and additionally the duration is short, no substantial changes in land use are advised.
In other cases there are several possibilities to reduce or avoid losses by adapted land use.
Prevention of strongly affected cultures like root crops, cultivating of more resistant corn, adjustment on renewable primary products or transforming arable land in grassland are steps to avoid economical damages. For highly affected areas land set-aside is recommended. In this case there is often a financial support from the government.

Acknowledgement

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EFFECTING OF WIND EROSION IN LAND DEGRADATION AROUND OF MIGHAN PLAYA

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Wind erosion is an intricate of desert area. This phenomenon is an executive of land degradation that is destroyed soil. This registration is studied in Arak Mighan playa with determine of moderate precipitation, moderate temperature, moderate moisture, moderate wind speed, vapor transpiration area, climate with Gosen and Amberotermic methods. Study of this area showed that this area is arid of temperature degree is very high. This area is under the Mediterania regime. The most climate factor in soil degradation is wind in this area. The control of wind erosion is effective in this time. We know reasoning of it. When we studies about salutation soil and sedimentation, it can obtained the potential of wind deflation and soil erosion. In this research was used from windy tunnel method for amount of estimate sedimentation that resulting winds erosion. We reached this result that the west- winds are the most principal and erosion in this area. In august, it imports many damages of the environmental economic resources. A mount specific sedimentation in all studies area is calculated about 1091/73 To/km2/hr or 839799(m3/km2/hr).

KEY WORDS: wind erosion, climate, IRIFR- E.A

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SOIL GEOCHEMICAL ATLAS OF CROATIA: BACKGROUNDS AND ANTHROPOGENIC IMPACT

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KEY WORDS: geochemical mapping, soil geochemistry, baseline mapping, Croatia

ABSTRACT

The Croatian geological survey commenced a national soil geochemical mapping programme performed at a density of 1 sample per 25 km^2. The comparison of concentrations and distribution maps for 27 elements in the topsoil cover revealed three distinct background geochemical landscapes which can be distinguished based on bedrock lithology: the Mediterranean, Mountain karst and Pannonian region. Approximately 5% of the sites can be considered as moderately enriched (polluted) either from mining activities or airborne deposition from diffuse and point pollution sources.

INTRODUCTION

Soil is a vulnerable geological medium, which sustains the bulk of human activities including, among others, the food production as one of the most important. In the age of increasing pollution and devastation of human environment the soil protection deserves every respect and mindfulness, particularly because of its vital importance not only to the human beings but also for the sustenance of each facet of life on this planet as a whole. In order to trace the increasing human contribution to overall contamination of the planet, particularly by the chemical elements harmful to health, it is necessary to determine the natural content of major-, minor- and trace elements in soils on the regional level. The present Geochemical Atlas of Croatia (to be printed in 2009) is a result of the first nation wide geochemical mapping research programme supported by the Ministry of Science, Education and Sports under the project of Geochemical Map of The Republic of Croatia. Geochemical research has shown a much greater natural variability among almost all elements in soil, irrespective of the soil type, when contrasted to the stream sediment (REIMANN, 1988). The soil cover in Croatia was sampled in a 5x5km uniform square grid over the whole territory of Croatia. In this way, over 2500 samples were collected and analysed for 25 elements. Using a GIS-technic, the chemical distributions of these elements have been prepared as a digital atlas. The atlas will be used by soil scientists, geochemists, environmentalists, consultants and local environmental planning authorities. The resulting database will enhance our ability to recognize and quantify changes in soil composition caused by urbanization, industrialization, agriculture, waste disposal, and other human activities. Also the data will help to develop health based soil criteria for potentially toxic elements for Croatia taking in account regional geochemical signatures.

STUDY REGION AND METHODS

The Republic of Croatia as a relatively small country (56,538 km2, and a population of 4,5 million) in south-eastern Europe is characterized by a complex geological framework, which resulted in the present distribution of mineral resources.

The territory of Croatia in a regional geological sense is subdivided into two major geological units, the carbonate (karst) terrains and the Pannonian basin. The carbonate terrains predominately consist of karstified Mesozoic and Tertiary limestones and dolomites, with less extensive occurrences of mainly Permian clastic rocks and Tertiary flysch deposits and Neogene lacustrine deposits. The Pannonian basin in the northern part of Croatia consists of predominately Neogene, Pleistocene and Holocene sediments (marl, sandstone, sand, clay and gravel) which cover a pre-Tertiary crystalline basement and mesozoic sedimentary and magmatic rocks, which form several smaller mountain ranges in northern and north eastern Croatia that crop-out through the mentioned younger deposits. Soils developed on these bedrocks are dominated by automorphic soils (56%) consisting of luvisols, cambisols (eutric, district, rhodic) leptosols, and hydromorfic soils (29%) in the Pannonian region (stagnosols, fluvisols, gleysols, hydroameliorated soils). About 14 % of Croatian territory is exposed bedrock lacking soil cover (BAŠIĆ, 2005). Due to different spatial distribution of specific climatic and soil conditions and a heterogeneous relief, Croatia contains a wide range of soils, with different degrees of fertility. As a result, Croatia has three clearly defined regions - Pannonian, Mountain and Adriatic (Fig. 1). The Pannonian region consist of three sub regions; central Croatia, Podravina and Posavina. These five natural regions are treated as statistical areas throughout the Atlas. Agriculture occupies 56.7% of the country, but the proportion of agricultural land varies from region to region (BAŠIĆ, 2005).

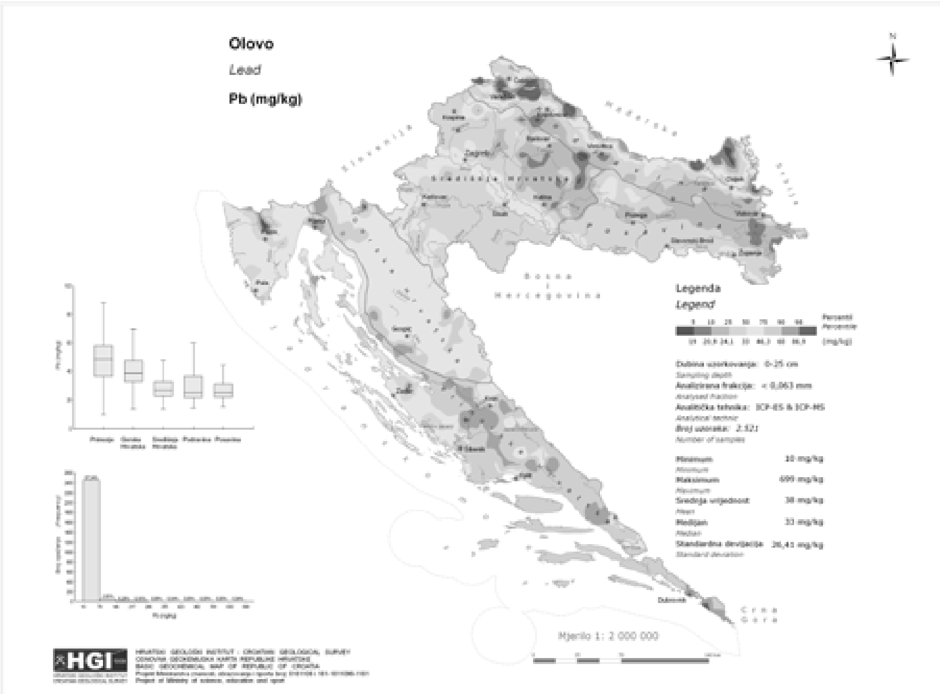

Figure 1 – Distribution of lead (Pb) in Croatia based on soil data from 2521 sampling sites (a map sheet from the Geochemical Atlas of Croatia; in press)

Soil samples were collected at a density of 1 site/25 km^2 in a regular grid with the intial point of the grid for the whole country located in Istria near the city of Rovinj. A total of 2521 sites were sampled. In the Adriatic and Mountain regions which are dominated by carbonate bedrock with developed karst phenomena (karst region) a total of 1140 samples and the rest in the other three sub-regions of the Pannonian region (Table 1).
The soil samples were taken at each sampling site from 5 shallow pits (the A_{mo}-; mollic horizon, from the depth of 0 to 20 cm) and one composite sample was prepared from each sampling site .

Analytical protocols included an extensive array of major and trace elements using ICP-AES and ICP-MS following a four-acid extraction ($HClO_4$-HNO_3-HCl-HF at 200°C) to determine total elemental content. This was supplemented by single-element determinations of Hg after aqua regia extraction, by HGAAS. The following elements were analyzed: Ag, Al, As, Au, Ba, Bi, Be, Ca, Cd, Co, Cr, Cu, Fe, Hg, La, K, Na, Nb, Ni, Mg, Mn, Mo, P, Pb, Sc, Sb, Sn, Sr, Ti, Th, U, V, W, Y, Zn, and Zr in ACME Labs in Vancouver.
Accuracy of analyses was controlled with the certified geological reference materials i.e. soils from the USGS; GXR-2, GXR 5, and SJS-1. The accuracy for most elements analyzed in reference soil materials is in the range of +/-10 % of the certified values. The precision of the analyses was determined by repeated analysis of both certified reference samples and randomly selected soil samples, the resulting coefficient of variation in average is approximately 5%. The field data and the chemical analyses are stored as a database, which besides the chemical data also contains 20 parameters that describe topographic, geologic, geomorphologic and pedologic features of the sampling sites and samples. All collected samples are preserved and stored for future use. The computer software ArcInfo- Geostatistics Analyst and Spatial analyst ver. 9.2 (ESRI - USA) was utilized to produce the geochemical single-element maps. Data used for the map generation were interpolated applying the gridding technique, and values in a regular grid were evaluated by the inverse distance method (Inverse Distance Weighting-IDW). The concentration contours running through interpolated grids were defined as the values of the 5th, 10th, 25th, 50th, 90th, and 98th percentile of the normal distribution of each element. Summary statistics, correlation analysis

and outlier identification were performed using STATISTICA v.7. on the whole chemical data set.

RESULTS AND DISCUSSION

In the secondary environments the geochemical background changes regionally with the basic geology, as is indicated by the results of geochemical mapping performed in the Panonnian and the Adriatic and Mountain (karst) regions of Croatia. The summary of statistics for Croatian soil geochemical data obtained so far during the geochemical mapping program are given in Table 1. For comparison the median concentrations of elements in European soil (SALMINEN et al., 2005) are also presented. From the summary data in Table 1., it is visible that most of the elements (Al, As, Co, Cu, Fe, La, Pb, Ni, Mn, Th, V, Cr, Zn, Zr and Nb) have higher median values in soils developed on carbonate bedrock in the Adriatic and Mountain regions with the exception of Na, K, Fe and Ba, which have higher concentrations in soils of the Pannonian region. Sr, P, Mg, and Ti manifest a similar range of contents in both regions. The non-outlier ranges show that the minor elements show the largest variability of content in soils developed on carbonate bedrock in southern Dalmatia, while the variation in north-western Croatia is far less expressed. The geochemical background is effortlessly calculable by the statistical methods regardless of the soil type or any of the natural or anthropogenic factors under consideration. The two main issues can be summarized by this work in respect to the geochemical background: 1) the greater part of all measured concentration values fall within the normal range of data whose thresholds can be determined by simple mathematical computations; 2) the soil complexity resists building a stable, symmetrical probability distributions complying to the Gaussian law, even within the calculated background limits. The soils from western Croatia have a geochemical signature with elements of a transition zone since the soils that are developed on the limestones on the Karlovac plateau are derived (as a result of aeolian transport) from material that originates from the Pannonian basin.

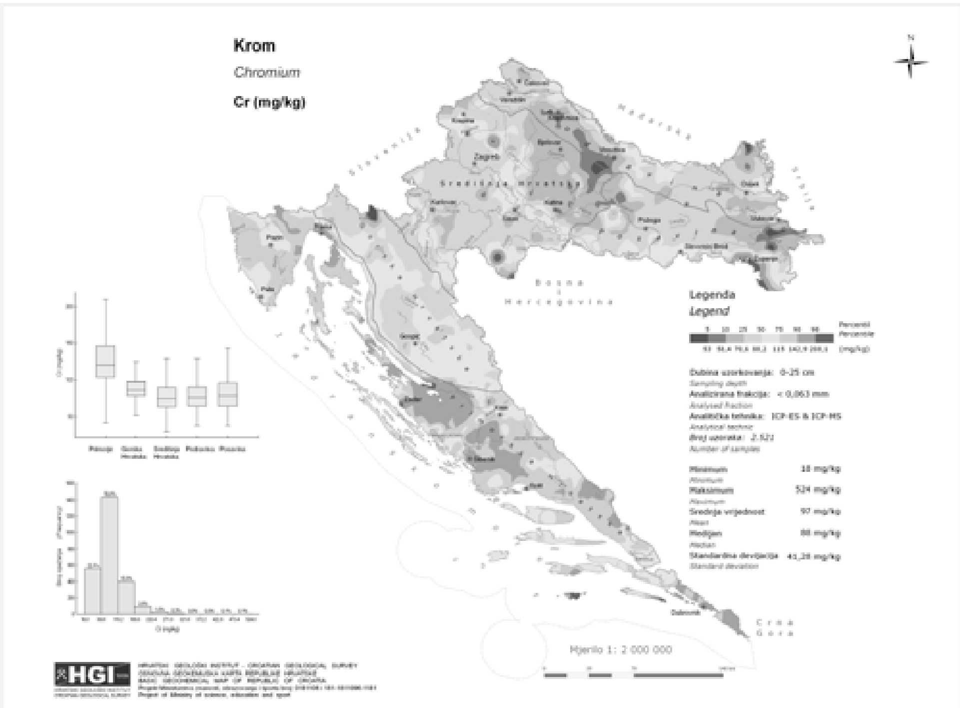

Figure 2 –Distribution of Chromium (Cr) in Croatia based on soil data from 2521 sampling sites (a map sheet from the Geochemical Atlas of Croatia; in press)

This is expressed by an intermediate variation between the other two geographically distant and geologically different regions. The relatively small variation of content of minor elements in soils of northwestern Croatia is probably due to the relatively limited area that was sampled. The major elements in all regions show a similar degree of variation. The results of geochemical baseline mapping performed in dominantly karst parts of the Croatia (Adriatic and Mountain) show that soil chemistry is influenced by different geogene sources from which the soils were derived. The results geochemical baseline mapping performed in Croatia whose soils originated on different geological substrates show that Al, As, Co, Cu, Fe, La, Pb, Ni, Mn, Th, V, Cr, and Zn have higher median values in soils developed on carbonate bedrock with the exception of Na, K, Fe and Ba, which have higher concentrations in soils of the

Pannonian part of Croatia. The distribution of Pb (Fig. 1), Zn and Cd in the Panonnian region is a consequence of secondary dispersion from mining activities (floodplain of the Drava River) and sulphide ore occurrences in the mountainous regions. The pollution effects caused by human activities (besides mining) cannot be unequivocally deduced especially in the floodplain regions that are both urbanized and that have in the past been flooded by waters that drained various mining regions.

Table 1 – Summary statistics for the analyzed elements in topsoils from Croatia and Europe.

Region	Adriatic region	Mountain region	Pannonian region			Croatia	Europe (SALMINEN et al., 2005)
sub-region			*Central Croatia*	*Posavina*	*Podravina*		
# sites	797	347	640	360	377	2521	845
element	Median						
Al (%)	7.85	7.17	6.58	6.09	6.46	6.86	11
As (mg/kg)	18	15	8.4	9	10	12	7.03
Ba (mg/kg)	297	313	395	399.5	420	365	375
Ca (%)	1.33	0.57	0.52	0.83	0.87	0.82	0.92
Cd (mg/kg)	1.1	0.6	0.2	0.2	0.2	0.4	0.145
Co (mg/kg)	18	14	11	10	10	13	7.78
Cr (mg/kg)	121.2	85.9	74	77.8	75	88.2	60
Cu (mg/kg)	35.5	24.6	19	19.6	21	25.4	13
Fe (%)	4.18	3.58	2.955	2.98	3.1	3.4	3.51
Hg (μg/kg)	64	75	50	40	35	50	37
K (%)	1.25	1.3	1.6	1.63	1.71	1.52	1.92
La (mg/kg)	52	46	37	31.1	34.6	39.9	23.5
Mg (%)	0.68	0.76	0.67	0.78	0.85	0.72	0.77
Mn (mg/kg)	1082	748	550.5	610	651	722	0.065
Na (%)	0.34	0.543	0.79	0.971	1.191	0.67	0.8
Ni (mg/kg)	74.6	52.8	33	34.9	31.2	47.5	18
P (%)	0.065	0.059	0.055	0.074	0.091	0.067	0.13
Pb (mg/kg)	48.7	39	27	25.4	25.3	33	22.6
Sc (mg/kg)	12	10	10	10	10	11	8.21
Sr (mg/kg)	86	80	102	107	125	99	89
Th (mg/kg)	16	13	12	11.6	12	12.5	7.24
Ti (mg/kg)	0.43	0.42	0.39	0.401	0.403	0.41	0.57
V (mg/kg)	148	125	96	89	88	108	60
Y (mg/kg)	28	21	14	17.6	18.7	19	21
Zn (mg/kg)	108	104	73	74	74	88	52
Zr (mg/kg)	85	65.6	38	46.3	28	49.3	230

Since the variation of geology at a regional scale influences the geochemical background considerably the definition of these values in future will be assessed when geochemical mapping at this density will be concluded for the whole country. The anthropogenic influence on top soil in high karst (Mountain) regions of western Croatia due to atmospherically introduced high Pb, Zn concentrations as a consequence high precipitation rates and long range transport of pollutants. The maps, statistical summaries and descriptions will be published in a Geochemical Atlas of Croatia in 2009 by the Croatian Geological Survey and maps will be available for viewing on www.hgi-cgs.hr.

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USE OF GAMMA RAY GROUND SPECTROMETRY FOR SOIL MAPPING IN CENTRAL ITALY

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KEY WORDS: gamma spectrometry, soil texture, soil mapping.

INTRODUCTION AND GEOLOGICAL SETTING

Nuclei of radioactive isotopes emit gamma radiation as a consequence of their transition from excited states to states of lower energy during the decay process. Each nuclear transition has a characteristic gamma emission peak that can be measured with a gamma spectrometer and can be potentially used to identify its “father” element.

The relative abundance of natural radioisotopes in the environment, like ^{40}K and the progeny of ^{238}U and ^{232}Th decay chains, strongly characterize rocks and sediments of different type and origin. Airborne and ground gamma survey have been therefore used as a source of indirect knowledge of the composition of the most superficial part earth crust (GSC, 1998).

Though gamma ray penetration depth is a function of soil density, it can be usually estimated in around 40-50cm that corresponds with the average ploughing depth of the soils used for industrial agriculture in alluvial plain in Italy.

In this work a detailed ground gamma survey, integrated by direct measurements on soil samples, has been used to characterize the texture of agricultural soils in the Rieti plain (figure 1), an Holocenic alluvial flatland of tectonic origin with an overall extension of about 80 km^2, in the mid of the Apennines chain, in central Italy (Cavinato, 1993).

The sedimentation in this area is mainly controlled by the Velino River, whose meandering course crosses the plain where receives the confluence of other two small rivers. The presence of a topographical gradient towards north originated a wide Holocenic lake that is nowadays artificially reduced to two small and shallow residual lakes confined near the north boundary (Leggio & Serva, 1991).

Centuries of agricultural use, progressive urban expansion at the south-eastern edge of the plain and marshland reclamation works, strongly influenced the sedimentation dynamics and influenced the evolution of different soil types in terms of texture, pH and organic matter content.

Today soil productivity, in terms of economic yield, is relatively low notwithstanding its undoubted growth potential. For this reason a detailed map of the agricultural soil horizon (Ap) may result very helpful to address the necessary land planning activities.

MATERIALS AND METHODS

Soil texture was measured for 289 soil sample, collected at a 0-45 cm depth, by wet sieving and sedimentation analysis.

Gamma ground survey was performed using a portable differential spectrometer Scintrex GRS-500, equipped with a NaI detector and working as a counter at different energetic windows. In particular we measured the total count above 0.08 MeV in order to record the energy from all the main radioisotopes existing in the soil. Measurements were performed by leaning the spectrometer on the floor of an off-road car which was driven at a nearly constant spread on the agricultural fields. Selected counting duration was of 10 seconds.

The portable spectrometer was associated to a GPS Garmin CSX to record the position of every measurement point. All the information collected during the survey was stored and integrated in a geodatabase to be managed in a GIS.

Gamma emission from a selection of samples was analyzed at the CNR-IGAG isotope laboratory using an intrinsic germanium detector system.

DISCUSSION

Analyses on soil samples identify a relatively wide variability of soil texture when classified accordingly to the USDA system, with particular occurrence of silty clay and silty clay loam soils (figure 2).

A traditional mapping procedure based on a mathematical interpolator, like IDW or kriging, highlights that the texture spatial distribution shows clear patterns that are mainly linked to the proximity to the basin edges, the proximity and the modification of the river courses and to the topographical gradient towards north.

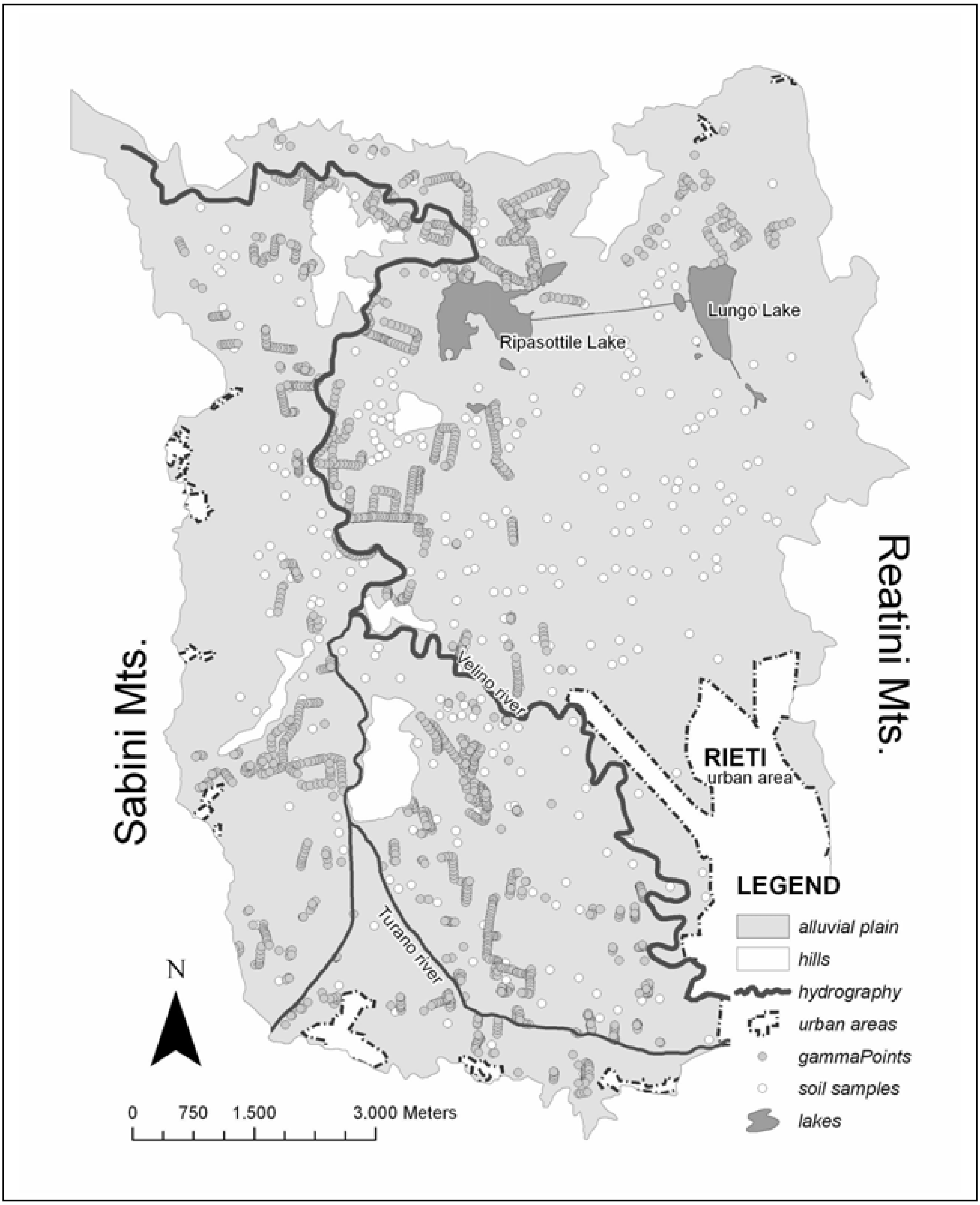

Figure 1 – The Rieti plain and the gamma ray ground survey.

This mapping approach, that is probably the best at the given sampling density, does not provide the necessary accuracy required by an operative soil map at a scale ≥ 1:25.000.

On the other side the further collection of samples from such a wide area to increase the current sampling density of 3.5 sample/km^2, require relevant effort both in terms of time and money consumption.

For these reasons we used the correlation existing between gamma radiation >80Kev emitted from the soil and the relative abundance of sand particles transported from the calcareous and marly–siliceous lithologies of the Apennine structure upstream. The interpretative key is given by the mainly calcareous nature of the sand in this area whose presence in the soil causes the diminution of gamma radiation that, on the contrary, is mainly due to the presence of radionuclides in the finest silicate fractions (clay and silt). We measured an inverse correlation between sand and gamma radiation in the lab using a soil samples subset (figure 3).

A calculated conversion factor K is used to convert laboratory into field data and to estimate sand content from a ground gamma recording.

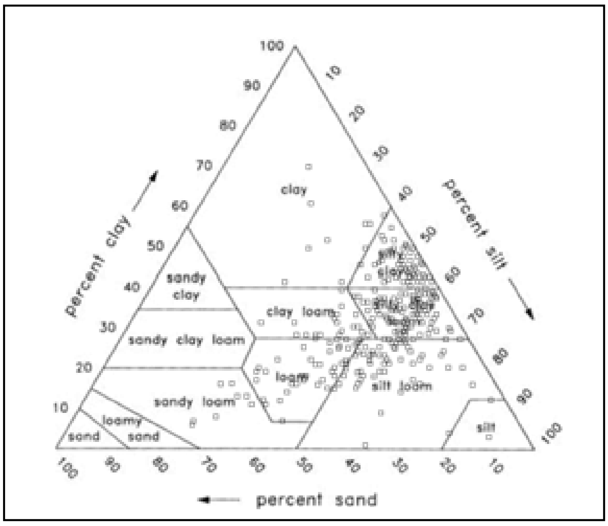

Figure 2 – Measure of soil texture accordingly to USDA triangle.

At the same time, the abundance of silt and clay inside the study area was estimated starting from their ratio. The latter has a clear spatial trend due to dependence of the sedimentation processes to the topographic gradient. Cross-validation demonstrated that usage of the combined knowledge of sand percentage and silt/clay ratio as estimated using an IDW spatial interpolator, allows to correctly classify more than 90% of the sample within the USDA classes.

Presently about 1600 measures were performed using ground gamma survey. These are mainly concentrated in the off-road car accessible part of the area, i.e. areas without cultivation at the time of the survey (figure 1). We estimate to finish this preliminary work whitin few weeks and successively pass to the second phase of spatial data homogenization, data interpretation and soil mapping.

CONCLUSIONS

Ground gamma measurement, calibrated in lab with soil samples of known texture, is a powerful tool of investigation capable to massively integrate data rising from traditional granulometric measures. The study conducted in the Rieti plain demonstrated that a basic knowledge of the sedimentation process and a relatively low soil sampling density are sufficient to productively conduct a ground gamma survey allowing to identify USDA texture classes. Gamma survey is relatively fast and cheap an allows to collect data potentially at every resolution useful to produce applicative maps.

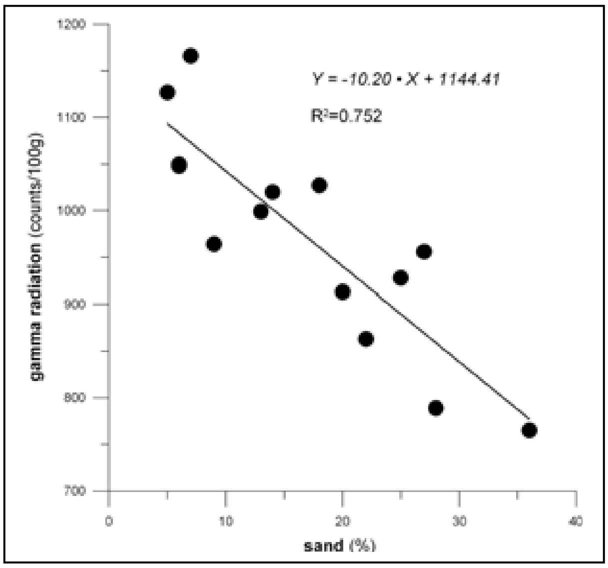

Figure 3 – Regression curve used to interpolate sand abundance in function of measured gamma radiation. A constant conversion factor K was successively used to convert laboratory into field data.

The integration of soil texture map with pH, organic matter content, carbonate content and pedoclimatic regime measurement will directly lead to a soil map that can be used to forecast the potential productivity for some type of cultivation that are new or poorly diffused in this area.

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Topic – Health aspects in Geology

URANIUM IN BAVARIAN GROUND AND DRINKING WATER – DISTRIBUTION, EVALUATION, MEASURES

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KEY WORDS: Survey, Uranium, Bavaria, Germany, Water, Health, Treatment

SURVEY

In the years 2000 to 2006, a survey of uranium concentrations in Bavarian ground and drinking water was performed on behalf of the Bavarian State Ministry of the Environment and Public Health. A total amount of 3560 water samples have been analysed. The samples were primarily gathered at

- drinking water supply facilities >10 l/s
- wells/springs which are known to contain heavy metals
- water supply facilities which are influenced by marsh in the catchment area
- wells/springs which are assumed to be influenced by uranium deposits

RESULTS

The uranium concentrations in the investigated water range from <0.1 µg/l up to 75 µg/l with an average of 2.2 µg/l. Concentrations of up to 40 µg/l were found in public drinking water supplies. In almost 73% of all samples the uranium concentration was lower than 2 µg/l.

This contamination of ground water is caused by the uranium contents of specific geological formations and their solubility. In the northern part of Bavaria, soluble uranium compounds are mostly found in the bunter sandstone and in the sediments of the lower and middle keuper. In contrast, it seems that in the southern part of Bavaria mostly the tertiary and the quaternary half-bog areas are affected, in which uranium is bound to organic matter.

Especially the districts of Lower, Middle and Upper Franconia exhibit average uranium concentrations which are considerably higher than the Bavarian average. In these districts, almost 11% of the measured uranium concentrations exceed 10 µg/l, compared to slightly more than 1% in the other four districts of Bavaria.

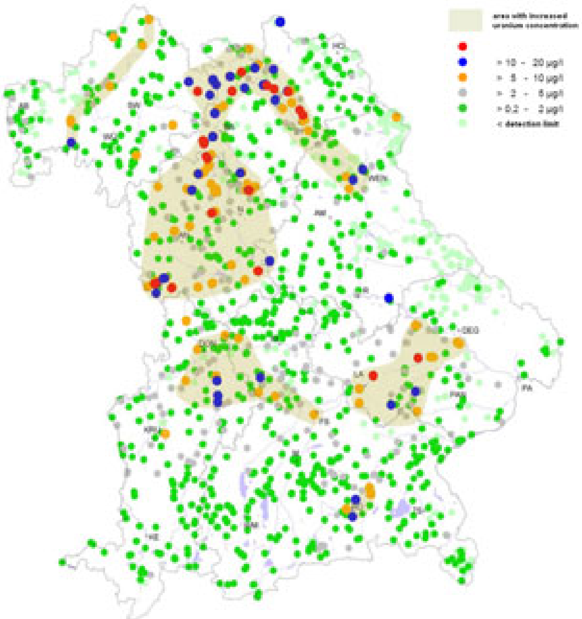

Figure 1 – Uranium concentrations in bavarian ground and drinking water.

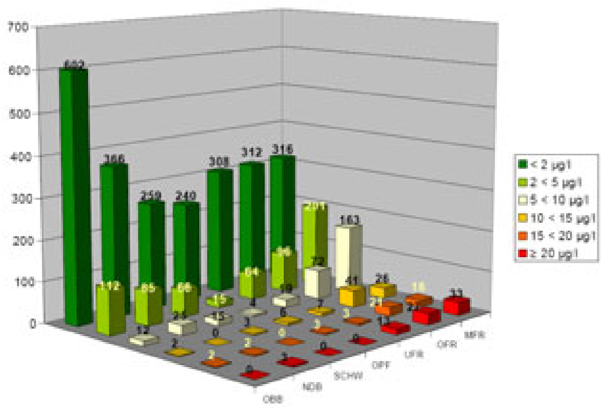

Figure 2 – Survey results for the bavarian districts.

HEALTH EFFECTS

The radio toxicity of naturally occurring uranium is negligible in comparison to its chemical toxicity because it gives off only very small amounts of radiation. As to its "heavy metal" toxicity, the closest analogy is lead, although lead has a considerably higher toxicity than metallic uranium. The observed or expected health effects from uranium intake are from nephrotoxicity associated with deposition in the kidney tubules and glomeruli damage at high doses. The kidney damage is dosage dependent and somewhat reversible.

LIMIT VALUE

Currently, neither the EU drinking water directive nor the corresponding German drinking water regulation contain a limit value for the concentration of uranium in drinking water. The US "Safe Drinking Water Act" defines a Maximum Contaminant Level (MCL) for uranium of 30 µg/l. The WHO suggests a provisional guideline value of 15 µg/l. The German Federal Environment Agency recommends a preliminary guideline value of 10 µg/l. This value should provide livelong protection against uranium caused kidney damage for all sections of the population and all age-groups, including infants. It is planned that the limit value of 10 µg/l will be incorporated into the next revision of the German drinking water regulation.

TECHNICAL MEASURES

The survey has shown that several Bavarian water supply facilities distribute drinking water with uranium concentrations higher than the guideline value of 10 µg/l. In these cases, it is recommended by the Bavarian State Ministry of the Environment and Public Health to take measures to lower these concentrations below the guideline value. In some cases, this can be achieved by closing down affected springs/wells and increasing the amount of water extracted from other springs/wells. In other cases, where the uranium containing water cannot be easily substituted with water containing less uranium, technical removal of the uranium is an appropriate option.

In order to find a sufficient, cost-effective water treatment to lower the uranium concentration in drinking water, the Bavarian Environment Agency initiated a corresponding research project in the year 2002. Among the different investigated treatment methods, the use of an anionic ion exchange resin proved to be the most efficient, combining long service life with a high uranium removal rate. The uranium which is removed from the drinking water is accumulated on the ion exchange resin, which increases its radioactivity. This has to be taken into account once the used resin is disposed or recycled.

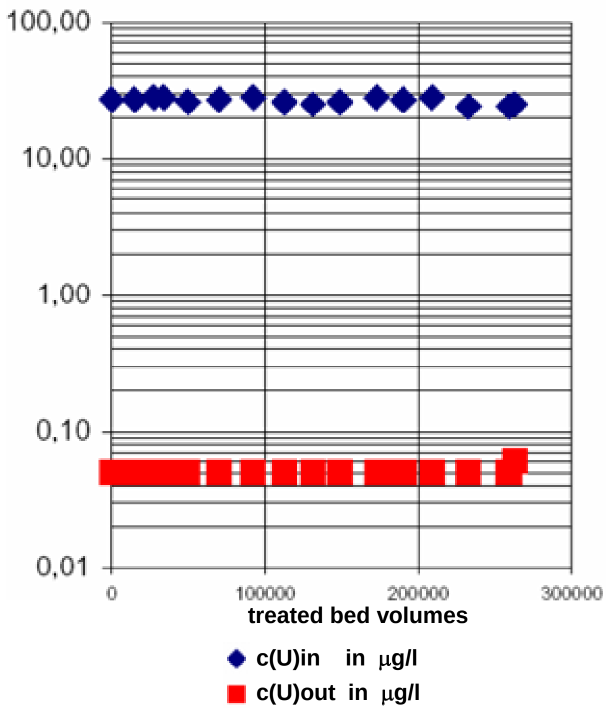

Figure 3 – Uranium removal with a strong base anion exchange resin (experiment run-time: 6 months).

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RADON – A GEOGENIC OCCUPATIONAL HAZARD IN BAVARIAN WATER SUPPLY FACILITIES

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KEY WORDS: radon, geogenic radon potential, exposure, occupational

INTRODUCTION

The inhalation of radon and its decay products composes the main risk of the public exposure to natural radiation.

Radon is a colourless, odourless and tasteless radioactive noble gas. Exposure to high radon concentrations considerably increases the risk of developing lung cancer. Radon is generated in every bedrock via the decay of radium, itself a decay product of uranium.

Radon diffuses into nearby soil air and dissolves in ground water. With the ground water radon enters the buildings of water supply facilities. There it outgases and accumulates due to poor air exchange and often small air volume in these buildings. Radon concentrations of up to 2,000,000 Becquerel per cubic metre (Bq/m³) have been measured. Subject to the time spent in the various buildings, high exposure levels for the staff working in these buildings can occur.

GEOGENIC RADON POTENTIAL IN BAVARIA

Bavaria can be partitioned into ten regions according to their "geogenic radon potential" [1], see fig. 1.

The geogenic radon potential describes an area with regard to the availability of radon in soil. The availability mainly depends on the radon content in the pores of the soil as well as on the porosity and permeability of the soil. To determine the radon potential, the following data, available on detailed maps, were taken into account: geological survey map, structure of the aquifers, radon concentration in soil gas and the distribution of the uranium and barium content in river sediments.

The highest radon potential is assigned to the East Bavarian region with its predominately granite and gneiss substructure. This is mainly due to the fact that those rocks naturally contain high amounts of uranium.

Figure 1 – the ten main regions of Bavaria within which the same geogenic radon potential can be expected. The regions with the highest geogenic radon potential are regions 5 and 10. Rock types of the regions: new red sandstone (1); shell limestone, Keuper (2); Franconian Keuper (3); Upper Jurassic, Dogger, Cretaceous (4); Granite, Gneiss (5, 10); Ejection material of the Ries meteorite (6); Sediment rocks, Molasses (7); young moraine (8); Trias, Jura, Tertiary (9). The dots show the location of all 79 water supply facilities with initial personnel exposure levels exceeding the action level of 6 mSv/a.

WATER SUPPLY FACILITIES

Since the protection against natural radiation was implemented in German law in 2001 [2], the radon exposure of the staff of all Bavarian water supply facilities has had to be assessed. The exposure is defined as the product of the mean radon concentration and the time a worker spent inside a certain plant. As the tasks in a water supply facility include occupancies at various plants, the exposures from all those plants must be added to obtain the total exposure.

From a study conducted in 500 Bavarian water supply facilities [1] it was found that an estimate of the radon concentration in the various plants from the radon content in the ground water is not possible. This is due to a variety of additional parameters that influence the radon concentration, e.g. the design and ventilation of the plant, the construction and amount of the water throughput and the various operational states. Therefore the exposure of the staff had to be measured. The Bavarian Environment Agency developed two different procedures for obtaining the exposure and recommended the use of track-etch detectors [1, 3].

When the exposure was first determined, in 79 of the 2550 Bavarian water supply facilities the personnel exposure level exceeded the action level of 6 mSv/a. According to the radiation protection ordinance [2] the exposure level of the staff employed by these water supply facilities is constantly monitored and remediation measures are in progress or even successfully completed. 48 of these 79 water supply facilities are located in region 5 (see fig. 1). This is not surprising as in this granite region high radon concentrations in the ground water occur more frequently and very high radon concentrations are found that can lead to high radon exposure even during short stays.

REDUCTION OF PERSONNEL EXPOSURE LEVELS

Remediation measures which can possibly be quite simple have been developed by the Bavarian Environment Agency in close cooperation with those water supply facilities whose staff was known to exceed the effective dose limit.

First of all the personnel must be sensitized to radon and advised to avoid unnecessary stays inside the units. Often part of the time needed for special processes such as backwashing of the filters or checking the water quality can easily be spent outside the units instead of inside as it is usually done.

By separating rooms with open water surfaces from other rooms, e.g. common rooms or offices, and installing an effective ventilation system, low radon concentration can be provided in the highly frequented rooms without open water surfaces. An example is shown in fig. 2.

Figure 2 – Example of separation of the filter basins from the control room by means of a glass wall and the installation of an appropriate ventilation system (not visible).

A very effective way of reducing the radon concentration and therefore the exposure level is to provide good ventilation. Special attention should be paid to the airflow to ensure fresh air with low radon content at the workplace.

By providing additional ventilation by e.g. mobile devices for cleaning of basins and reservoirs as well as actions in bad ventilated pits, the radon concentration can be considerably reduced.

Due to the implementation of several of these remediation measures, in 58 of the 79 water supply facilities where the exposure of the staff initially exceeded 6 mSv/a, have successfully completed their remediation measures and the exposure levels lie well below the action level of 6 mSv/a. Right now the staff of only 21 water supply facilities is subjected to exposure levels above the action limit of 6 mSv/a.

CONCLUSION

The frequency of the occurrence of elevated personnel exposure levels in Bavarian water supply facilities reflects the geogenic radon potential in the aspect that most of the elevated exposure levels occur in the East Bavarian crystalline region 5 (see fig. 1). But in other regions personnel exposure levels exceed the action level of 6 mSv/a as well. Therefore a prediction of the personnel exposure levels for a particular water supply facility based on the geogenic radon potential is not possible due to the amount of additional parameters.

In case of elevated radon exposure there is a variety of partly simple and low priced but nevertheless very effective remediation measures. This can be seen in terms of personnel exposure levels well below the action level of 6 mSv/a in the water supply facilities who carried out these remediation measures.

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COPPER SMELTING AND SOIL POLLUTION IN SARCHESHMEH COPPER COMPLEX, KERMAN, IRAN

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KEY WORDS: Sarcheshmeh copper complex, soil pollution, geoaccumulation index, heavy metals TER, Iran.

INTRODUCTION

Soil as a part of the terrestrial ecosystem, plays a crucial role in elemental cycling. It has important functions as a storage, buffer, filter and transformation compartment, supporting a homeostatic interrelationship between the biotic and abiotic components (Kabata-Pendiads and Sadurski 2004). However, the most important role of soil is its productivity, which is basic for the survival of humans (Kabata-Pendias and Pendias 2001). Metal pollution of soils is as old as man's ability to smelt and process ores (Boutron et al. 1995). The metal industry is one of the most important sources of anthropogenic contamination of the soil environment today (Ettler et al. 2007).In the vicinity of nonferrous metal smelters, high concentrations of toxic compounds have been detected in soils and vegetation (e.g. Ettler et al. 2005a)

Sarcheshmeh copper deposit, the largest porphyry copper deposit in Iran is located 160 km SW of Kerman city in Kerman Province (Figure 1) Copper mineralization in Sarcheshmeh is associated with a granotoid stock of 12.2± 1.2 Ma intruded into a thrusted and folded Early Tertiary volcano-sedimentary series comprising andesitic lavas, tuffs, ignimbrites and agglomerates (Shahabpour and Kramers 1987). Surface temperature varies between -20 $^{\circ}$C in the winter to + 32 $^{\circ}$C in the summer. The mean annual rainfall is 440mm. Prevailing wind directions based on available meteorological data from Sarcheshmeh meteorological station are NE and N. The objectives of this study are 1) to investigate the distribution and concentration of heavy metals (As, Cu, Ag, Pb, Sb, Mo, Cd and Zn) in the study area; 2) to examine the interrelationship between potentially toxic metals; and 3) in general to assess the impacts of copper smelting on soil contamination in the study area especially around human population centers.

MATERIALS AND METHODS

In the present study, soil samples were collected from a multiple-metal contaminated area. A total of 40 soil samples, 20 topsoils (0-5 cm) and 20 subsoils (15-20cm) were collected. At each sampling point, five subsamples were taken and mixed to obtain a composite specimen. Most samples were taken close to the smelter, copper city and villages in various directions

Soil pH, soil texture and the total organic carbon in soil samples were determined in the laboratory. All analyses were crried out in AMDEL laboratory in Australia.

CALCULATION OF HEAVY METAL ENRICHMENT IN SOIL SAMPLES

One way to look at the anthropogenic enrichment of metals is to compare the abundance of the metals to background (or reference values). A commonly used reference is average shale (Eby 2004).

The geoaccumulation index is generally used to assess the degree of contamination. The index is calculated as follows:

$$I_{geo} = \log_2 (Cn/1.5\ Bn)$$

Where I_{geo} is the geoaccumulation index, $\log_2$ is log base 2, Cn is the concentration of element, and Bn is the background or reference concentration.). In this study, I_{geo} was calculated using metal concentration of average shale (Turekian and Wedphol 1961)

TOPSOIL ENHANCEMENT RATIO (TER)

In order to assess the vertical extent of soil contamination, topsoil and subsoil concentrations were compared. Topsoil enhancement ratio (TER) is calculated by dividing the topsoil concentration by the subsoil concentration (Verner et al. 1996, Rieuwerts and Farago 1996).

STATISTICAL ANALYSIS

In order to investigate elemental associations among heavy metals and major elements in soil samples, Pearson's correlation coefficient and factor analysis were performed using SPSS software version 13.

RESULTS AND DISSCUSION

Tables 1 and 2 show maximum, minimum, and mean of measured trace elements in the copper complex together with world mean for uncontaminated soils (Ure and Berrow 1982). As tables show, it is clear that in comparison with the world mean values, Sarcheshmeh soil samples are extremely enriched in As, Cu, Mo, Zn, Sb, Cd, Pb and Ag. This is especially more evident in topsoil samples.

Element	Max. (ppm)	Min. (ppm)	Mean (ppm)	World mean (ppm)
As	427	23.7	121.9	11.3
Cu	12100	64	1849.5	25.8
Zn	894	69	207.8	59.8
Pb	332	9	79.25	29.2
Cd	12.8	0.2	2.98	0.6
Ag	5.94	0.07	0.854	0.4
Mo	56.8	0.8	9.2	1.9

Table 1 – mean conc. of heavy metals in topsoils.

Element	Max. (pp)m	Min. (ppm)	Mean (ppm)	World mean (ppm)
As	293	2.5	57.2	11.3
Cu	2170	45	320.85	25.8
Zn	486	54	114.75	59.8
Pb	79	4	32.5	29.2
Cd	2.9	0.1	0.65	0.6
Ag	1.4	0.05	0.24	0.4
Mo	7.7	0.5	2.21	1.9

Table 2– mean conc. of heavy metals in subsoils.

Geoaccumulation index is used to assess the degree of topsoil contamination by heavy metals. The I_{geo} of As, 3. Considering the data in table 4, and the contamination levels, the degree of contamination from strong to weak in topsoils is: Cu>Ag>Cd>As>Mo>Pb>Sb>Zn.

In general all stations are contaminated to varying degrees with heavy metals. This is especially alarmous for the health of copper town residents and other nearby population centers. The prevailing wind direction does not seem to be the sole determining factor in the induced soil contamination.

Topsoil enhancement ratio (TER), is calculated to assess enrichment by heavy metals relative to subsoil. Table 3 shows the results of calculated TERs for the sampled stations. In general, TER values clearly show topsoils enrichment with heavy metals relative to subsoils.

Element	Max.	Min.	Mean
As	18.04	0.78	3.7
Cu	14.31	0.66	4.2
Zn	3.33	0.81	1.64
Pb	10.4	0.53	2.7
Cd	25	0.66	6.3
Ag	8.03	0.44	2.5
Mo	11.3	0.82	3.3

Table 3 – Topsoils enhancement ratios (TER)

According to Rieuwerts and Farago (1996), high TER values indicate high rate of aerial metal deposition. It is interesting to note that TERs of stations in the proximity of the stacks (S9, S10, and S19) with highest metal loading are lower than TERs of S18 station. The reason must be sought in the low pH values of S9, S19, and S10.

In general high TER does not necessarily imply high aerial deposition. It seems that, chemical partitioning of trace elements in soil phases is also an important determining factor in trace element mobility and hence TER values.

STATISTICAL ANALYSIS

Statistical analysis of the data was carried out by factor analysis (Krumbein and Graybill 1965) and Pearson correlation coefficient. According to Simeonov et al. (2005), the pollution process is in principle a multivariate one and therefore only multivariate treatment of data is appropriate for site assessment.

Accordig to obtained correlation coefficients, there is a strong correlation among measured heavy metal concentrations in all soil samples. The concentration of heavy metals is negatively correlated with soil pH, probably reflecting decreasing heavy metal mobilities with increasing pH. Also there is a significant positive correlation among heavy metals and OC contents, indicating the role of organic matter as an important adsorbent of heavy metals in the study area.

Significant positive correlation also occurs between heavy metals and S concentration. This indicates a common origin for heavy metals and S i.e. ore minerals, as a major part of heavy metals emitted from the stacks are sulfide phases. Furthermore, according to Klumpp et al. (2003) decreasing sulfur content with soil depth reflects the contribution of atmospheric deposition. The results show that in all cases S content of topsoil is lower than that of subsoil. Significant negative correlation between distance from stacks and heavy metal concentrations reflects decreasing heavy metal content with increasing distance.

The weak positive correlation between heavy metals and Fe concentration shows that Fe-oxy-

hydroxides are not major adsorbents of heavy metals at Sarcheshmeh complex.
Factor analysis was carried out using principal component analysis method. Rotated components were produced using Varimax method with Kaiser Normalization. Factor analysis reveals that more than 89% of total variance is explained by two factors (table 4).

	Factor 1	Factor2	commonality
As	0.860		0.750
Cu	0.991		0.982
Mo	0.963		0.750
Zn	0.971		0.954
Cd	0.964		0.929
Pb	0.980		0.965
Ag	0.982		0.926
Fe	0.962	0.811	0.798
Al	0.374	0.887	0.811
Mn	-0.155	0.878	0.773
S	0.985		0.973
% r.	71.136	18. 494	

Table 4. Rotated factor analysis of elements in soils

According to calculated factor loading coefficient, the first factor, which explains more than 71% of the total variance, appears to represent an " anthropogenic factor" (Zhang et al. 2008), as it is strongly correlated with the elements Cu, Zn, Pb, Cd, As, Mo, Ag and S.
The low correlations between first factor and heavy metals, Fe, Mn and Al, indicate the weak controlling effect of Fe/Mn/Al oxy-hydroxides on heavy metals distributions and also mobilities in topsoils.
The second factor in table 4, which accounts for more than 18% of the total variance, is mainly composed of Fe, Al, and Mn. It is concluded that factor2, represents the chemical composition of soils. Figure 2 shows component plots of the heavy metals and major elements in soil samples. The figure clearly represents the association of heavy metals in factor 1 and major elements in factor 2.
The factor scores of all sampling points are calculated for factor1 and illustrated in figure 5. The first factor which was loaded for heavy metals and S content shows the highest scores at stations, 9, 19, 10 and 1. These sampling sites are very close to the smelter and have the highest heavy metal loadings.

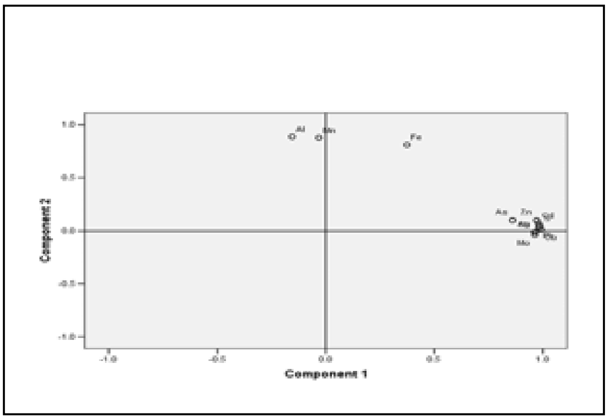

Figure 2. The factor analysis plots of heavy metals, major elements and S.

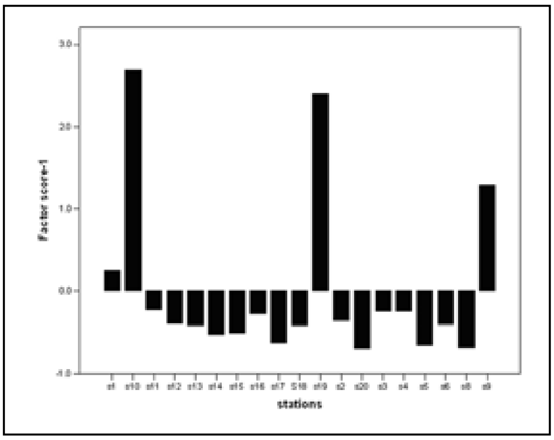

Figure 3. Factor score plot for factor 1

CONCLUSIONS

The concentration of heavy metals in the soils of the Sarcheshmeh copper complex, especially in areas adjacent to the copper smelting plant, is extremely high and exceeds of uncontaminated soils guideline. Toxic element concentration ratios in the area and in particular in residential areas are causes of concern. As the sampled sites are pastures, the soils are likely to become phytotoxic and provide a pathway for the toxic elements to enter the food chain. Decreasing heavy metal concentrations with increasing distance from the smelter, extensive enrichment of topsoils with heavy metals, and I_{geo} and TER results, along with strong correlation coefficient of heavy metals confirms the pollutant role of the smelting plant. The sandy texture, limited buffering capacity of soils, strong soil contamination with potentially toxic metals such as, As, Cu, Pb, Ag, Mo, and Cd , and mountainous topography of the region, facilitate leaching and hence groundwater contamination in time.

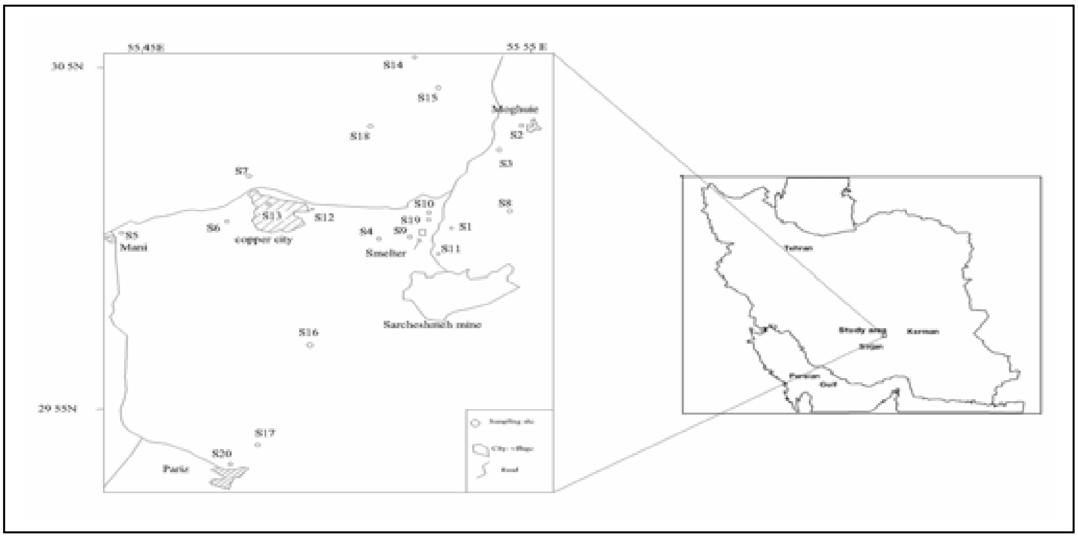

Figure 1 – Study area

The Pearson's correlation coefficient indicates that, the most important controlling parameter of the heavy metal mobility in the study area is pH. However, OC and Fe-oxy-hydroxides are also of minor importance. Although most contaminated areas are located in the prevailing wind directions (N, NE), but I_{geo} and TER, indicate that soil contamination is not confined to these directions. Seemingly other factors such as topography, atmospheric inversions (particularly in winter), and dispersion of the plume in calm conditions also have their effects on contamination

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EVALUATION OF THE SEASONAL VARIATION OF FLUORIDE CONCENTRATION IN POSHT-E-KOOH-E-DASHTESTAN, SOUTH OF IRAN

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KEY WORDS: fluoride, fluorosis, Posht-e-Kooh-e-Dashtestan, groundwater

1. Introduction

Major sources of fluoride in water are fluoride-bearing minerals in rocks and anthropogenic sources including industries that manufacture pesticides, fertilizers and aluminum (Apambire et al.1997; Chadha and Tamta.1999). A lot of work has been done to understand the source and genesis of high-fluoride groundwater (Shanker et al.2003; A.Asghari Moghaddam & E.Fijani.2007).

Objective of the study were:

1. To determine fluoride concentration in groundwater in the study area.
2. To evaluate the seasonal variation of fluoride concentration.

2. Geology of study area

The study area is situated in the southeastern part of Bushehr Province, South of Iran, it covers approximately 3000 km^2 and is bounded by the latitudes 28°40´ N and 29°30´ N, and longitudes 51°15´ E and 51°45´ E (Fig. 1). Lithologically the area is characterized by folded and faulted carbonatic (limestone and dolomite), evaporatic (gypsiferrous) and conglomeratic formations. In the study area groundwater is the main source of water for drinking and irrigation.

3. Materials and methods

Water samples were collected in liter plastic bottles (previously washed with deionised water and 2 times with water to be sampled) from 30 sampling sites including 28 wells, 2 springs, during dry and wet months in 2006. The first samples were taken from 15 water sources during dry season (July 2005) and the second set of samples were taken from 15 of the same sampling points during wet Season (January 2005) in order to evaluate seasonal variation of fluoride concentration in the study area.

The samples were analyzed and fluoride was measured using SPADNS method. The locations of the sampling points and fluoride concentrations are shown in Figs.1 & 2 respectively. Table 1 presents the details of the fluoride concentration determined for the water samples.

4. Results and discussion

- Results for the dry season (July 2005), and the wet season (January 2005)

Fig. 2 shows the fluoride concentration in water samples in the dry season in ***July 2005*** and the wet season ***January 2005***. All samples fluoride in wet season is higher than dry season.

Fig. 3 shows the average fluoride concentrations in the dry and the wet season. Fluoride values in wet season are higher than the dry season: 3.3 mg/l and 1.9 mg/l respectively.

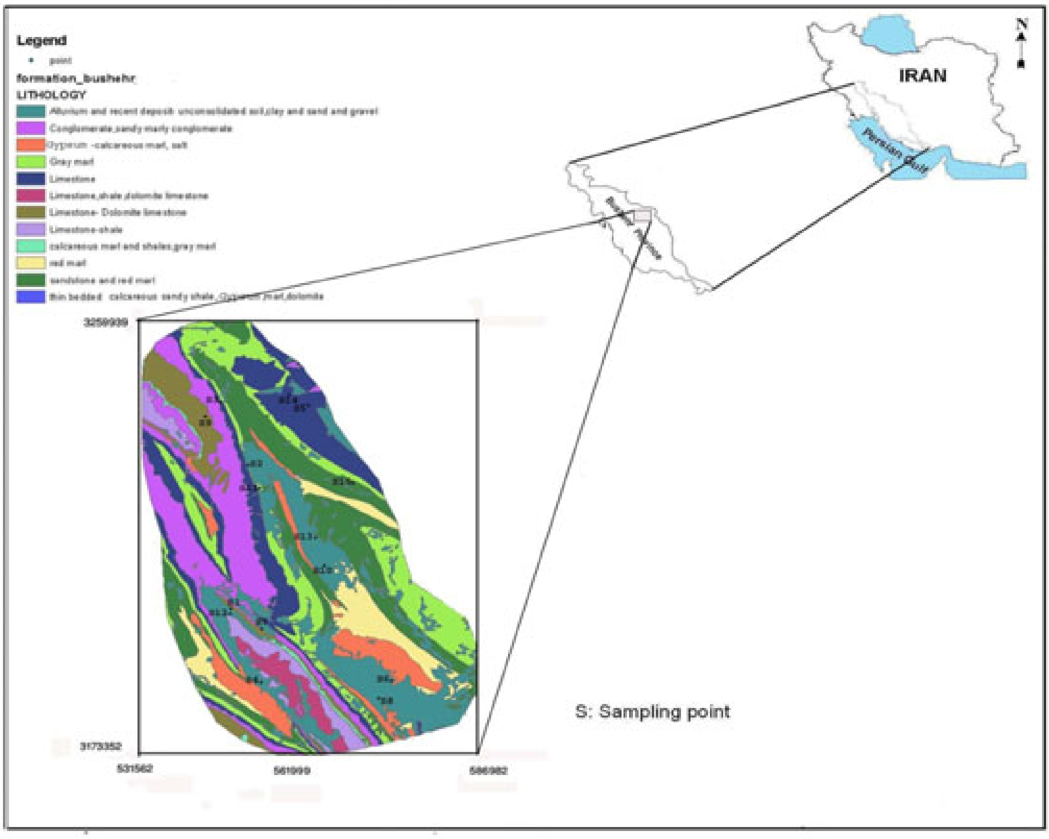

Fig 1. Geology map of the study area and the locations of the sampling points.

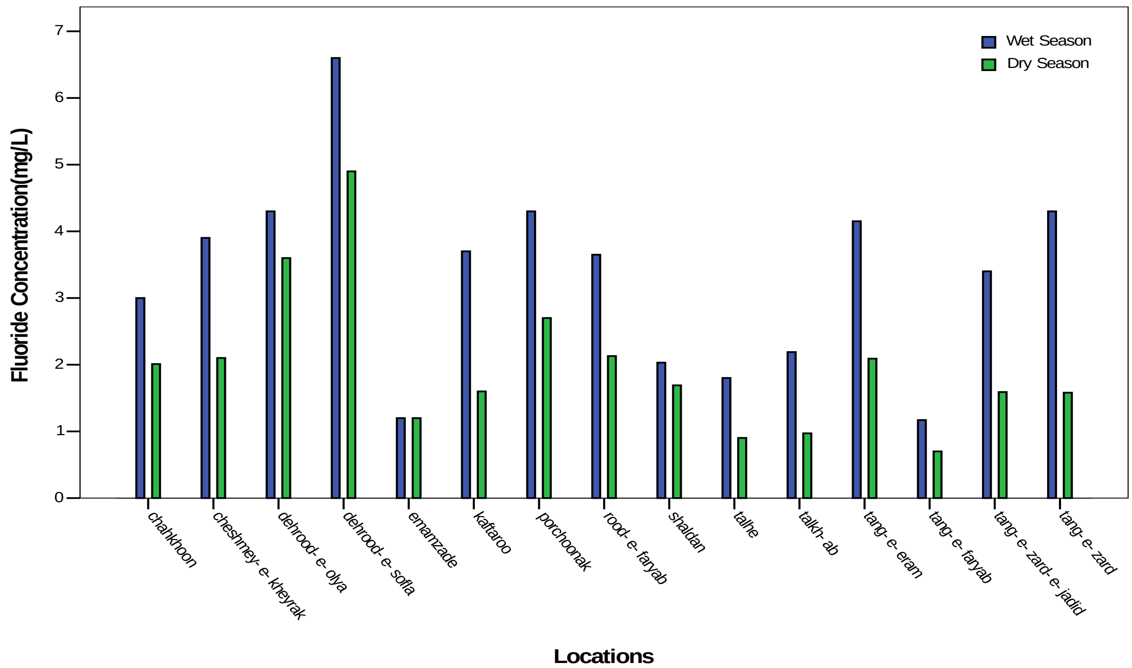

Fig. 2. Fluoride concentration of water samples in wet and dry seasons

Table 1. The details of the fluoride concentration for the water samples. Well (w), Spring (s).

Sampling points	Fluoride concentration	
	Wet season	Dry season
S1: Shaldan(w)	2.03	1.69
S2: Chah-khun(w)	3	2.01
S3:Emamzadeh(w)	1.22	1.2
S4:Dehrud-e-sofla(w)	6.6	4.9
S5:Dehrud-e-olya(w)	4.3	3.6
S6:porchoonak(w)	4.3	2.7
S7:Tang-e-eram(w)	4.15	2.09
S8:Kaftaroo(s)	3.7	1.6
S9:talk-hab(w)	2.19	0.97
S10:Rud-e-faryab(w)	3.65	2.13
S11:Tang-e-faryab(w)	1.17	0.7
S12:Cheshmey-e-kheyrak(s)	3.9	2.1
S13:talhe(w)	1.8	0.9
S14:Tang-e-zard(w)	4.3	1.58
S15:Tang-e-zard-e-jadid(w)	3.4	1.59

Fig. 4 shows the range of fluoride concentration in the sampling points in percent. Results for the fluoride concentration in the dry season in the water samples ranged from >0.7 to 4.9 mg/l. 12 water samples had a fluoride content above 1.5 mg/l indicating that 73.2% of water samples had fluoride content more than the WHO maximum permissible limit of 1.5 mg/l.

Results of fluoride in the wet season water samples ranged from >0.97 to 6.6 mg/l. 13 samples had fluoride concentration more than 1.50 mg/l indicating that 86.6% of the water samples had fluoride concentration above the WHO maximum permissible limit of 1.5 mg/l.

The concentration of fluoride in wet season in range of higher than 3 mg/l is much higher than that of fluoride in dry season so that 60% of water samples in wet season have concentrations higher than 3 mg/l while 13.2% of water samples in dry season have the same concentration (Fig. 4).

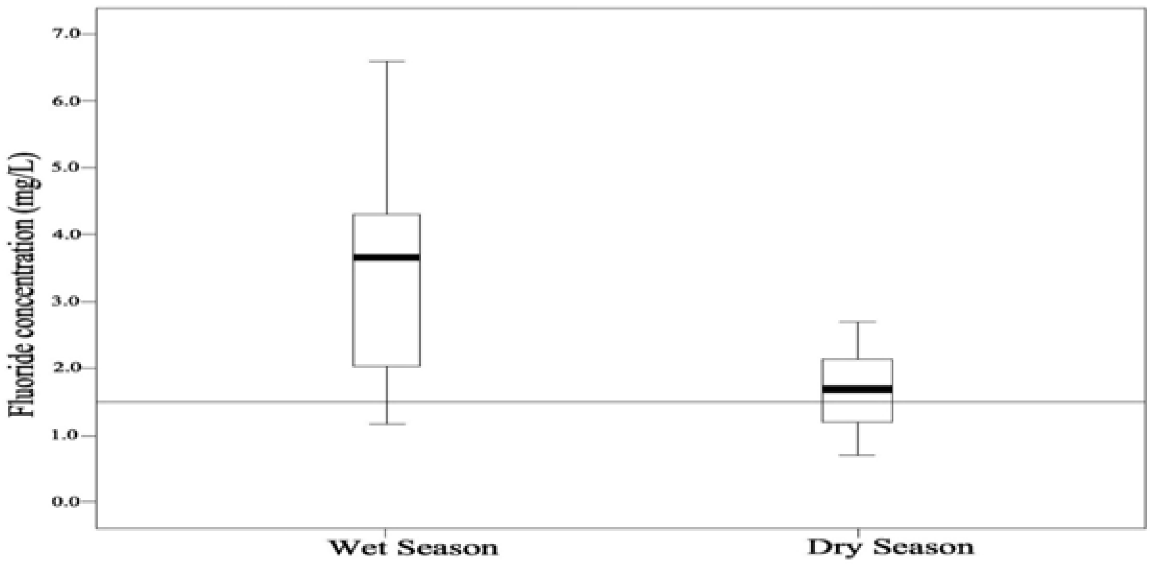

Fig. 3. Box plot of fluoride concentration in dry and wet season (line shows the permissible limit of F)

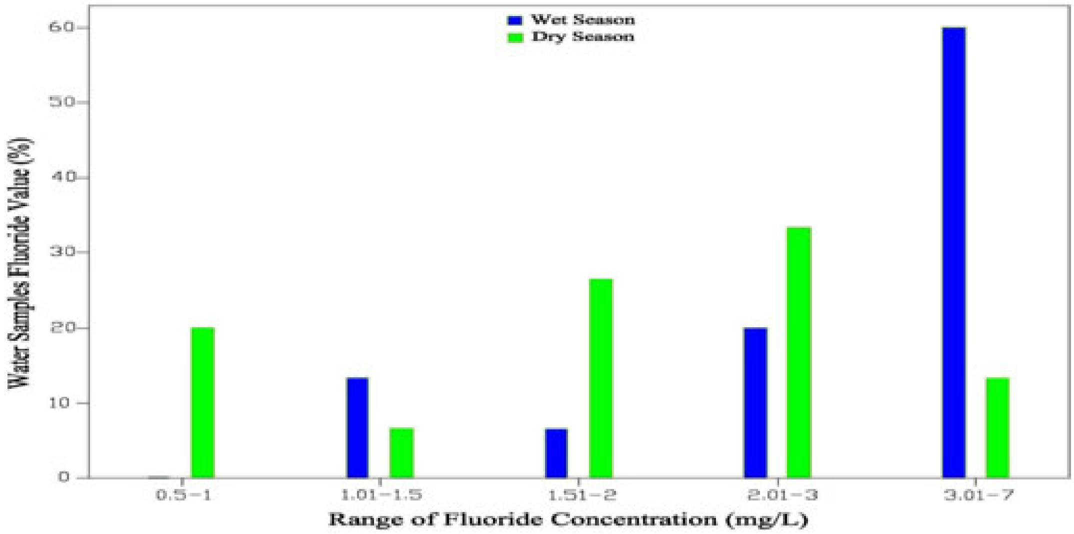

Fig. 4. Ranges of fluoride concentration during dry and wet season

5. Conclusion

This is the first study on the fluoride occurrence in the south of Iran. As dolomite and limestone exist in the study area in plentiful amounts, also as appreciable quantities of fluorite (CaF2) occur in some limestones and dolomites as fissure veins and in other forms (Alina Kabata-Pendias and Pendias.2001), it seems that limestone and dolomite can be sources of fluoride in our study area. Also it has been suggested that the fluoride containing minerals such as gypsum are weathered and decomposed to release fluoride (Zhang Bo et al.2003) and this is the another probable source of fluoride.

A comparision between the dry and wet seasons shows that fluoride values in the wet season are much higher that the corresponding values in the dry season and it seems that leaching of fluoride in wet season causes accumulation and enrichment of fluoride. Although this study indicates that fluoride concentration in spring water is high, the local populations believe that drinking from springs is safer and this misbelief increases the adverse health effects of high fluoride concentrations. Many people in the area show evidence of dental fluorosis with few cases of severe occurrences.

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RADON IN ROCKS, WATER, AIR AND UNDERGROUND QUARRIES OF SLATE AND COTICULE IN THE SOUTH PART OF THE CALEDONIAN STAVELOT MASSIF, VIELSALM AREA, BELGIUM.

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KEY WORDS: Belgium, Vielsam, Stavelot, Radon, coticule.

INTRODUCTION

In the Caledonian Stavelot Massif, the radon risk concerns the siliciclastic rocks of the Revin Group (Upper Cambrian) and the Salm Group (Middle and Lower Ordovician). In these groups, blacks slates dominate and quartzitics rocks are secondary. The measurements of the radon fluxes vary strongly from a zone to the other, independently of the distance. Local variations have bigger amplitude than regional. Considering the radon behaviour, a first sketch alea map of the radon in the Stavelot Massif have been realised by combining in the GIS all measurements realised. The resulting map is a stack of maps coming from the measure of the concentration of the radon in open air, water and undergrounds. This map is a first step to help the legal authorities to produce a risk map by taking into account the human constructions.

RADON

The fluids circulation in compact rocks of the Stavelot Massif is helped by fractures, joint, faults, weathered zones and unloaded areas by ungrounded works. Blended in air, the radon behaves as gas and moves across networks of fractures and can concentrate in rooms and galleries or evacuate the outside by the help of air current. The ancient underground quarries of "coticule" and slates are privileged places for production, circulation and accumulation of radon.(Figure 1) The highest concentration is noticed when wells are blocked up and that any circulation of air is reduced as in the deepest galleries. The higher radon concentration is therefore the result of particular shapes and geometry. The radon activity varies extremely with the atmospheric conditions (change of the direction of the air flux), atmospheric pressure, temperature and humidity are the keys, mainly because the radon is very soluble in the water.

Some geological surface sites and underground tunnels (Salmchâteau, Regné…) are, for the first time, characterised by their radon activity. New data show that the radon exhalation during the time is very "capricious". It evolves between some dozens to some thousands of Bq/m succeeding one another by direct transitions. Some day low levels are followed by long periods at high level and zones of well-known instability which daily fluctuation changes during several days in a row of a low level to a high. A representative value of the activity of the radon of a region must be a «global measure» or to be precise, a «medium measure over several months».

RESULTS

Most water sources of the Stavelot Massif containing radon were measured. The water comes from deep aquifers with a large extension or distant from the spring. During its underground itinerary, the water circulated in different types of rocks containing uranium compounds. The radon content of an aquifer depends firstly on the concentration in uranium of the water-bearing rock and on the radioactive descendants of the U dissolved in the water. Furthermore, the variability of the measurements in some ferrous deposits from springs regionally called "pouhons" is also determined (Figure 2).

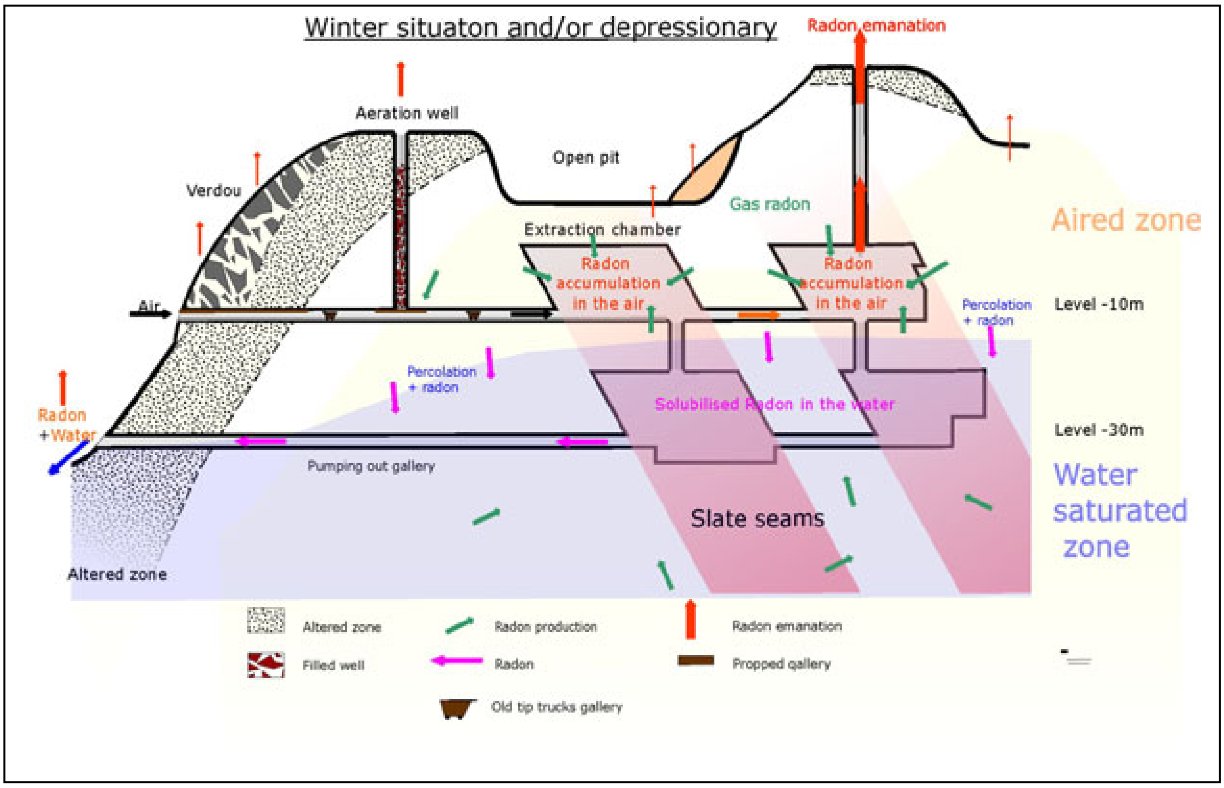

Figure 1 – Radon circulation into an undeground slate quarry

Radon activity in real conditions	Athm	d
Underground gallery of Bêche (38 samples)	3 Bq/m^3.kg	1.7
Underground gallery of Comtes de Salm (Salmchâteau) (15 samples) –end of the galery	9.2 Bq/m^3.kg	1.1
Underground gallery of Comtes de Salm (Salmchâteau) (7 samples) – gallery entrance	2.9 Bq/m^3.kg	1.3
Outcrops (8 with many measurements)	3 to 34 Bq/m^3.kg*	1.5 to 1.4
Water (spring) – Stavelot-Venn inlier (25 data)	6 to 1220 Bq/l	
Water (spring) – Liège province (5 data)	1 to 120 Bq/l	
Well - 3 m depth - overflow pipe - pond (radon degasing)	 1220 Bq/l 1030 Bq/l 140 Bq/l	
Ferrous deposits from springs (23 data)	1 to 640 Bq/m^3.Kg*	
Air in a gallery: extreme variability (daily, monthly, seasonal, atmospheric condition changes: pressure and temperature) → need for an integral value established on a long period of measurement	Tenths to thousands (>6000 Bq/m^3)	

Athm: Radon activity average
d: Factor between High and low Ath
*: Extreem value
Figure 2 – Characterisation of some geological sites in the Stavelot-Venn Inlier.

POLLUTION EVALUATION OF CHILD-CARE CENTERS AND PLAYGROUNDS OF ZAGREB: GEOCHEMICAL MAPPING AND GIS MODELLING

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KEY WORDS: ten words as a maximum.

ABSTRACT

Guidance values for heavy metals in soils for child-care centers and playgrounds have not been developed in Croatia. Evaluation of heavy metal pollution for 150 child-care centers and 50 playgrounds in Zagreb allowed derivation of guidance values for heavy metals based on oral intake of soil by children. Modeling was performed on heavy metal concentrations of surface soil (0-5 cm), household dust and background concentrations of deeper horizons (30-40 cm), and soil heavy metal data for urban Zagreb analyzed in the early 1990s.

INTRODUCTION

Heavy metals as urban soil contaminates of environmental concern have been targeted by numerous studies in the past 20 years (KABATA & MUKHERJEE 2007). Urban soils present a media that greatly effect health of young children (under the age of 7) due to their contamination by certain heavy metals from different sources (OTTESEN et al., 2008). The chemical composition and contamination of urban soils is a result of chemical and mineral constituents inherited from original mineral soils, transported soils, organic materials, building materials, household waste, incineration ash (OTTESEN et., al., 2008). The *aqua regia* extractable contents of a rather limited number of heavy metals (Cu, Cd, Zn, Pb, Hg, Cr and Ni) have been determined for the city of Zagreb and its rural surroundings (PALINKAŠ et al., 1995, ROMIĆ & ROMIĆ, 2003). These studies determined that the anthropogenic urban geochemical signature of soils in the city of Zagreb is characterized by elevated concentrations of Pb, Hg, Zn and Cu while Ni, Cr, Co represent a lithogenic signature of the local bedrock geology (PALINKAŠ et al., 1995). Although both studies were quite comprehensive with an urban soil sampling density of 1 km^2 they did not target issues related to the playgrounds and human health. In order to determine the heavy metal status of soils in playgrounds and possible health impacts on children, the City Office for Physical Planning, Environmental Protection, and Construction of the City, Construction, Utility Services and Transport initiated geochemical mapping program in 2008 together with the Croatian geological survey. Playgrounds associated with day-care centers in Zagreb are located at 191 sites and host about 28.000 pre-school children.

Based on previous geochemical mapping surveys (PALINKAŠ et al., 1995, ROMIĆ & ROMIĆ, 2003) a general pattern of elevated heavy metal concentrations (Pb, Hg, Zn) in urban soils which are found in the older central part of the city gradually decrease towards the suburban areas of the city. Also the floodplain soils along the Sava river have higher concentrations of these elements as a consequence of past metal mining activities in the Slovenian part of the Sava river catchment.

Specific objectives of this study were to determine if there are statistically significant differences between the metal concentrations (i) in surface urban soils (0-5 cm in depth) and shallow subsurface soils (50-60 cm in depth), and can this data be used to calculate enrichment factors to determine which elements have a significant anthropogenic load. The German (BBodSchV, 1999) and the Norwegian (OTTESEN et al., 2008) health-based soil quality criteria for inorganic compounds in playgrounds were used to evaluate concentrations in soils that will trigger remediation in the day-care centers in Zagreb since these have not been determined by Croatian heath authorities. Also one of the goals of the study was to evaluate the background concentration of metals in the soil in an urban environment and how well geochemical data obtain from regular grid sampling (PALINKAŠ et al., 1995, ROMIĆ & ROMIĆ, 2003) predicts the heavy metal concentrations of targeted urban soils of playgrounds.

STUDY REGION AND METHODS

Zagreb (45°10′ N, 15° 30′E) is situated beside the Sava River and on the Medvednica Mountain slopes. It is located in the south-western front of the Carpathian Basin of Central Europe. Zagreb is the capital of Croatia and its largest industrial centre with a history of over 1,000 years and its oldest part was settled during the Bronze age.

The industrial part of the city developed on fluvisols formed on recent alluvial deposits, a Pleistocene plateau, while the older part of the city lies on Miocene marls, sandstones and limestones on the Medvednica Mountain slopes. The aluvilal sediments in the Sava river floodplain are characterised by Molic Fluvisols, Calcaric Fluvisols, Eutric Cambisols and the Pleistocene terrace, by Stagnic Podzoluvisols which prevail on the plateau, and Stagnic Podzoluvisols and Glayic Podzoluvisols on the slopes (ROMIĆ & ROMIĆ, 2003). The mountain itself consists of Palaeozoic and Mesozoic rocks (para-metamorphites, ortho-metamorphites, carbonate sedimentary rocks, igneous rocks and clastic sedimentary rocks) with some smaller occurrences of lead-zinc and copper mineralization (DURN et al., 1999).

Sampling in 200 playgrounds (Fig 1) was undertaken using plastic spade (topsoil) and a stainless steel auger (subsoil), the samples were taken from 0–5 cm (topsoil) and 50–60 cm (subsoil) depths at all locations. Random sampling pattern was used, with 5 to 10 subsamples depending on the size of the playground. The sub-samples of soil from each day-care center were combined to a composite sample for analysis, a part of the original sub-samples was stored for follow up analysis in case of high concentrations in composite samples. Paint chips taken from metal playing equipment in the playgrounds (45 locations) and dust from floors were sampled with *GhostWhipes*© in toddler rooms in child-care centers (62 locations) specifically targeted to evaluate the presence of Pb.

The geographical coordinates for subsample sites were determined with a global positioning system (GPS) receiver (sub meter accuracy, MobileMapper CE, Thales), and were then incorporated into a geographical information system (GIS) for further analysis.

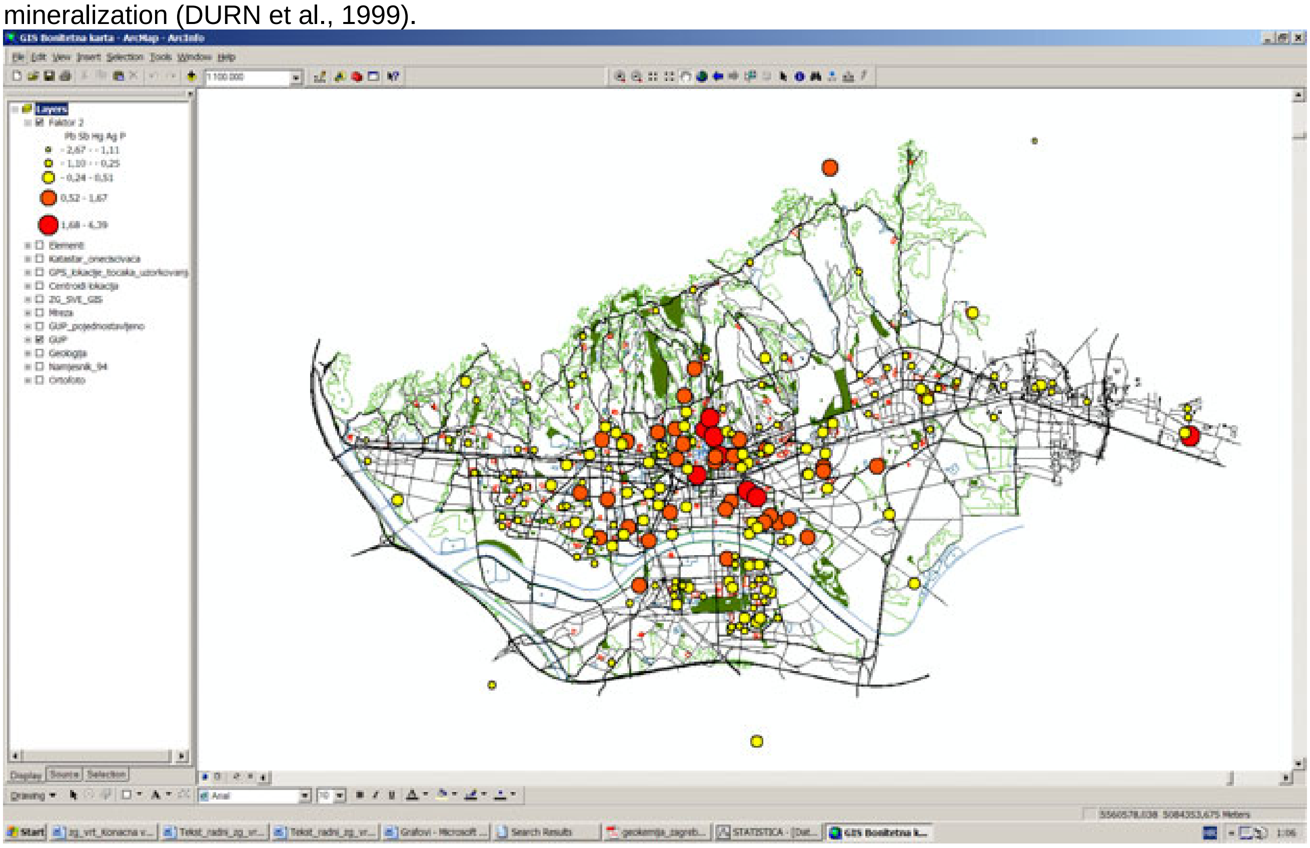

Figure 1 – Locations of day-care centers in Zagreb and the map of factor scores (F2; Pb, Sb, Ag, Hg, P, Cu) in topsoil Scheme of functionality operation.

The GIS project (ArcMap 9.2 ESRI) was organized in order to collect and analyze the information on the study area, in terms of geologic, topographic maps, land uses data, spatial planning data and orthophoto.

The soil samples were air dried and prepared for further analysis by passing through a 2 mm mesh sieve. Using standard methods, basic soil parameters were determined: pH ($CaCl_2$), cation exchange capacity and percentage of organic matter (percentage loss on ignition, 450°C). During the study *aqua regia* (ISO 11464) soil extracts were analyzed for 42 major and trace elements by ICP-MS (ACME Labs, Vancouver, Canada).

Summary statistics, correlation analysis and principal component analysis (PCA) were performed using STATISTICA v.7. on the whole chemical data set for both topsoil and subsoil. For characterizing the probable anthropogenic inputs of As, Hg, Cr, Cu, Zn, Cd, Tl and Pb, was evaluated by calculation of enrichment factors (EF) for these elements based on the difference in concentrations between subsoil and topsoil samples. The basic geochemical approach to calculate enrichment factors from geochemical data by means of a conservative component whose levels are unaffected by contaminant inputs, for example, grain size, Al, Fe, Sc, Ni, TOC and Li. Typical normalization approaches identify one or several reference elements, most frequently used conservative element is Al, alternatively this element is replaced by Sc (SHOTYK et al. 2001). The EF is a concentration ratio of a given element ($C_{ntopsoil}$) to the conservative element (Al in this study) in the topsoil sample ($C_{cons.topsoil}$) with respect to same ratio in the standard material (or subsoil in this study) $C_{nsubsoil}/C_{cons.\ subsoil}$ (FÖRSTNER and WITTMANN, 1981):

$$EF = (C_{ntopsoil}/C_{cons.topsoil}) / (C_{n\ subsoil}/C_{cons.subsoil}) \quad (1)$$

This calculation method of enrichment factors in sediments is widely used in environmental studies and usually relies on the use the average composition of shale which often is not necessarily representative of the local or regional concentrations of soils in the study area. Therefore a calculation procedure, which does not use an average referent material but rather concentrations of potentially toxic elements and conservative elements from deeper layers (subsoil, 40-50 cm depth), was used to evaluate anthropogenic inputs of potentially toxic elements at each individual playground. GOLCHERT et al., (1991) distinguish three categories of the enrichment factors: EF≤2, 2<EF<10 and EF≥10, where EF lower than 2 indicates a natural variation of an element and those higher than 10 indicate severe pollution.

RESULTS AND DISCUSSION

The playground soil located in the central and former industrial sites in Zagreb is enriched with Pb, Hg, Sb, and Zn compared with sites located in new residential and former rural surroundings of Zagreb. At these sites both topsoil and subsoil samples have high concentrations of Hg and Pb (Fig 1). The general soil properties as well as Ca and Mg contents show the differences in soil parent materials the alluvial sediments in the Sava river floodplain and the Pleistocene terrace and Miocene deposits on the slopes. The topsoil and subsurface samples have slight differences for pH and OM showing higher levels of organic matter in the surface samples and lower pH.

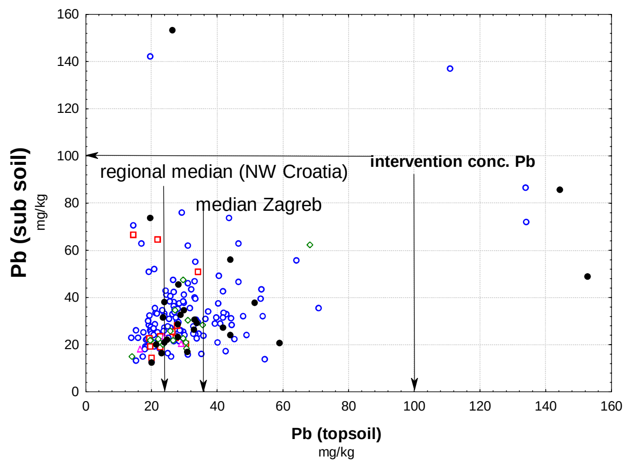

Figure 1 – Lead distribution in playground soils (topsoil= 0-5 cm; subsoil= 40-50 cm), regional median fo NW Croatia and the wider Zagreb region, Norwegian intervention concentration (100 mg/kg, OTTESEN et al., 2008).

Table 1 – Summary of soil data for selected elements from playground in Zagreb (topsoil 0–5 cm and subsoil 50–60 cm samples)

Element	Mean	Min.	Max.	S.Dev.
		mg/kg *(Hg µg/kg)*		
Cu (topsoil)	24.94	6.93	69.27	9.95
Cu subsoil)	31.52	9.64	163.08	21.28
Pb (topsoil)	32.45	14.00	152.73	20.73
Pb (subsoil)	98.96	12.21	>10000	716.43
Zn (topsoil)	96.36	42.80	2632.80	181.53
Zn (subsoil)	98.28	26.80	965.10	91.74
As (topsoil)	9.1	3.3	21.6	2.7
As (subsoil)	11.3	4.9	29.0	4.1
Cd (topsoil)	0.32	0.10	1.56	0.14
Cd subsoil)	0.33	0.03	2.55	0.21
Cr (topsoil)	23.5	10.2	45.2	6.4
Cr (subsoil)	28.9	9.7	79.2	10.9
Hg (topsoil)	114	22	737	108
Hg (subsoil)	149	29	1292	170

The elemental content of the topsoil and subsoil samples for Pb, As, Hg, Zn, Cr, Cu and Cd similar content and range, with outliers in enrichment factors (EF; Fig 3.) for Pb, As, Hg and Cd (25 sites). In the case of Pb, Hg and Cu their anthropogenic input through industrial and urban development is also shown with higher mean concentrations in the subsoil mainly restricted to the central area of the city. Lead and mercury show the most number of outliers with extreme values.

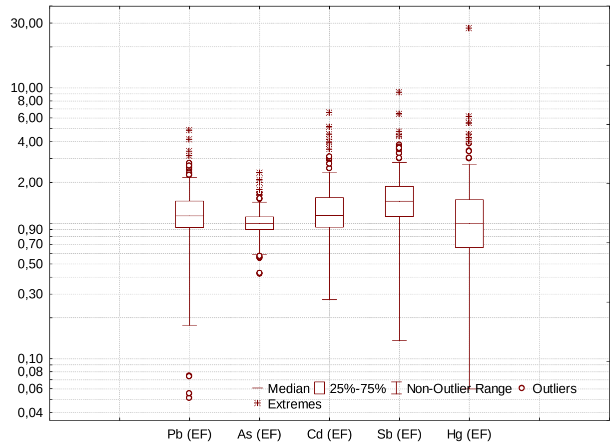

Figure 3 – Box plots summarizing enrichment factors for elements exceeding quality criteria thresholds for playground topsoil samples

The PCA was used as an assessment tool to extract major components responsible for variation in elemental distribution and to. Element concentrations that did no fit a normal distribution were log transformed before analysis. The results of the Varimax-rotated PCA for all topsoil samples are presented in Table 2. Based on the data four factors are identified with individual factors explaining only between 27 and 9% of the total variability. The first factor contains a signal from the influence of lithological bedrock composition (Ca, Mg, Al, Fe, Th, Co, Cr, Ni), the second (Fig. 1) shows the Pb, Hg, P, (Cu) Sb, Ag (Au) attributed as an anthropogenic pollution signature. The As, U, Mo and (Na) is a characterized by elements effected by redox processes and similar geochemical behavior. The fourth represents the contribution of Ba, Zn and Cd, and could represent a second anthropogenic factor but not linked with the same sources as factor 2. The distribution of high enrichment factors (Pb, Hg and Sb) and high factor scores for factor 2 (Fig.1) showed very good overlapping of anomalous sites. The application GIS analysis of spatial data (geology, distance to roads, topography) allowed better understanding of element distributions related to anthropogenic influence and contributions of pH and organic matter as well as and the contribution of geological background. The significant inputs of anthropogenic origin are present in 20% of the playgrounds, although in most analyzed old paints from playing equipment we identified as lead-based paint(Pb content >0,5%). In 16 the composite topsoil contained more 100 mg/kg Pb. Lead, Hg, As, Zn, Cd and Cu concentrations in topsoils were found to be higher than those defined by health-based soil quality criteria at 10% of the childcare playgrounds.

Table 2 – Results from PCA of topsoils from all playgrounds

	Factor1	**Factor2**	**Factor3**	**Factor4**
Mo	0,20	0,30	**0,69**	-0,10
Cu	0,40	0,50	0,45	0,17
Pb	-0,03	**0,75**	0,15	0,33
Zn	-0,02	0,28	-0,09	0,85
Ag	-0,03	**0,69**	0,29	0,21
Ni	**0,65**	-0,11	0,48	0,15
Co	**0,89**	0,08	0,10	-0,04
Mn	**0,77**	0,09	0,14	0,08
Fe	**0,94**	0,13	0,12	-0,07
As	**0,65**	0,23	**0,54**	0,06
U	0,16	0,33	**0,67**	-0,22
Au	0,10	**0,59**	-0,07	0,08
Th	**0,82**	-0,18	-0,15	-0,09
Sr	0,00	-0,20	0,61	0,39
Cd	-0,07	0,29	0,41	0,78
Sb	0,00	**0,75**	0,30	0,17
V	**0,79**	0,31	0,16	-0,14
Ca	**-0,75**	-0,14	0,47	0,09
P	0,29	**0,68**	0,10	0,05
Cr	**0,83**	0,27	0,23	0,00
Mg	**-0,76**	-0,01	0,27	-0,03
Ba	0,07	0,29	-0,06	0,85
Al	**0,95**	0,01	0,05	-0,04
Na	-0,05	0,23	**0,76**	-0,08
K	**0,59**	0,18	0,30	0,21
Tl	**0,57**	-0,21	0,48	0,28
S	-0,00	0,28	0,50	0,29
Hg	-0,21	**0,54**	0,19	0,20
Se	0,15	0,33	0,40	0,20
pH	-0,31	-0,45	0,27	0,19
Expl.Var	8,32	4,28	4,28	2,90
Prp.Totl	0,27	0,14	0,14	0,09

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Topic – Former climate evolution at regional scale

CLIMATE CHANGE AND ITS INFLUENCE ON VARIOUS STAGES OF DEGLACIATION OF CHORABARI AND DOKRIANI GLACIERS, GARHWAL HIMALAYA, INDIA

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KEY WORDS: Climate Change, Glacial maxima, Geomorphology, Lichenometry, Little Ice Age.

INTRODUCTION

Mountain glaciers are sensitive indicators and provide a valuable tool for reconstruction of Holocene climatic changes. The present work, thus, deals mainly with the Climatic Changes and its Influence on the Chorabari and Dokriani glaciers based on the dating of lichens, developed on loops of moraines formed due to various stages of their deglaciation. Chorabari glacier is located between Latitudes 30^0 44’ 50” & 30^0 45’ 30” N, and Longitudes 79^0 1’ 16” & 79^0 5’ 20’’ E. The basin area of the glacier is about 38 sq. km, whereas the area covered by the glacier is 15 sq. km. The glacier is also fed by several hanging glaciers. The length of the glacier is about 6 km.

Dokriani Bamak is a well-developed compound valley type glacier of the Gangotri group of Glaciers in the higher Central Himalaya. This glacier is located between longitudinal 30^o 50’ to 30^o 52’E and latitudinal 78^o 45’ to 78^o 51’N. Total catchment’s area is 15.15 sq km, out of which 5.76 sq km is covered with ice, and 4.10 sq km is covered by permanent snowfield and remaining 5.29 sq km is the non-glacierized area.

CYCLES OF ADVANCE AND RETREAT

In order to study different cycles of advance and retreat of the Chorabari and Dokriani glaciers, various loops of lateral and terminal moraine have been studied in their inactive zones (i.e. the zone which is no longer in contact with the glacier). A series of well defined four lateral (Figure 1) and terminal moraine loops are noticed which have been used as the basis for reconstructing the glacier history in defining the sequence of glacier episodes before its complete deglaciation from the inactive zone. . These loops suggest that after their development, no major movement / advance / activity of the glacier took place in the region. The four stages of advance and retreat have been dated with the help of lichenometric study.

LICHENOMETRY

The moraines were dated by lichenometric studies which depends on the assumption that if colonization delay and growth rate of lichens are known in a particular area, then a minimum date can be obtained by measuring maximum diameter of the largest

Figure 1. Four loops of lateral and terminal moraines of advance and retreat of Chorabari glacier (Chaujar, in press)

lichen at the site. This method is very useful in regions of glacial environment which are mostly above and beyond the tree line where lichens grow very slowly and have great longevity. In such conditions, it is possible to date deposits up to thousand years (Winchester 2004), but in most of the cases, this method is useful for dating deposits just up to 500 years. The study is based on lichen size/age correlation and lichen population distribution using approaches described by Winchester and Harrison (1994, & 2000) and Winchester and Chaujar (2002) Lichenometry is a technique used to find relative or absolute date of rock surface exposure. Details of the technique and criticism have been published by Webber and Andrews (1973), Locke et al. (1978), and Innes (1985). Absolute dating is based on the size of the largest surviving lichen. Therefore, reference to their specific details in the paper should be taken as minimum approximations only. Other factors leading to lichen mortality and, subsequently, renewed colonization are: competition for growing space on the rock surface, vegetation growth, animal or human interference, weathering or other geomorphologic processes.

The most common lichen growing on the morainic boulders is Rhizocarpons *geographicum*. It belongs to the yellow green Section Rhizocarpons most frequently used in lichenometry. Longest axes of all the lichens of this species growing on the upper faces of selected boulders were measured with a flexible tape and digital caliper with measurements estimated to the nearest 1 mm. Growth curves were constructed to find a maximum growth rate of the species, with maximum diameter measurements taken or largest specimens growing on different boulders of loops of various stages of advance and retreat of the two glaciers.. About 4000 (in Dokriani, Figure 2) and 2000 (in Chorabari) lichens in the region were measured on different moraines and their frequency distribution is plotted to display relative age structure of the population. Seven prominent lichens on different moraines were well marked in the field for future reference in the Chorabari area. The first measurement of about 2000 lichens in the region was done during last week of October, 2003. These lichens were measured again during first weak of November, 2004, 2005, 2006, & 2007 and a growth of 1 mm was found from their Calibration Curves Thus, a growth rate of 1 mm per year was established in the area.

Most of the monuments of known dates do not have any lichen grown / developed over them. In such cases, there is no other way, but to use indirect method to find the value of colonization delay, i.e., the time gap lichens took to start growing on the surface after their exposure to the atmosphere. After enquiring local people and authorities, a bridge close to the Kedarnath temple was found to be around 85 years old. That bridge and the surrounding walls do not have any lichen grown over it. If we take the age of the bridge as 85 yrs (approximate), then we can presume the colonization delay to be 85 yrs (minimum). Considering these values of colonization delay and growth rate, the dates of lichens on various glacial boulders of different loops are calculated (Table 1a)

In the Dokriani glacier growth rate of lichens was calculated by remeasuring some of the selected lichens after a gap of three years. Growth rate was calculated as .66mm/year. Indirect method was also applied in this glacier to find the colonization delay by finding a bridge of about 72 years old having no lichen grown on its sides/walls. It could be presumed that a minimum of 72 years took by the lichens in the region to start growing. The diameter of largest lichen on these loops was measured and their ages are shown in Table 1.

Figure 2. Lichens on the morainic boulder of stage I of retreat of Dokriani glacier

(a)

Stage	Largest Lichen	Age (Size/Growth Rate + Colonization delay)	Position of max. advancement (in meters)	Retreat (in meters)	Rate of Retreat (Retreat / Age, in m/year)
I	173 mm	173/1 + 85 = 258	3750	3750–3500=250	250/18=13.7
II	155 mm	155/1 + 85 = 240	3500	3500-3000=500	500/61=8.2
III	94 mm	94/1 + 85 = 179	3000	3000-700=2300	2300/51=45
IV	43 mm	43/1 + 85 = 128	700	700	700/128=5.46

(b)

Stage	Largest Lichen	Age (Size/Growth Rate + Colonization delay)	Position of max. advancement (in meters)	Retreat (in meters)	Rate of Retreat (Retreat / Age, in meters/year)
I	160 mm	160/0.66=242+72=314	4500	4500-1700=2800	2800/90=31.1
II	144 mm	144/0.66=152+72=224	1700	1700-1600=100	100/65=1.5
III	58 mm	58/0.66=87+72=159	1600	1600-1550=50	50/15=3.3
IV	48 mm	48/0.66=72+72=144	1550	1550	1550/144=10.8

Table 1- Shows (a) Lichen and Retreat data of Chorabari Glacier and (b) of Dokriani Glacier

DISCUSSIONS AND CONCLUSIONS

Here it has been shown that the dates of largest lichen on the loop of moraines that indicate, the position of maximum advance of the Chorabari and Dokriani glaciers are 258 and 314 years respectively. It shows the period when the two glaciers started receding from the point of their maximum advancement in this part of the Himalaya. North facing Dokriani Glacier in the Garhwal Himalaya indicates ‘Little Ice Age’ maximum during AD 1692 whereas south facing Chorabari glacier show its maximum during AD 1748.

Four stages of deglaciation/ advance and retreat, on the basis of loops of terminal and lateral moraines, of the two glaciers are noticed in the field. Largest lichens on the boulder of moraines of different loops of advance and retreat of the glaciers are 173mm, 155mm, 94mm & 43mm (Chorabari), and 160mm, 144mm, 58mm & 48mm (Dokriani) of stage I, II, III and IV respectively. The colonization delay and growth rate of the lichens, as calculated by field observations, are 85 yr & 1mm/yr (Chorabari) and 72 yr & 0.66 mm/yr (Dokriani) respectively. Based on these values the dates of deglaciation of four stages of Advance and Retreat of the glaciers are 258, 240, 170 & 128 yr (Chorabari) and 314, 224, 159 & 144 yr (Dokriani) respectively. The overall average rate of retreat of two glaciers are 14.53 m/yr (3750m/258yr) and 14.33 m/yr (4500m/314yr) respectively. These dates of different loops of deglaciation indicate the influence of climate change on the glaciers and differences in values suggest the effect of orientation of two glaciers- Chorabari is south facing and Dokriani is north facing, and local topography. These dates further suggest that climatic changes in this part of the world started nearly 314 yrs ago, since the retreat of the glacier is associated with the global warming.

ACKNOWLEDGEMENTS

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ATLASES OF OCEANOGRAPHIC OBSERVATIONS AS THE TOOL OF CLIMATIC ANALYSIS

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KEY WORDS: climate, the Sea of Azov, water temperature, spatial distributions.

INTRODUCTION

The great interest shown by specialists in long-term and still debatable climatic tendencies should be balanced by a deep consideration for weather cataclysms. Their scrutiny in a long-term aspect may help to orient the society and economy toward the assessment of real natural risks. When analyzing climatic rhythms, one should rely upon the whole arsenal of methods and approaches, which give an integral image of natural trends.

The modeling of secular and future climatic fluctuations has become almost the basic investigation technique in the last decade. The newest mega-bases of thermohaline data are being developed and applied for analyzing, forecasting, and modeling the ocean climate. In this work, systematization techniques of oceanographic information elaborated in [MATISHOV G., MATISHOV D., GARGOPA Y., et al., 2006; MATISHOV G., ZUEV A., GOLUBEV V., et al., 2005] are adapted to conditions of southern inland seas. The database structure and procedure of the data quality control and information analysis were elaborated by specialists from MMBI KSC RAS, SSC RAS and NOAA within the framework of the Project "Global Oceanographic Data Archaeology and Rescue" (GODAR). The technique was tested during the compilation of climatic atlases of northern seas [LEVITUS S., BOYER T., 1994].

THE CLIMATIC ATLAS OF THE SEA OF AZOV

The climatic atlas of the Sea of Azov presents a unique mega-base of primary data, which involves more than 133 000 stations and 120 years of observations throughout the whole sea area. The number of sea observations exceeds 40000 stations. The archive base comprises historical data from Marine Hydrological Year-Books of 1946–1968, Proceedings of the Azov–Black Sea Scientific–Fishery Expedition, and other offshore cruises in the past century [PLAKHOTNIK A., 1996]. Our database also comprises primary information obtained for the decade 1997–2007 by specialists from MMBI KSC RAS and SSC RAS with the use of state-of-the-art methods on board the R/V *Professor Panov* and *Deneb* [MATISHOV G., GARGOPA YU., BERDNIKOV S., DZHENYUK S., 2006].

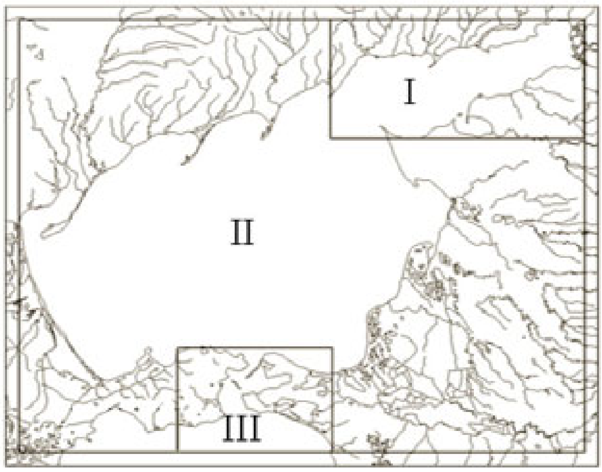

Figure 1 – The Sea of Azov Areas. I – Taganrog Bay, II – Central Part of the Sea of Azov, III – Kerch Strait and neighbouring part of the Black Sea.

Month	Tmin	Tmax
January	-0.80	7.80
February	-0.80	6.60
March	-0.70	9.90
April	0.0	18.10
May	1.16	26.50
June	8.90	30.00
July	10.01	31.6
August	13.70	29.61
September	10.10	28.50
October	4.40	22.00
November	-0.26	19.50
December	-0.80	12.20

Figure 2 – Allowable range of temperature variation for the Sea of Azov.

Data quality control was carried out according to the pattern approved by the NOAA Ocean Climate Laboratory. First, gross errors in primary data were determined and corrected. Regularities of annual climatic cycle of temperature and salinity variation for the Sea of Azov were considered at the second stage of the data quality control to determine the range of allowable values for these parameters.

To describe the pattern of temperature and salinity variation in the Sea of Azov three areas were distinguished (Figure 1). For each individual month, minimum and maximum temperature variation ranges were calculated for the entire Sea of Azov area, Tmin and Tmax correspondingly (Figure 2).

Important elements of the technology are as follows: a special interface for base formation, programs for quality control and duplicate omission, and user's interfaces for sampling, applied scientific analysis, and comparison of diverse information [KULYGIN V., DASHKEVICH L., 2006]. The MMBI format consists of blocks describing the site, time, procedure, and conditions of data collection, as well as information. Blocks with data are similar in form to the standard disciplinary tables of information presentation.

The GIS medium was applied for the compilation of more than 100 monthly mean climate maps of the distribution of temperature and salinity in the Sea of Azov water for the horizons of 0, 5, and 10 m, as well as the bottom horizon [DASHKEVICH L., KULYGIN V., 2008]. Optimal parameters of the net domain and interpolation in the Climatic Atlas of the Sea of Azov (2008) were chosen on the basis of numerical experiments. A uniform grid with a 10x10-km step was used in the map of standard geographic projection. Monthly mean temperatures and salinity for each year were calculated in grid nodes by the method of weighted interpolation with a range of 30 km. Average long-term climatic values in grid nodes were estimated by smoothing the monthly mean values calculated for each point for a period of no less than 3 yr.

Most of the measurements (from 2300 to 2700 per year) were made in 1927, 1935, and 1952. More than 800 measurements were carried out during 2005 and 2006. During the warm season, more than 6000–6500 measurements of water properties were made each month (June–September) over 120 years. Such a thorough study of the seawater area covering 39 000 km^2 gives grounds to draw a series of general conclusions.

The analysis of the seasonal dynamics of the water temperature over 100 yr at three geographic points of the Sea of Azov showed natural (latitudinal) differences in sea weather. Warmer (+2 to +5°C) water masses are formed in the Kerch Strait from September to April. By contrast, the Taganrog shallow bay is relatively warmed up (up to 25–30°C) in May–August. It is obvious that thermohaline properties of water vary in winter under the influence of the air temperature and wind direction, as well as the extent of advection of the Black Sea warm water to the Azov basin.

Severe weather in winter seasons was reflected in the thermal rhythms of the Sea of Azov water, for instance, in 1928, 1937, 1939, 1950, 2003, and 2006 (Figure 3). Depending on salinity, the mean winter water temperature during the century-long observation period varied from –0.1 to +0.2°C in the Taganrog Bay, from −0.3/–0.7 to +0.2/+0.4°C in the central part of the Sea of Azov, and from –0.5/–0° to +0.5/+1.5°C in the Kerch Strait. Winter weather conditions did not develop during relatively warm years (1927, 1933, 1940, 1981, and 1997). The water temperature exhibited typical "autumn" properties: +2.5/+6°C, +3/+7°C, and +4/+9°C in the Taganrog, Azov, and Kerch areas, respectively.

Not all winter months were involved in oceanographic measurements over 100 years. At the same time, there is a probability of successive manifestation of severe and warm winters in the Sea of Azov water and their full synchronism with the air temperature dynamics on the coast.

To get a complete climatic picture, we analyzed the daily mean air temperature for December–February of the years 1885–2006 along the coast. We also calculated the average winter temperature above the Sea of Azov. The following regular dynamics has been revealed for winters: severe winters with moderate frosts (up to –5/–10°C) in the period of 1885–1941; mild winters with average temperatures above the sea up to +2/+4°C in the years 1942–1984; and severe winters alternating with mild winters with air temperature up to +2°C in the period of 1985–2006 (Figure 3). Drifting ice floes as large as tens of meters are encountered in the sea up to May after severe winters.

CONCLUSION

The results of analysis along with data systematization suggest the following preliminary conclusions. In publications devoted to the analysis of the Sea of Azov temperature regime, emphasis is placed on positive trends in recent years and they are attributed to global warming. However, the results presented here suggest that we are most likely dealing with intra-secular climate fluctuations with a periodicity of 20, 40, and 60 yr. The climate of the Sea of Azov region over the last 120 yr is characterized by alternations of cold cycles (with freezing and abundance of ice cover over the entire sea) and warm ice-free phases during the whole winter. Moreover, warm or cold periods could be more expressed in different historic periods.

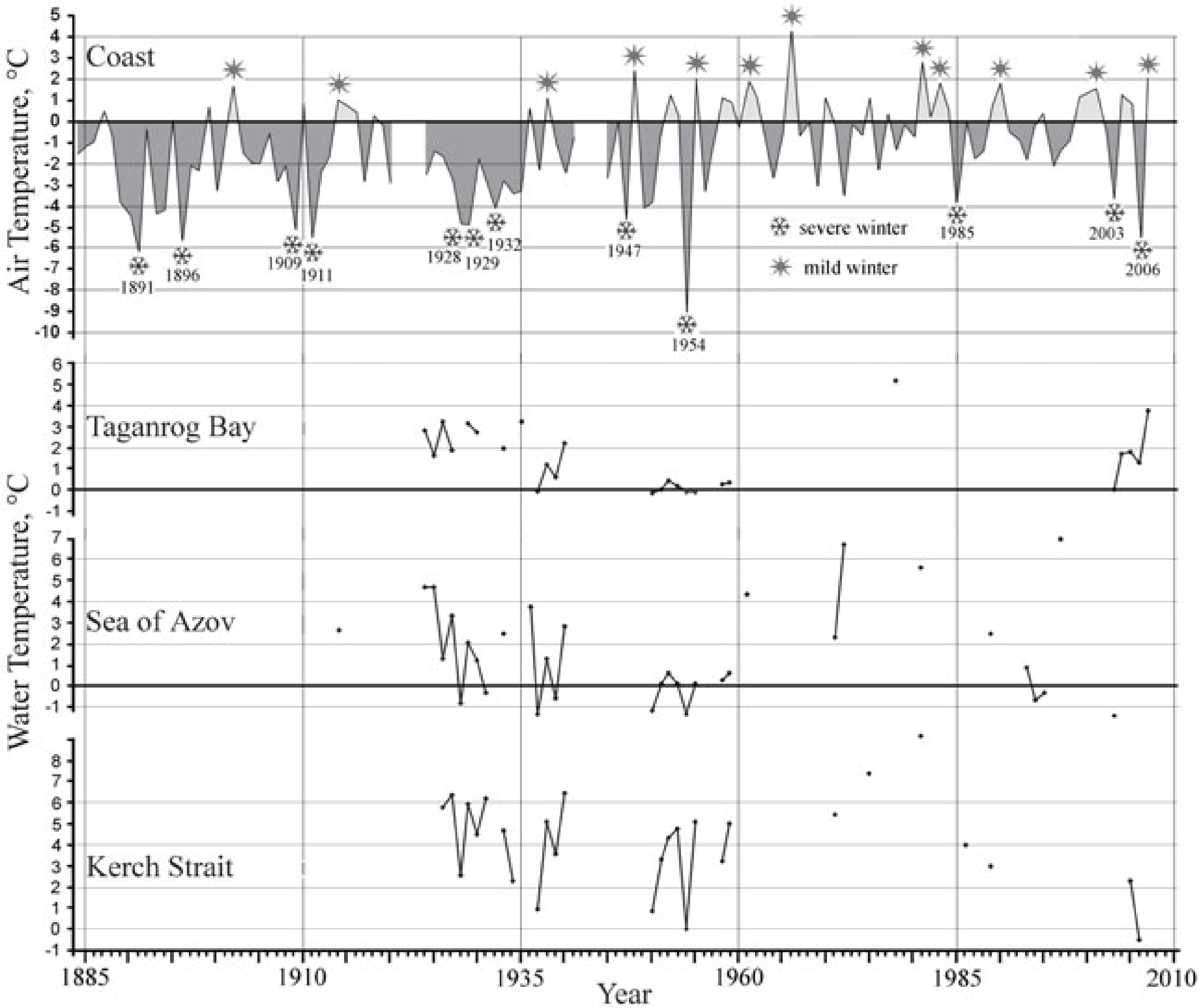

Figure 3 – Secular weather regime over the Sea of Azov in the winter period.

Nowadays, to assess the duration of contemporary period and forecast anomalous climatic phenomena, it is necessary to compile and use secular mega-bases of thermohaline data. Therefore the atlases, which present both primary data and additional research materials, are useful and necessary tools for the climatic analysis.

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PERMAFROST IN THE BAVARIAN ALPS AND ITS ENGINEERING GEOLOGICAL CONSEQUENCES

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KEY WORDS: Mountain permafrost, climate change, Zugspitze, subsidence, rock stability.

INTRODUCTION

Permafrost in mountain regions received increasing attention in the past years, mainly in the context of the discussion about global warming and its possible consequences. Even if no definitive proof for the correlation of permafrost degradation and slope stability has been given so far, numerous indications point to their relation (e.g. Gruber & Haeberli 2007). In the Bavarian Alps permafrost occurrence is not widespread because they only exceed an altitude of 2500 m a.s.l. at few summits and ridges. However, possible problems related to degrading permafrost should be considered and anticipated also in this region. In the framework of the EU-Interreg-IVB project PermaNet, the distribution and possible consequences of the future evolution of permafrost will be examined for the whole alpine arc. The Bavarian Environment Agency is partner of this project.

PERMAFROST IN BAVARIA

The climatic history of the Holocene indicates that the currently permanently frozen areas in Bavaria (e.g. the Zugspitze Mountain) are probably not older than the late middle ages. It can be assumed that during the warm periods at the early Middle Ages (ca. AD 800–1300) or that of the Roman period (ca. 300–0 BC) or at least during the so called “Holocene climatic optimum” (ca. 6000–4000 BC) permafrost had disappeared more or less completely in these areas.

Permafrost is material of the underground that has temperatures below 0 °C for the entire year and is, hence, purely defined on temperature. Its occurrence depends on several factors, for example, elevation. Therefore only the highest mountains in the Allgäu, the Wetterstein-Karwendel area and the Berchtesgaden Mountains can be expected to be within permafrost. At high elevations, only steep rocky summits exist and permafrost occurrence is restricted to bedrock. Some smaller debris cones may also contain permanent ice but are in negligible extent.

Another important factor for the existence of permafrost is the slope exposition. On sun exposed slopes the minimum altitude of permafrost in bedrock may exceed 3000 m a.s.l., on north faces it goes down to ca. 2200 m a.s.l. (Gruber et al. 2004). Under specific cold local conditions even at 2000 m a.s.l. permanent ice was found (Spaun, oral comm.). An isolating snow cover may significantly influence the existence of permafrost. In steep rock faces, however, typically no thicker snow cover persists.

The shape of a permafrost body inside a mountain is strongly influenced by the differences in surface temperatures of north and south exposed slopes. For example, inside a ridge having positive temperatures on the south and negative temperatures on the north (e.g. the Zugspitze), the permafrost boundary in the mountain is nearly vertical (fig 1., GIUZ 2006, Noetzli 2008). The zone of annual alternation of thaw and freeze is the so called active layer. Increasing temperature will cause the active layer to thicken and to proceed deeper into the bedrock. Accordingly, the rock mass affected by repeated thaw/frost processes will be enlarged.

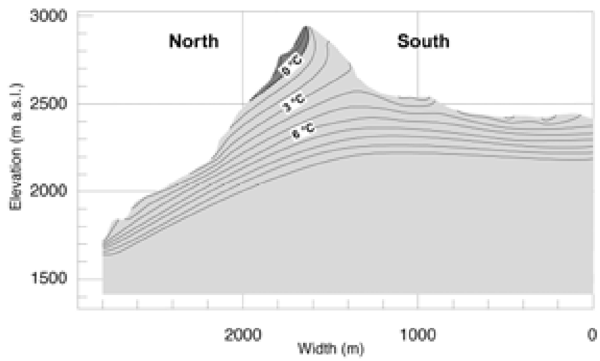

Figure 1 – Modeled temperature distribution and permafrost body in the Zugspitze Summit, modified after GIUZ (2006)..

The degradation of a permafrost body is mainly a result of warming conditions at the rock surface, which penetrate into the underground by heat conduction. The generally low thermal conductivity of rock induces a delayed reaction of the temperature at greater depth to the changes at the surface (cf. fig. 4). The monitoring station at the

Zugspitze Mountain shows a delay of the annual summer temperature maximum of about 6 months at a depth of about 20 m. Because rock surfaces are directly exposed to atmospheric conditions (Gruber et al., 2004) and steep topography accelerates the penetration of a warming signal into the ground (Noetzli & Gruber, in revision), rocky summit areas such as the Zugspitze are particularly sensitive to permafrost degradation.

Another thaw process is related to heat transport by percolating water. Krautblatter (2007) and Gruber & Haeberli (2007) point out that this is much more effective and rapid than heat conduction. Accordingly, the degradation of permafrost bodies may be significantly accelerated by the propagation of water along discontinuities, such as faults, joints or karst cavities. However, only limited knowledge on these processes is available so far.

The shape of a permafrost body under boundary conditions as in the Northern Calcareous Alps is not well confined but may be quite discontinuous (cf. fig. 2). Due to a heat flux, e.g. by water percolating in open joints, separate smaller bodies of permafrost can be divided from the main body creating a zone of discontinuous permafrost. Krautblatter et al. (2009) have detected such separated bodies by geophysical investigations (i.e., electrical resistivity tomography ERT) for example in a gallery on Zugspitze Mountain at an altitude of 2800 m a.s.l.

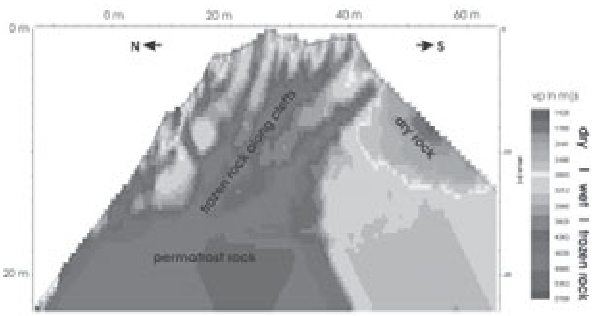

Figure 2 – Permafrost body showing disintegration along discontinuities. From: Krautblatter (2007).

MECHANICAL CONSEQUENCES

Permafrost is defined on the basis of temperature irrespective of the presence or absence of ice. The difference to non-frozen ground and the practical relevance of permafrost, however, comes with the ice contained in the underground, which can significantly change its characteristics (geotechnical properties, water permeability, etc.). This is particularly important in connection with infrastructure and when permafrost conditions are changing.

Under the aspect of engineering geology or risk management several different mechanisms have to be considered. Firstly, the recurrent process of freezing and thawing is known to have destabilizing consequences. It concerns the rock surface of all alpine areas, regardless of the occurrence of permafrost. In non-permafrost areas, the maximum depth of the freezing influence is restricted to ca. 1–2 m, even at higher altitudes. The increase in volume of water of about 9% during phase change can create high pressures and open up even smallest crevasses. That way, it contributes to the general weakening and disintegration of the rock close to the surface. In permafrost areas, increasing air temperatures lead to a thickening of the active layer. That is, rock masses not yet subjected to positive temperatures are influenced by thaw processes .

A second mechanical aspect is the behaviour of ice-filled discontinuities in the rock mass. It has been shown in laboratory experiments that the shear strength of ice depends on its temperature (Davies et al. 2001). At temperatures of about –5 °C the shear strength of ice-filled discontinuities is very high, but decreases until about –2 to –1.5 °C, where it is in fact lower than in ice-free clefts. That means, failure may occur following an increase in temperature without a total thaw of the ice. Once the ice disappeared, the friction of rock on rock re-increases the shear strength.

It is known that ice reacts ductile under high pressure and that its plasticity index is temperature dependant. Accordingly, under specific conditions slow creep deformation can occur. Frost heave can open crevasses in an extent that the interlocking rock particles are completely separated only in zones with limited overburden. In such cases, and under the condition of a favourable geometry of the ice-filled discontinuities, rock slabs can move slowly out of the former position. The creep process will accelerate with an increase of the plasticity parallel to rising temperatures.

A very important influence of changes in permanent ground ice concerns the hydrologic regime because a permafrost body generally is an aquiclude. As mentioned above, disintegration processes often follow cavities percolated by water. Here, ice melt can open new water corridors within the rock and bring water to new areas. An increase of hydrostatic pressure in sensible areas is possible. This may concern also areas some hundred metres deep in the mountain and as a result even large volumes of bedrock can be destabilised.

MORPHOLOGICAL CONSEQUENCES

Figure 3 – Recently opened sinkhole in limestone of the Zugspitze crest

The morphological and geotechnical consequences of permafrost degradation are manifold. As in Bavaria permafrost exists only marginally in scree slopes, soil slips and debris flows due to ice melt can be neglected.

In recent years, many rock falls have had their starting zones in permafrost areas, some of them involving large volumes of material (i.e., >1 mio m^3). Ice was visible in many starting zones just after the event, which is seen as an important indicator of the relation between permafrost and slope failure. A first approach to determine thermal conditions in rock fall starting zones from permafrost areas points to a concentration of events from warm permafrost slopes (Noetzli et al. 2003). However, the understanding of the processes involved and knowledge of the thermal conditions under which such events develop are limited. Frequency and magnitude of a rock fall event likely correspond to the time and depth scales of permafrost changes: a thickening of the active layer may lead to small events as a fast reaction to increasing surface temperatures (for example the events in the extremely hot summer 2003). In contrast, permafrost degradation at depth may lead to large events that involve large volumes of rock and are delayed by decades or centuries (e.g. Brenva rock avalanche 1997).

Gruber and Haeberli (2007) give a detailed review of the current understanding of the connection of permafrost ice contained in fractures and the stability of steep rock slopes. They list five main physical processes that alter the geotechnical conditions in fractures and, eventually, may lead to rock fall. Some of them have been discussed above: (1) Thawing permafrost can lead to a loss of bonding in ice-filled fractures («ice cement»); (2) Ice segregation has the potential to slowly widen fractures and fissures; (3) Volume expansion of water during freezing; (4) Permafrost thaw and consecutive flowing water can lead to strong hydrostatic pressures; and (5) the shear strength of ice-filled fractures decreases with warming ice.

Even in bedrock areas sudden collapse of the surface in form of sinkholes can occur. Obviously, this is caused by caverns in the underground formerly filled with ice and debris. In the cases observed, it is not yet known if the primary creation of the caverns is caused by karst or by older slope deformation. The subsidence was partly slowly with several decimetres per year, partly large holes opened suddenly with the collapse of the roof.

A common and one of the most important consequences of permafrost degradation for infrastructure in high alpine areas is ground deformation. It is not only atmospheric warming that leads to ice melt, but also the heat input of buildings. It is known, that heated buildings influence the thermal conditions of the subsurface to a depth of 10 m and more. The direction of the settling movement is predetermined by the discontinuity pattern and the distribution of ground ice and may not be only vertical. Damage on buildings occurs especially in case of differential settling. The total amount of a possible displacement is hard to predict as it depends on the volume of ice in the subsurface, which is typically unknown.

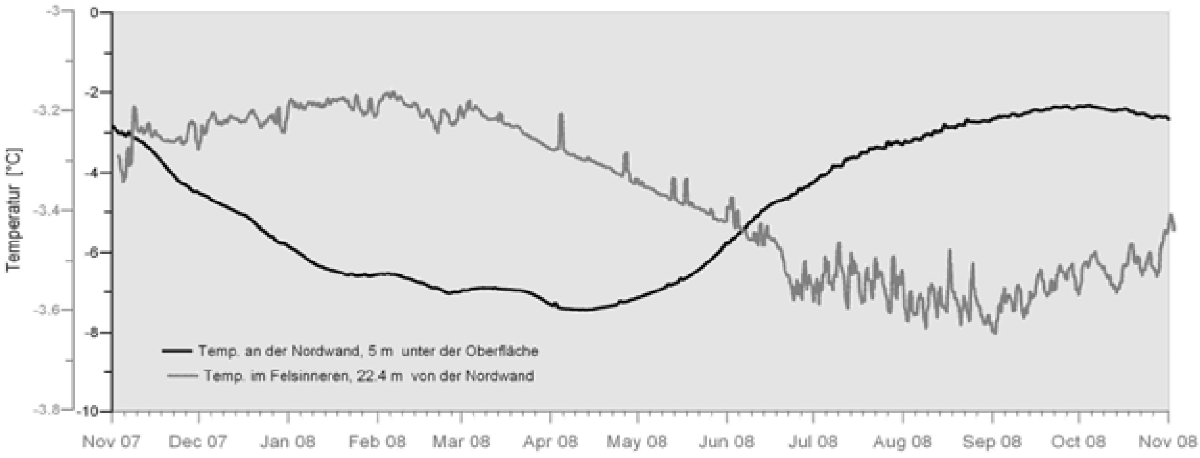

Figure 4 –Temperature-time diagram for the Zugspitze monitoring station. The dotted line gives the temperature on the north face, the straight line the temperature in the borehole at a depth of about 20 m from both north and south face. At this depth, the annual temperature variations are delayed by about half a year. Note the different scales for temperatures.

CONCLUSION

In the Bavarian Alps the occurrence of permafrost is restricted to a number of high elevation sites that are mainly located in bedrock. Due to the elevation range of the Bavarian Alps, temperatures in permafrost are only little below the melting point and therefore permafrost occurrence is sensitive to changes in atmospheric conditions. Most of the permafrost areas are remote, even without any infrastructure. However, a number of sites exist with considerable buildings and constructions. Thorough investigation and observation of permafrost conditions at these sites are essential to early detect and anticipate possible problems in connection with increasing underground temperatures and melt of ground ice.

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Topic – Geothermal energy and other georesources

SPRINGS DOCUMENTED IN "HISTORICAL" TOPOGRAPHIC MAPS: CREATION OF A DIGITALIZED DATABASE AND CONTRIBUTION TO A WEBSITE.

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KEY WORDS: topographic maps, Istituto Geografico Militare, springs, database.

REFERENCE CARTOGRAPHY AND AIMS

The "historical" Topographic Map of Italy published by the *Istituto Geografico Militare* (IGM), in the period between the end of the 19th century and the years leading up to the Second World War, documents springs, fountains and dimple springs. This information is of great value since it allows us to pinpoint the location of various types of springs prior to the considerable anthropization of the past fifty years which altered their appearance and behaviour.

Thus, by comparing historical and more recent data, we are able to obtain a comprehensive picture of areas with the most abundant groundwater resources (which are often also sites of historical, long-established settlements), highlighting springs historically used for human consumption.

Studies of these springs in general are useful for both hydrogeological and cultural-historical purposes.

STUDY AREA

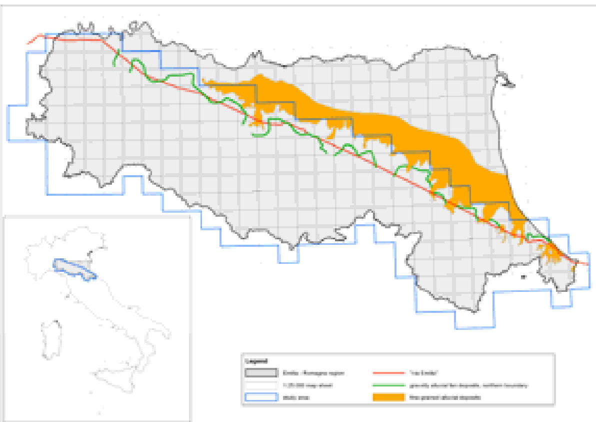


Figure 1 – geographic setting.

The study area lies between the southern regional boundary of Emilia–Romagna and the line determined by the boundary between the gravel deposits of alluvial fans and the finer sediments of the alluvial plain just north of the via Emilia road. Indeed, much thought was given originally to the line traced by this major communications artery; its position follows a morphological boundary as well as the ancient line of the karst springs known to the Romans. Figure 1 shows the geographic setting of the study area.

CARTOGRAPHIC ACQUISITION AND SCANNING

The Institute of Artistic, Cultural and Environmental Heritage of Emilia-Romagna Region (IBACN) provided the maps or "tables"[1], as they are referred to, (on transparent polyester film) of the series produced by the IGM titled "II° impianto". These were compiled around the 1930s and later updated.

The tables pertinent to the designated study area number 207 in total. Some of these (30) belong to a different series, given that the reference ellipsoid used was Bessell rather than Hayford, as for all the others. It became apparent, even at this early stage, that these tables would require a different approach.

GEOREFERENCING

The reference system adopted is UTMA-ED50, which differs from the European UTM-ED50 cartographic system solely in the false northing equal to –4,000,000.000000 m.

[1] *The tables form part of the Italian cartographic system, which comprises topographic sheets called "fogli" at scale 1:100.000 covering areas of 30' longitude x 20' latitude. Italy is covered by 277 such sheets, each of which is in turn divided into four quadrants. Each quadrant comprises four "tavolette" or tables at scale1.25.000*

For each table, a minimum of 8 points were calculated, distributed evenly over the vertices of the kilometric grid.
The number of points required for good georeferencing changed each time in accordance with image quality. In the presence of clear deformations (attributable to the scanning process or the intrinsic quality of the paper support) the number of points was increased whilst still striving to maintain the most uniform distribution possible. When deemed necessary, points were concentrated in the most critical zones.
In those cases where the tables provided by the regional cartographic archive had no kilometric grid, georeferencing was based exclusively on the four vertex points corresponding to the paper shear.

The georeferencing parameters of each table (number of points used, order of transformation and root mean square error) were entered in a table, as shown in the following diagram (table 1).

field name	field type	description
sheet	textual	Indicates the 1:100.000 sheet from which the table is derived.
table	textual	Table.
scanning	numeric	Number of dpi used for scanning the table.
points used	numeric	Number of points used for georeferencing
order	numeric	Order of transformation used for georeferencing.
rms	numeric	Root mean square error.

Table 1 – georeferencing parameters.

DIGITALIZATION

Before digitalization of points or springs using symbols visible on the maps, a table was compiled allowing for all the possible elements which would sooner or later have to be represented. During the compilation of this table, the structure of fields was expanded and completed, culminating in the definitive version described and represented in the diagram below (table 2).

Name of field	Type of field	Description
permanent	1/0	Indicates whether the spring, well, fountain, dimple spring or drinking fountain is perennial (active all year round) or temporary. This is represented on paper with the letter “P”. 1: perennial 0: temporary
mineralized	1/0	Indicates whether the spring, well, fountain, dimple spring or drinking fountain is sulphurous. This is represented on paper with the letter “S”. 1: sulphurous 0: non sulphurous The occurrence 1 is given also in the absence of the letter “S”, but in the presence of a place name indicating the particular chemical composition of the later, documented information.
type	textual	Represents the nature of the map element, identifying the following: spring well or fountain drinking fountain spring with tank uncertain spring This final occurrence is adopted wherever the symbol could not be clearly distinguished.
place name	textual	Name of the spring or fountain when indicated in document.
revision	1/0	Numerous tables provided by the cartographic archive, while maintaining all the other characteristics, differ from equivalent IBACN tables in that they represent a more up-to-date situation on the ground. As a result, it was deemed appropriate to indicate the symbols present on revised maps and not those on older versions. 1: present in revised map only 0: present in both maps

Table 2 – table structure associated with point vector layers.

RESULTS AND DISCUSSION

Three new data sets were obtained:

- A polygonal vector layer of index maps of IGM tables
- A table indicating the georeferencing parameters for tables
- A point vector layer of springs

Further information was obtained by combining these files.
Using a “join”, georeferencing data was added to the vector layers of the index maps. Subsequently, a “spatial join” was used to import RMS error data from the table to all points within it. In this way, every point has a parameter indicating the precision of location, based on the accuracy with which the table containing it was georeferenced.
Of a total of 307 tables at scale 1:25.000 which cover the territory of Emilia–Romagna region, 200 tables have been acquired and scanned.
The georeferencing phase was carried out for 170 of the 200 tables, the remaining 30 were created using the Bessell ellipsoid, hence a simple conversion of coordinates is necessary.
Of the 170 georeferenced tables, in 5 cases the georeferencing parameters were not calculated.
The remaining 165 tables have a root mean square error categorized as follows (see pie chart diagram 1):

- <2 [optimal error]: 134 tables, equal to 81.21 %

- 2 – 4 [negligible error]: 21 tables, equal to 12.73 %
- 4 – 10 [non negligible error]: 6 tables, equal to 3.64 %
- 10 – 20 [significant error]: 3 tables, equal to 1.82 %
- >20 [serious error]: 1 table, equal to 0.61%

Figure 2 shows the diagram and distribution of data throughout the territory.

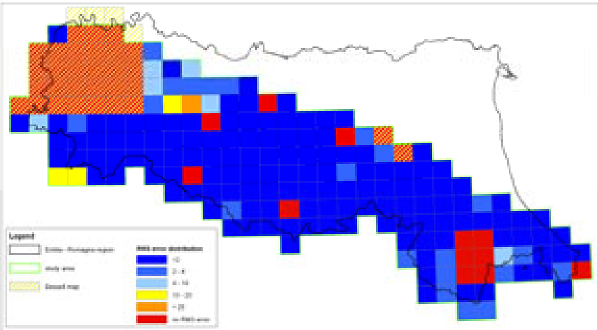
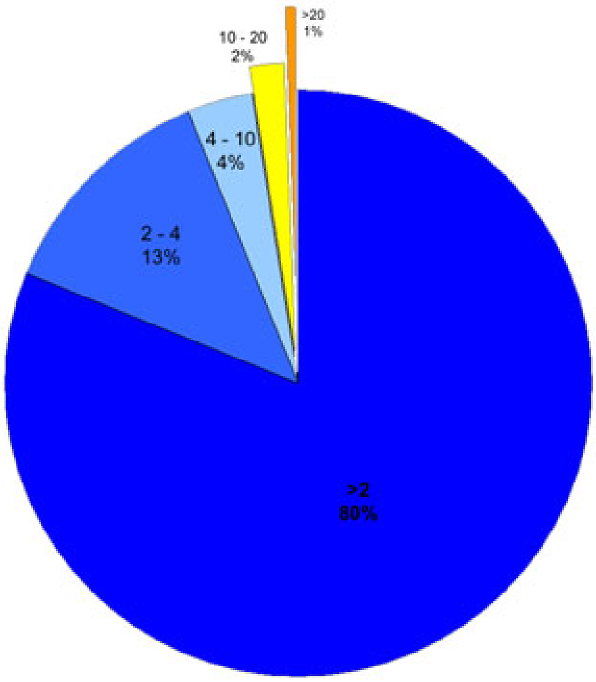


Figure 2 – territorial distribution of RMS error.



Pie chart diagram 1 – distribution of RMS error in percentages.

It is important to bear in mind that there is no uniformity between the tables. The various maps were produced by a number of different mapmakers and operators, who in turn used a range of support materials for printing.

For example, some tables make no distinction between perennial and temporary springs; in others the density of symbols relating to points is variable, as is the possibility of confusing them with themes relating to springs.

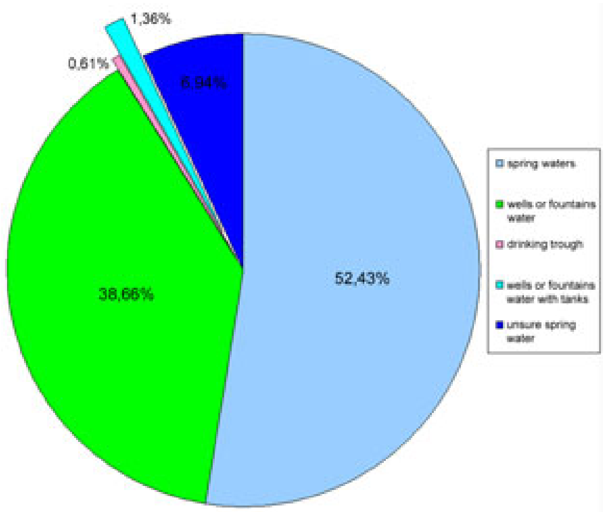
Moreover the quality, state of conservation and type of support (paper, transparent film, etc...) did not permit uniformity in corresponding digital copies.

In total some 9855 points were digitalized for the entire study area. 5167 are springs (with no distinction between perennial and temporary and including sulphurous springs), 3810 are wells or fountains (with no distinction between permanent and temporary), 134 are wells or springs with tanks, 60 are drinking fountains, and points with a significant degree of uncertainty number 684. The results obtained are described in diagrams 2 and 3.

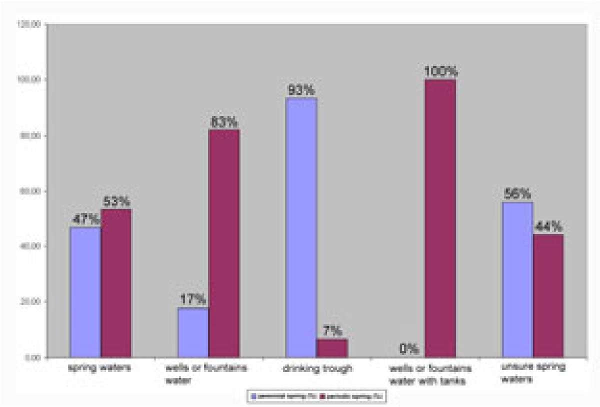
Springs represent 52% of digitalized points and are in general the most “reliable” theme given that it is easily recognizable and different from other symbols. Wells and fountains represent 39% of points. Identifying this type of theme is more difficult as they are easily confused with other symbols.

The theme of uncertain springs is reserved for those cases where it was not possible to distinguish between a spring (represented by a droplet) and a well or fountain (represented by a circle). There are also cases where this theme has been attributed to symbols which are very vague. In any case, the latter represent almost 7% of total points.

The theme of drinking fountains (which accounts for 0.6% of cases) was taken into consideration when the symbol (usually reserved for constructions) is accompanied by the letter “P”.



Pie chart diagram 2 – percentage distribution of the various types of point themes relating to springs.



Bar chart diagram 3 – comparison of permanent and temporary springs arranged by type.

CONCLUSIONS

The "historical" Topographic Map of Italy published by the *Istituto Geografico Militare* (IGM), in the period between the end of the 19th century and the years leading up to the Second World War documents springs, fountains and dimple springs. This information is of great value since it allows us to ascertain the location of various types of springs prior to the considerable anthropization of the past fifty years which significantly altered their appearance and behaviour.

Thus, by comparing historical and more recent data, we are able to obtain a comprehensive picture of areas with the most abundant groundwater resources (which are often also sites of historical, long-established settlements), highlighting springs historically used for human consumption; in addition, we are able to identify areas where groundwater resources have been "abandoned" and others not yet abstracted.

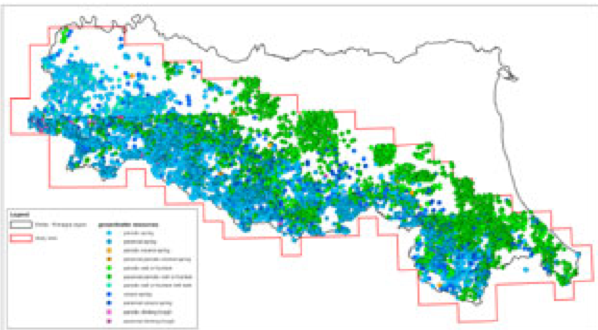


Figure 3 – result of point digitalization.

Studies of these springs are generally useful for both hydrogeological and cultural-historical purposes: for hydrogeological studies, pertinent data enables the identification of "reservoir rocks", while for cultural-historical studies they are a valuable tool for the surveying of fountains and the localization of historical or abandoned settlements.

Points corresponding to perennial springs were entered on a web map of the Servizio Geologico, Sismico e dei Suoli website (http://www.regione.emilia-romagna.it/wcm/geologia/canali/acque.htm). The position and distribution of points largely confirms prior knowledge of "reservoir rocks" of Emilia-Romagna region. This new vector layer further boosts our knowledge of groundwater resources and circulation. Moreover, as regards areas which require protected status, it is yet another tool for optimum demarcation of the boundaries of vulnerable areas.

ACKNOWLEDGEMENTS

Special thanks to Renato Tegoni for his advice and expertise in this field and to Roberto Bertozzi for his technical support.

GEOSPATIAL INFORMATION SYNTHESIS FOR MINERAL EXPLORATION USING BAYESIAN NEURAL NETWORKS (BNNS)

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KEY WORDS: Bayesian neural network, copper porphyry, feature extraction, mineral deposit model.

Abstract

Artificial Neural Networks (ANNs) is a powerful tool to simulate multivariate systems in the Computational Intelligence (CI) based methods. This methods has been used frequently in the geospatial information synthesis for mineral exploration. But conventional artificial neural networks needs to high sample data and it makes difficulties in the cases with low sample data, which has insufficient training patterns.
In this paper, a Bayesian Neural Network (BNN) has been used to simulate porphyry copper mineralization in the study area as a complex and multivariate system.

Introduction

Mineral deposit exploration is the process of searching for undiscovered mineral deposits. Behind of this simple statement there are complexity and diversity of decisions and processes that make architecture of modern mineral deposit exploration using geographic information systems and geospatial databases. The ultimate result of all geospatial information synthesis for mineral deposit exploration can be consider as mineral-potential mapping, which can show probable high potential to low potential areas of mineralization. In other word, mineral-potential mapping subdivides areas according to mineral favorability and carried out in commercial exploration programs or in governmental mineral-resource assessments (Bougrain et al, 2003).
Mineral deposit exploration researches using different geospatial information for geospatial synthesis is more effective in the accuracy of the ultimate results(Pan and Harris, 2000). CI-based approaches methods could analyze all data simultaneously in a different and more useful kind of reasoning system in GIS. In this research geospatial explorations data of a part of Ahar area in the NW Iran has been synthesized for copper phorphyry deposit mineralization potential mapping (figure1). The study area has been known as high potential area for different kind of the mineralization specially porphyry copper.

Famous Sungoon porphyry copper is occurred in the study area and with simulation of its properties can model geospatial exploration information to predict new mineralization area. For this purpose, at first geospatial information has been managed in a proper geodatabase system. Then the Mineral Deposit Model (MDM) of the study area has been realized. This conceptual method is the result of both description (empirical) and genetic (theoretical) methods for realizing the patterns of porphyry copper mineralization system in the study area. In continue, the best methods for feature extraction from every geospatial layers has been selected.

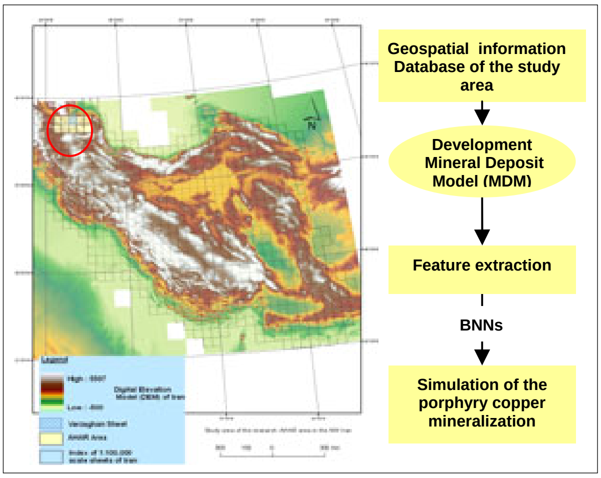

Figure 1 – Location of the study area on DEM map of Iran and general steps of the BNNs approach for simulation porphyry copper mineralization in the study area.

Geospatial Data
x1=Regional structures
x2=Local structures
x3=Intersect of regional structures
x4=Altration area (emote sensing)
x5=Geological map (Pluton units)
t_total=Mine&indication

Figure 2 – Existing Geospatial Data layers in the study area that has been used for feature extraction according Mineral Deposit Model (MDM) to generate input and output traning (x) and testing (t) data in a BNN.

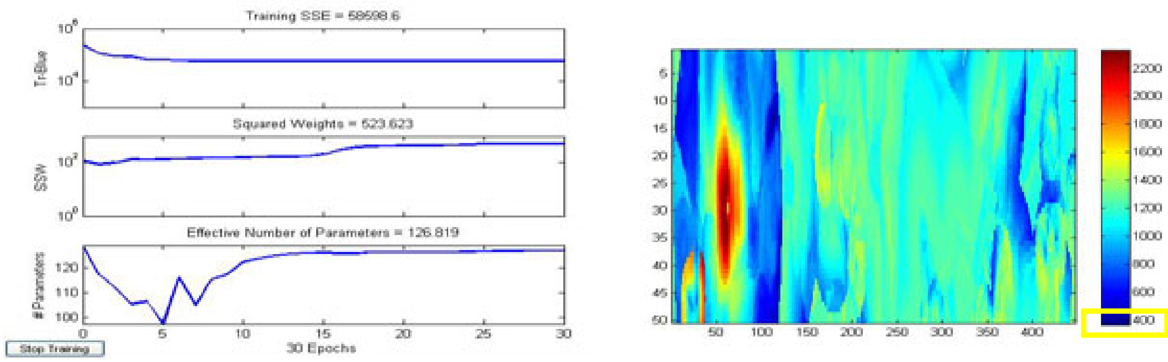

Figure 3 -The performance of the BNN with 17 hidden layers in the 50 epochs and the result of the simulationin.The best result of simulation regarding to existing porphyry copper mine and indications are in the color range whichhas beenshown in the yellow box.

Bayesian Neural Network

The Bayesian framework for back propagation networks or Bayesian neural network was firstly introduced by McKay in 1991. Bayesian learning can improve training power of the neural network in the low sample data input cases. The novelty of the study lies in the use of Bayesian learning instead of the Back propagation part of a feed forward neural network for simulate copper porphyry mineralization in the study area. Bayesian Neural Networks (BNNs) combines statistical learning and neural networks properties as universal function approximator.

As mentioned before, the existing geospatial information for porphyry copper mineralization in the study area has been processed according the conceptual model of mineralization. Extracted features or variables of the mineralization system are synthesized as multidimensional arrays with continues scores by Bayesian Neural Network (BNN). In this way, prior knowledge, building the best architecture for neural network, input selection, parameter estimation and outputs properties are crucial to reach the best result. Here a neural network with specified architecture A was trained using a data set

D= {(x(1), t(1)), (x(2),t(2)),...,(x(N),t(N))}

By adjusting connections **w** so as to minimize an objective function or error function as follows (figure2):

$$E_D(D \mid w, A) = \sum_{m=1}^{N} [y(x^m \mid w, A) - t^m]^2$$

Bayesian regularization improves the generalization power of neural networks. When using Bayesian regularization, it is important to train the network until it reaches convergence. The sum of squared errors, the sum of squared weights and the effective number of parameters should reach constant values when the network has converged (figure3). Bayesian regularization generally provides better performance compare to early stopping when the networks are used for the function approximation, because Bayesian regularization does not require a validation data set except the training data set. It uses all of the data.

Conclusions

Result of the simulation by BBN has acceptable results regarding to the existing porphyry copper mine and indications in the study area (Figure 3). As mentioned before, Bayesian Neural Networks (BNNs) combines statistical learning and neural networks properties as universal function approximator in the simulation. For future work using geochemical data also may improve the results.

Aknowledgment

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ASSESSING GROUNDWATER QUALITY IN THE FRIULI VENEZIA GIULIA ALLUVIAL AQUIFERS, NORTH-EAST ITALY.

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KEY WORDS: Hydrochemistry, Groundwater maps, Aquifers, Water management, Italy, pesticides.

INTRODUCTION

In the Friuli Venezia Giulia alluvial plain, northern Italy, irrigated agriculture plays a very important role in the region's economy. Therefore the characterization of the transfer of pesticides to and in groundwater is essential for effective water resource management. A suite of chemical and isotope tracers have been analyzed in the confined and unconfined aquifer systems of the northern Italian alluvial plain to determine likely recharge sources, ground water residence times, and the extent of mixing between local and intermediate flow systems, presumably caused by large well screens. The Friuli Venezia Giulia is bounded by the Julian and Carnic Alps in the north, by the Classical Karst to the east and opens to the Adriatic Sea to the south.The total area of the basin's watershed is 3,500 km^2. The regional hydrogeological situation of the Friuli Venezia Giulia Plain is characterized in the north by an extensive alluvial unconfined aquifer some hundred meters thick. This area extends from the Pre-Alps to the resurgence belt. This zone covers a strip of plain 2 to 8 km wide and 80 kilometres long. In this strip of plain the water table intersects the topographic surface forming numerous plain springs and rivers (Mosetti, 1983; Fontana, 2006). The resurgence belt sets a boundary between the high and middle-low plain. In this strip the unconfined aquifer changes into a multi-layered confined that reach a thickness of up to 500 m with a progressive increase towards the Adriatic Sea. The Friuli Venezia Giulia Plain has been formed by river systems (mainly Tagliamento and Isonzo) as well as deposition and reworking of marine and terrestrial deposits that formed during different climatic periods. From a geomorphological and hydrogeological perspective, the FVG Plain has two provinces separated by a resurgence belt. The Upper Friuli Plain, composed mostly of calcareous and dolomitic gravels, characterised by the lack of surface drainage waters hosts an unconfined aquifer (up to 180 m thick). The Lower Friulian Plain is characterized by multi-layered confined aquifers that have been subdivided in shallow and deep confined aquifers (up to 350 m thick), separated by a 10 to 25 m thick impermeable layer of silty material found at approximately 100 to 120 m depth (Cucchi et al., 2008).

MATERIAL AND METHODS

One hundred and forty nine wells were selected from the physical-chemical characteristics database of ARPA FVG, all of which have chemical analyses available dating from 1995 to date. Sample location, type, electric conductivity (EC), pH, total dissolved solids (TDS), temperature (T), alkalinity (Alk), total hardness (TH), Sodium Adsorption Ratio (SAR), major ions, triazinic content and stable isotope ($\delta^{18}O$) have been analysed The water temperature, electrical conductivity (EC) and pH of each sample were measured *in situ* by ARPA FVG with a conductivity meter standardised to 20 °C and a pH electrode previously calibrated with standard buffers. The water samples were chemically analysed by ARPA FVG by atomic absorption spectrometry (Ca^{2+}, Na^+, K^+, Mg^{2+}, accuracy 5–10%) and ion chromatography (Cl^-, SO_4^{2-}, NO_3^-, HCO_3^-, accuracy 5–10%). Triazinic analytes (ATZ and DATZ) were made by ARPA FVG by hyphenate technique, i.e. gas chromatography—mass spectrometry. TDS, Alk, TH and SAR were calculated using Aquachem version 4.0 whereas the saturation indices (Table 1) were calculated with PHREEQC (Parkhurst et al., 1980). A subgroup of 128 of the 149 wells were selected for stable isotope ($\delta^{18}O$). Isotopic analyses were carried out at the University of Trieste on a VG Optima mass spectrometer. The oxygen isotopic composition ($\delta^{18}O$) was measured by means of a water-CO_2 equilibration technique at 25°C (Epstein and Mayeda, 1953). The values are reported as per mil deviations from the VSMOW standard.

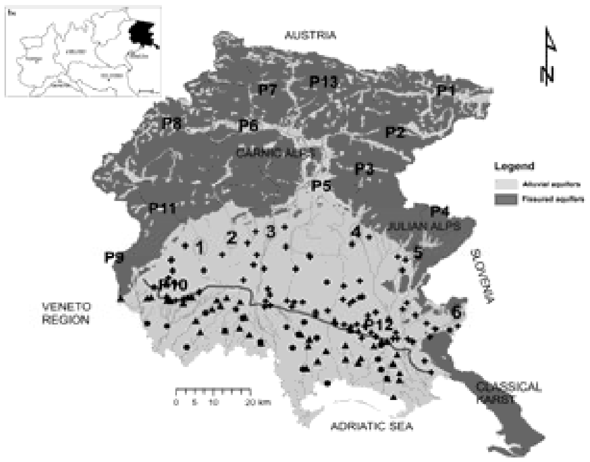
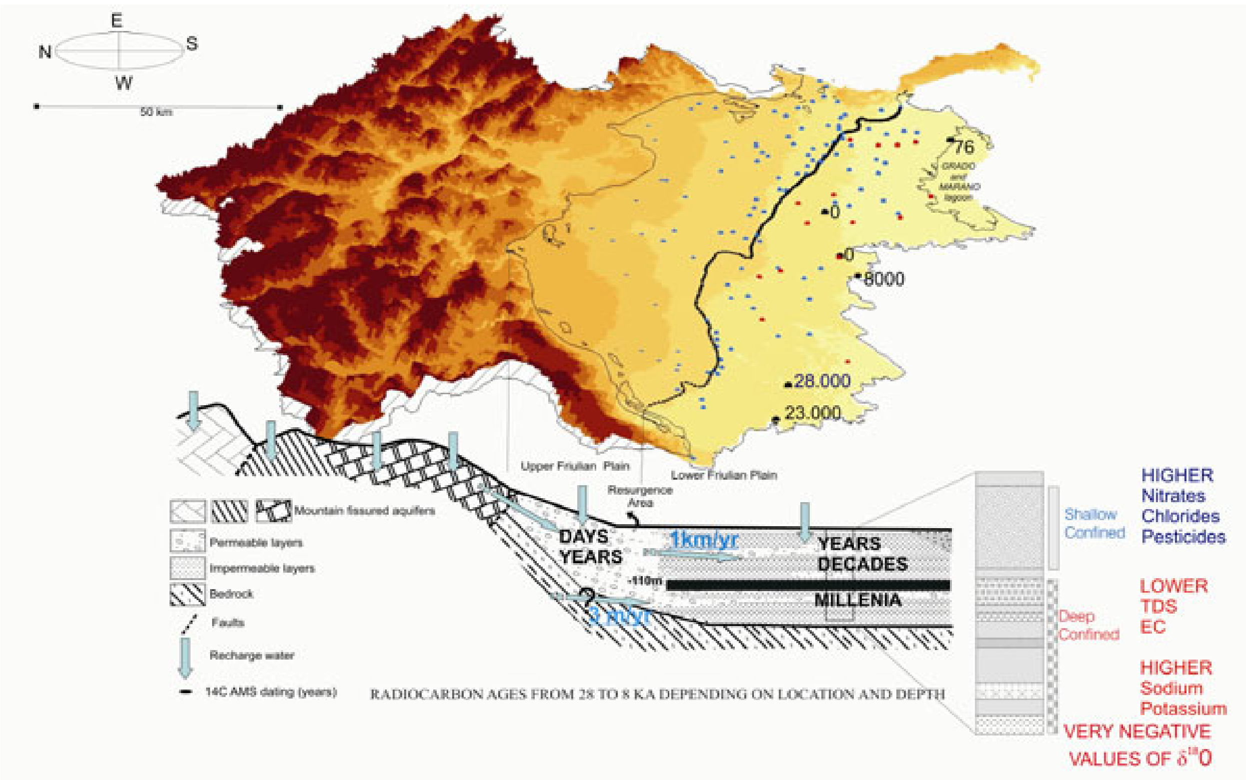


Figure 1 –Location of the study area (P=Pluviometer, crosses=unconfined samples, triangles=SC samples, circles=DC samples; 1-6 FVG major rivers.

General geographical distribution of the groundwater samples has been performed based on Kriging technique of the major ion distribution, stable isotope and pesticide distribution data using ArcGIS by Esri.

The pattern of geochemical, pesticides data and stable isotope variations suggests that the unconfined and shallow confined groundwaters are recharged mainly by rainfall and local river infiltrations. This fast recharge process makes these groundwaters susceptible to contamination by discharge from urban areas and small-scale industries. Four hydrogeological provinces have been recognised for these subsurface groundwaters.

These maps identify the mode and degree of agricultural pollution in view of possible future degradation of their quality due to increasing human activities.



DISCUSSION AND CONCLUSION

Figure 2 – Summary of the geochemical data for the Friuli Venezia Giulia Plain aquifers.

The geochemical data, presented in the form of GIS-based geochemical maps, provide a baseline that can be used as a useful diagnostic tool to monitor the hydrochemical evolutions.

Radiocarbon dating indicates that there is very little continuity between these aquifers and the deeper aquifers that have more complex groundwater circulations that have probably substantially changed during the varying temperature regimes of the Holocene-Pleistocene. Comparison with deep confined aquifers in other regions of the Padain Plain indicates that the recharge rates of these deep confined aquifers are low and that, consequently, the deep groundwaters are impacted by over abstraction.

ACKNOWLEDGEMENTS

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GIS MODELLING AS A TOOL FOR SPATIAL PLANNING DECISION – MAKING FOR STONE AGGREGATE SITES IN DALMATIA

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KEY WORDS: GIS, mineral resources, ArcSDM, stone aggregate, quarrie, weights of evidence (WofE)

INTRODUCTION

The aim of the paper is presentation of GIS based modelling for stone aggregates potential in Dalmatia. The low consumption of aggregate in the region (less than 30%) of EU average is putting pressure on local authorities for the access to new extraction sites. The GIS model allows resource management and priorities of potential mineral extraction areas and sites in Dalmatia while taking in account both environmental or marketplace needs.

MINERAL RESOURCES OF CROATIA AND STUDY AREA OF DALMATIA

Mineral resource map of Croatia include more than 4000 mineral occurrences and deposits. The Croatian non-metals and stone industry are the most essential part of Croatian base industry.

Croatia has a wide range of non-metallic raw materials. The mineral deposits of non-metallic raw material include silica, sand, bentonite, ceramic and brick clay, gypsum, tuff, marl, dolomite, limestone and gravel used for building materials and architectural stone. Sea salt is also produced. The explored but non producing deposits consist of quartzite, barite, and graphite.

Croatia has 626 exploitation sites, covering less than 400 km² of territory, mostly crushed stone aggregate (253) sites, dimension stone (103) sites, and gravel and sand which are used as building materials.

The study area (Dalmatia) is located in southern part of the Republic of Croatia (covering 36,473 km², and with a population of 855,000). In Dalmatia there are 68 active crushed stone aggregate quarries (25% of sites in Croatia) and 82 active dimension stone quarries (80% of sites in Croatia).

Exploitation reserves of dimension stone are 13.5 mil. m³ (80% in Dalmatia), and exploitation reserves of crushed stone aggregate are 350 mil. m³ in Croatia (25% in Dalmatia).

The economic development of county as in general, is reflected with increase demand for stone aggregate in the region and their production from 1997 to 2003 (Fig. 1).

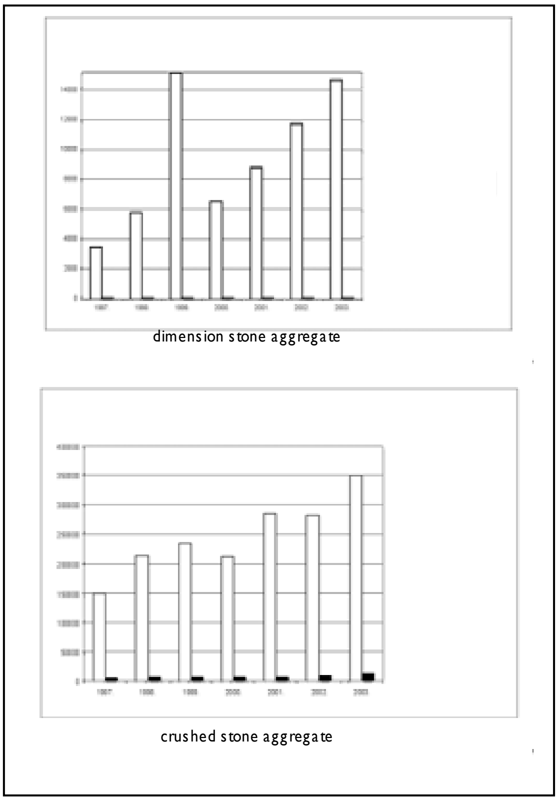

Figure 1 – Graphs of increase production of crushed and dimensional stone aggregate in Croatia from 1997-2003

WEIGHT OF EVIDENCE (WofE)

Geographic Information Systems (GISs) are very useful exploration-oriented tools for processing of spatial data, which enables the production of potential maps for stone aggregates (ROBINSON et al. 2004). Weights of evidence analyses (WofE), modelling was used to measure associations between the sites and different spatial features in a way that their individual effects could be evaluated and used to infer relative influence on development.

The WofE analysis approach is a quantitative method using evidence to test a hypothesis. The results of this analysis can be used to describe and explore relations in spatial data from diverse sources, make predictive models, and provide support for decision makers. The WofE analysis method was adapted to GIS for mineral potential mapping by Bonham-Carter, Agterberg, and Wright (1988) and Agterberg, Bonham-Carter, and Wright (1990), and the method is summarized in RAINES, et al., (2000).

The method tests the hypothesis that the area is suitable for occurrence of a mineral deposits site, defined by a set of response variable point locations (termed *training sites*), relative to a set of predictor variables (termed *evidence*). In the mineral resource- potential mapping example presented here, the training points are the set of locations of active crushed stone quarries and the predictive evidence consists of geology, transportation network, and population distribution spatial data.

For each binary evidential theme, a pair of weights is calculated relative to the training sites, one for presence of the evidence criterion (w +), and one for absence of the evidence criterion (w-).

The magnitude of the weights depends on the measured spatial association between the evidence criteria and the training sites (crushed stone quarries) in the study area.

WofE analysis was used to analyze spatial associations among the training sites relative to the multiple evidence categories and to reclassify the evidence categories into binary or multiclass groups for optimal prediction.

Three evidential theme layers were used for predictive evidence:

(1) bedrock potential-geology map with general characteristics highly suitable for aggregate derived from 20 maps sheets in digital format from compilation of basic geological maps of Republic of Croatia in scale 1:100 000.

(2) proximity to the transportation network was into groups at distance intervals of 2 km and 4 km. Most of the crushed stone quarries are sited within 4 km of principal highway or a rail line in the region. These relations illustrate the importance of proximity of transportation corridors to the industry.

(3) spatial population density information (people pre km²), the population density distribution was divide into six intervals with similar range. In Dalmatia, 80 % of crushed and dimension stone aggregate occur in census tracts with population densities exceeding 50 people /km², illustrating the importance of proximity to the urban communities.

All evidential theme layers were prepared in grid format using ArcView 9.2. and Arc-SDM extension (KEMP et. al, 2001). Each grid has a cell size of 100 m, which is less than the minimum spatial uncertainty of the evidential theme source data.

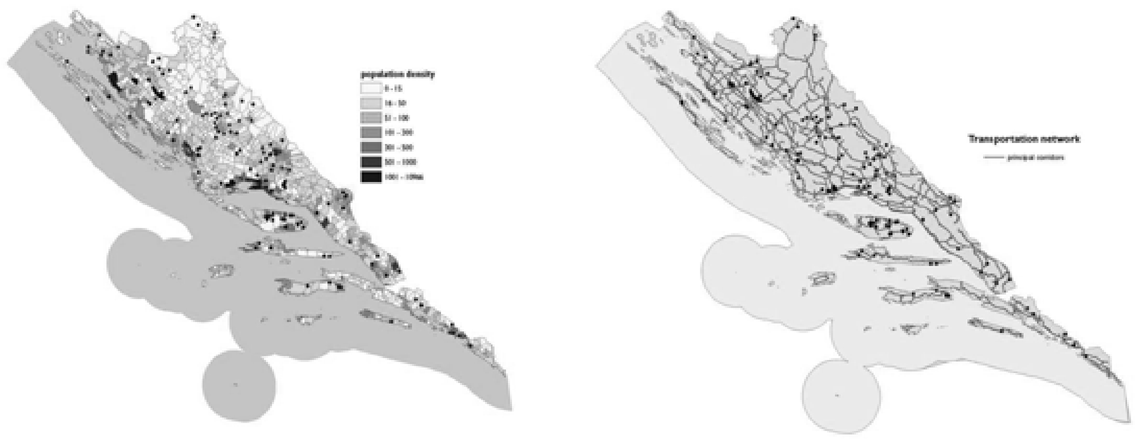

Figure 2 – Study area with predictive evidence of spatial population density and proximity to transporation network

RESULTS

Geology provides the stongest predictive evidencefor crushed stone quarry locations followed by population density and transportation evidence based on the WofE contrast evaluated for both binary and muliticlass models. Final products are different suitable area for aggregate production, divide to four class high, moderate, generally and low suitability.

After administration restrictions have been applied on geological potential, we have restricted geological potential area whichs shows (dimensional and crushed stone aggregate quarries). The next phase would be application and validation of the devoloped model to the most suitable areas for extraction, so that it could be a method applicable and used on the whole teritory of Croatia as an aid to the spatial planners to manage better the use of mineral resources in based on identification of more suitable areas for stone production taking in account both environmental and marketplace restrictions.

AKNOWLEDGEMENT

We are grateful to Ministry of education, science and sport for financial support in the project No 181-1811096-1104 “Mineral resource map of the Republic of Croatia”.

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GEOLOGICAL SUITABILITY MAPPING OF PLEISTOCENE FLUVIO-ESTUARINE DEPOSITS.

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KEY WORDS: Quaternary, fluvial deposits, Eemian, Weichselian, layer model, overburden, geotechnical maps.

INTRODUCTION

In Flanders, sandy Quaternary deposits are abundant in a region called the “Flemish Valley”. It is an ancient valley system that was formed by cutting in deep into the Tertiary strata during the Late Pleistocene. The main cut-in phases occurred during the beginning of the Saale and Weichsel ice ages, triggered by a lowering of the sea level at that time. The multiple phase infill occurred during the Saalian, Eemian and Weichselian stages and represent complex niveo-fluvial and estuarine deposits.

These sandy deposits, that can reach thicknesses up to 35 meters and more, are at present exclusively used for low-grade applications (mainly fill sands). In order to use the sands for more high-grade applications (construction sands), and to locate future areas suitable for sand extraction, a new evaluation of these deposits is necessary.

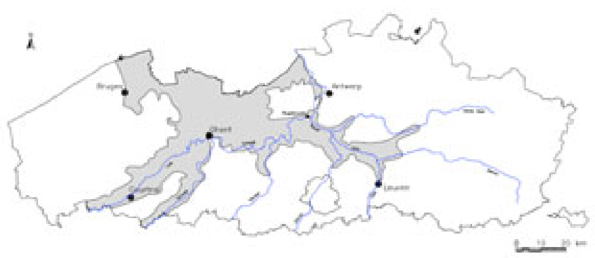

Figure 1 – Location of the ‘Flemish Valley’ area in Flanders (Northern part of Belgium)

METHODOLOGY

The Quaternary deposits in the Flemish Valley display very heterogeneous lithologies, resulting from the succession of multiple cut-in and filling phases and from rapidly switching depositional environments. Great differences occur over small distances, both lateral and vertical. A new simplified layer model is introduced here in order to map these heterogenic deposits in an orderly way. In the latter simplified model, the Quaternary deposits are divided into four distinct layers: a cover layer on top, a layer with the main part of the infilling sediments, a loamy layer and a valley bottom layer, containing the coarse valley bottom infill (Figure 2).

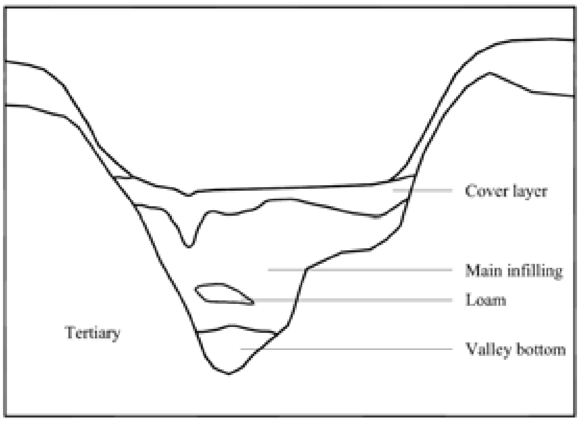

Figure 2 - Schematic view of the simplified layer model.

Over 14000 boreholes (DOV – Database Subsoil Flanders – http://dov.vlaanderen.be) have been drilled in the Flemish Valley area. At each drilling site, the reported and described Quaternary sedimentary deposits are grouped according to the above simplified scheme. It is obvious, however, that not all of the layers are present within each drilling site. It is possible that a layer is absent in a certain area or, on the other hand, a drilling can be too shallow to reach all of the layers.

The cover layer corresponds to the top deposits that represent the “overburden” for sand extraction. This cover layer consists mainly of fine-grained Holocene alluvial deposits and polder clay deposits.

The main infilling layer groups the major part of the original sediments of Weichselian and Eemian age that filled in the Flemish Valley. The latter sediments are rather heterogeneous, ranging from coarse sand to clay. They also contain sandy aeolian deposits from Late-Weichselian to Early-Holocene age. These cover sands are, despite their younger age, added to this layer because of their suitability with respect to sand extraction.

In the deeper parts of the fluvial system, coarse sands and gravel lie directly on top of (erosional contact) the Tertiary sediments. These coarser deposits (the valley bottom fill) form the basalmost part of the Flemish Valley deposits. They are fluvial in origin and of Eemian and Weichselian age. Some remnants of Saalian deposits can also be present in the westernmost coastal region of the studied area.

After grouping the sediments into the above categories, the sediments of each layer are studied in greater detail. The sediments within a single layer are converted into one single lithology type. This simplified lithological description is preferred because it gives the best overall view of the sediments present within the layer.

For a limited number of boreholes however, this poses a problem. In some cases, a series of loamy deposits (lenticular bed) is present within what would normally be considered as the main infilling layer. When focussing on the presence of the loamy deposits in the sand (which is a negative quality parameter), the importance of the upper sandy part of the main infilling, possibly suited for sand extraction, is lost (because the whole of the main infilling will become, at best, impure sand). When, on the other hand, the loamy deposits are totally ignored, the depth to which sand can be extracted will be rather overestimated. To handle this problem, the main infilling layer is split up into two sub layers: an upper more sandy sub layer and a lower loam-rich sub layer. In this way, the lithology of the upper part of the main infilling (i.e. the part above the loamy sediments) is taken into account and becomes part of the main infilling layer.

So at the end, after completing these conversions for all of the drillings, each drilling will display one specific type of lithology for each layer present. These data are stored in a database which can then be used for interpolation and generation of digital maps.

CREATING MAPS

After interpreting all of the drilling data and after conversion of the lithologies, the resulting information is transformed by GIS-tools into 'geological suitability maps'.

A first important step is creating isopach maps of the Quaternary deposits. Besides borehole data, also data from cone penetration testing are used. The isopach map is constructed using non-equidistant isopachs, because there are more data available for the shallower Quaternary deposits than for the deeper parts.

Next, an isopach map of the cover layer deposits is constructed. Equidistant isopachs of 2m are used to get a detailed view of the potential overburden for a sand extraction pit. The lithology of this cover layer is less important, since it consists solely of sediments that are not suited for sand extraction (clay, loam, peat, etc.).

Perhaps the most important map is the map outlining the lithology of the main infilling layer. In order to construct a comprehensible map, the broad spectrum of lithologies is narrowed down to 7 lithological classes: coarse sand, sand, fine sand, impure sand, loam, sandy clay and clay. An interpolation between the drillings is then performed which leads to a map with the most likely lithology (class) to be found at one specific location.

In areas with a loamy layer present in the subsurface, the potential sand extraction depth is limited by the depth of the top of this loamy layer. Therefore, an isohypse map (equidistance 1m) of this top is constructed.

Criterium / Group	Very suitable *(1)*	Suitable *(1)*	With cover layer *(2)*	Less Suitable	Unsuitable
Cover layer	maximum thickness 2m	maximum thickness 2m	thickness between 2 and 6m	thickness over 6m	-
	and	**and**	**and**	**or**	**or**
Lithology	coarse sand	sand, fine sand	coarse sand, sand, fine sand	impure sand	loam, (sandy) clay
	and	**and**	**and**	**or**	
Quaternary thickness	minimum thickness 6m or Tertiary is sand	minimum thickness 6m or Tertiary is sand	minimum thickness 10m or Tertiary is sand	less than 6m *(1)* or 10m *(2)* and Tertiary is clay or silt	-
	and	**and**	**and**	**or**	
Depth top loamy pack	minimum 6m or absent	minimum 6m or absent	minimum 10m or absent	less than 6m *(1)* or 10m *(2)*	-

Figure 3 – combination matrix outlining suitability towards sand extraction.

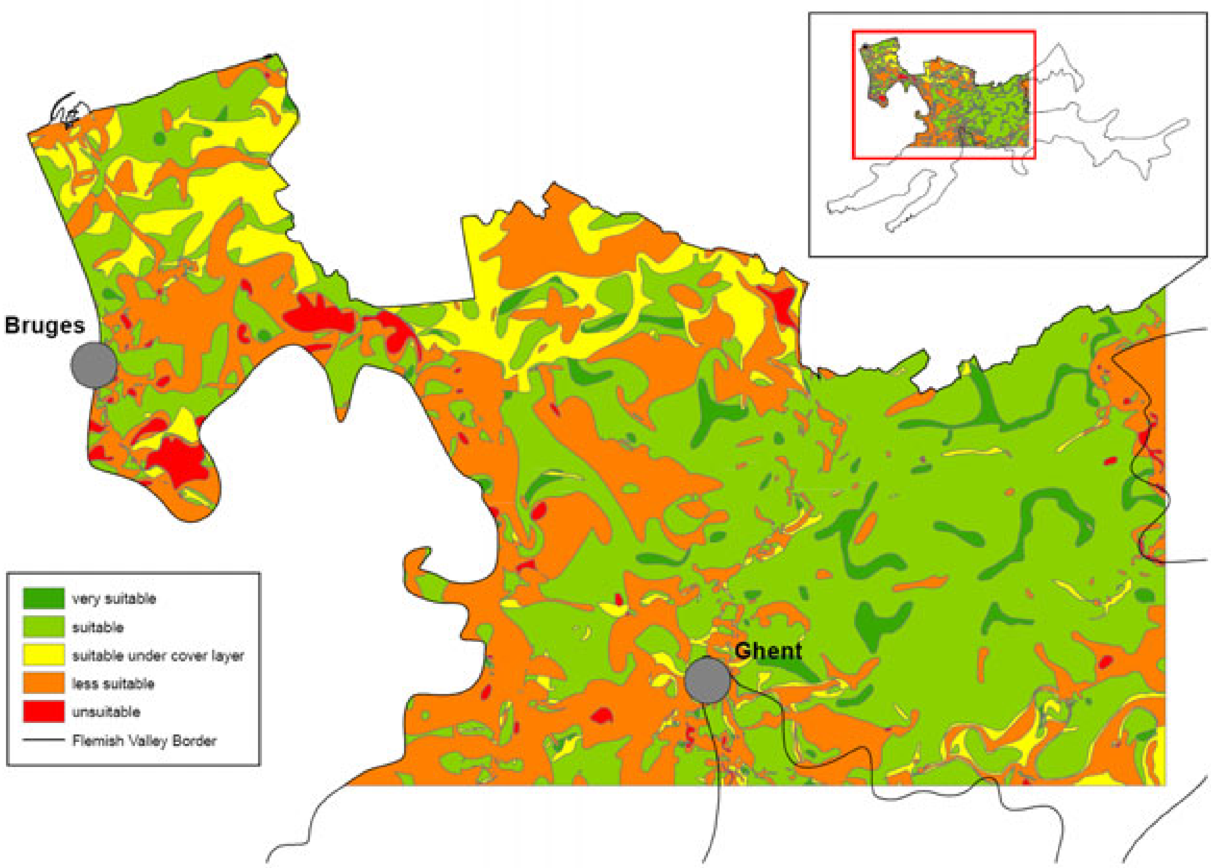

Figure 4 – Geological suitability map (based on the criteria in the combination matrix)

In order to assess at a glance whether or not a specific location is suited for sand extraction, a 'geological suitability map' is constructed, combining all of the previously generated maps. On this map, 5 suitability categories are used with respect to the possible extraction of (construction) sands. These are: 'very suitable', 'suitable', 'suitable but under cover layer', 'less suitable' and 'unsuitable'. The different criteria were chosen in agreement with the Land and Soil protection, Subsoil and Natural Resources Division of the Flemish Government.

The criteria used for constructing these suitability maps are listed in a combination matrix (see Figure 3). This combination matrix takes into account the amount of overburden, the lithology, the thickness of the Quaternary deposits and the presence or absence of the loamy layer. These criteria can always be modified and adapted to changing economic or extractive conditions.

An example of a geological suitability map is shown in **Fehler! Verweisquelle konnte nicht gefunden werden.**.

CONCLUSIONS

In the past, the sands extracted from the Flemish Valley were almost exclusively used for low-grade applications (fill sands) because of their supposed overall low quality. Recent re-interpretation of the available geological data and a new mapping methodology applied to these Quaternary fluvial deposits has proven that it is possible to find, locally, sands that can be used for higher-grade applications (construction sands). These higher quality sands are expected to be found in the areas classified as 'very suitable'. It is recommended, however, to look at their particle size distribution and to analyze their chemical composition, before setting up a new sand extraction unit.

Furthermore, these geological suitability maps provide civil services (who will not necessarily have a good geological background) with a simple evaluation tool that can be used for future planning of additional sand extraction locations.

A great advantage of using this type of mapping technique is that it is possible to quickly generate a new geological suitability map when parameters change, since the base maps are already available.

AKNOWLEDGMENTS

We are grateful to the Land and Soil Protection, Subsoil and Natural Resources Division of the

Environment, Nature and Energy Department of the Flemish Government for permission to publish the results of the ongoing mapping project in the Flemish Valley. We would also like to thank DOV ('Database Subsoil Flanders' – http://dov.vlaanderen.be) for allowing us to use their drilling and cone penetration test data.

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SECURING THE SUPPLY OF RAW MATERIALS IN BAVARIA – A VIEW OF THE BAYERISCHE INDUSTRIEVERBAND STEINE UND ERDEN E.V.

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KEY WORDS: Bavaria, industrial association, raw materials, regional schemes, mineral resources, protectorates, geographical information system, GIS.

Abstract

There are very important industrial minerals in Bavaria like sand and gravel, different natural stones, clay, silt, and gypsum. Every resident of Bavaria uses every year approx. 7 t sand and gravel, all together approx. 12 t raw materials. One of the major tasks of the industrial association for sand and gravel is to secure the supply of raw materials to satisfy the requirements for the whole economy. Therefore different areas were fixed in regional schemes for mineral resources.

Major task of the Bavarian industrial association

As an industrial organisation of enterprises we represent the interests of the Bavarian non-metallic mineral processing industries to the public, state, social partners and sciences (www.steine-erden-by.de). We try to solve conflicts through decision making through consensus.

We have over 700 members who are responsible for more than 15000 jobs, for a sustainable raw material production and an ecological renaturation and recultivation. One of the major tasks of the industrial association is to secure the supply of raw materials to satisfy the requirements for our companies and the whole economy.

Mineral resources of Bavaria

Bavaria is rich in mineral resources like sand and gravel, different dimension stones, silt and clay, gypsum, limestone, industrial minerals (kaolin, feldspar, bentonite, silica, quartz and salt).

These domestic mineral resources were mainly used for the building sector, dimension stones and different industries like glass ware, ceramic and chemical, paper, steel and electrical industry.

Each resident of Bavaria uses every year approximately 7 tons sand and gravel, all together approx. 12 tons raw materials (Tab. 1). With 85 million tons per year sand and gravel is the number one of the mineral resources of Bavaria, followed by the natural stones with 35 million tons per year.

Table 1 – Demand on domestic raw material for every resident per year in Bavaria (BayStMWVVT, 2002).

raw material	weight [kg]
sand and gravel	7.000
natural stone	2.900
silt and clay	830
cement material	720
industrial minerals	625
limestone	250
gypsum and anhydrite	85
dimension stones	30
	12.440

Securing the supply of raw materials

One of the major tasks of the industrial association for sand and gravel is to secure the supply of raw materials to satisfy the requirements for our companies, the whole state and economy.

The Bavarian land development program (LEP 2006) regulates that mineral resources are the main basis for every industry. As an essential requirement for the economic development of the country the main goal is to secure the supply of raw materials. The LEP makes also clear that a shortage of resources through competing usages leads to extensive rising prices in the building sector. Therefore the production of mineral resources is a public interest. One of the main goals of the LEP is to secure the usage of raw materials. The mining for raw materials leads to different conflicts of interests. It is necessary for the regional development and country planning to coordinate these different interests by dint of the regional planning.

Our industrial organisation proposes raw material areas in a technical paper to secure the demand for the non-metallic mineral processing industry. After a consideration of the different interests these raw materials were fixed and concluded in regional schemes for mineral resources through the regional planning staff.

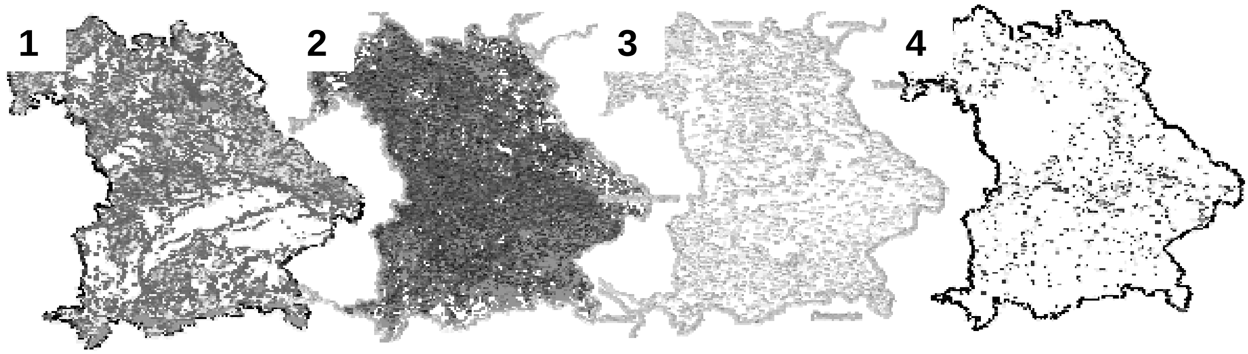

Figure 1 – Protected areas in Bavaria: Nr. 1: Nature and landscape conservancy, Nr. 2: Memorials, Nr. 3: Water protection areas, Nr. 4: Mineral resource areas in regional schemes (© Bayerisches Umweltministeirum, Bayerisches Landesamt für Umwelt, Bayerisches Landesamt für Vermessung und Geoinformation, Bayerisches Landesamt für Denkmalpflege).

The planning staff always keeps in mind that locations for raw material mining are bounded, rare and that the pollution of the environment should be avoided. The government validate it. This regional scheme should secure the present and the future demand for raw materials. These areas for mineral resources vary in there priority status: priority and reserved areas (VR) and exceptional areas (VB).

Figure 2 – Artificial walls for sand martins – constituted through the raw material production of sand.

Protected Bavaria

Approximately 4.4 million hectare of Bavaria is protected by nature, forest and planning law (Fig. 1). This is approximately 63 % of the countries territory. Several areas are ternary (15 %) or seven-time (7 %) protected. Natura-2000 areas cover 11.3 % of Bavaria.

Bavaria is covered with a lot of raw materials and many protective areas. Therefore different planning collides with each other.

Because of this reason the administration, the different departments and the non-metallic mineral processing industries are looking for flexible solutions. Therefore they should keep in mind that the interference through the raw material productions is only a temporary use.

The production of raw materials mostly takes place in intensive used agricultural areas or in forests with spruces or pine monocultures. In the majority of cases impulses for biodiversity come from the raw material production which leads to an enrichment of the fauna and flora (Fig. 2).

GisInfoService – a modern information platform

GisInfoService is the realisation of the leading project "GeoRohstoff" of the commission for geographic information from the Federal Ministry of Economics. The ministry support the development of a geographic information platform in Germany (www.gdi-de.de). They also help the economy for using geo-data.

The main goal of the national project “GeoRohstoff.org” is to make public geo-dates available for our raw material production industry (Fig. 3). The companies have the possibility to secure the raw materials and do their planning via a browser-based GIS-system.

Figure 3 – Website for the raw material production industry: www.Georohstoff.org.

The system GisInfoService (Fig. 4) allows the members of the different associations and organisations in Germany to have an up-to-date view for example over the protectorate banishments for the future or present company locations.

Before the system works properly a lot of meetings have to be done with the original owner of the data, the administration departments like the State office for topographical survey. In Bavaria a lot of these data are free of charge, except for the topographical data. To calculate the price a testing period was arranged to see how many and often the members uses this service. On this basis a fair price can be calculated.

Figure 4 – The internet portal for the members of the different associations: www.gisinfoservice.de

The main advantages of the web-based system are:

- fast and up to date information over the requirements of the environmental and natural protections and the land-use planning
- the company doesn't need a GIS working station and a software
- they have all the information they need in one tool (Fig. 5)
- they have the possibility to combine the public data with their own firm-specific planning data (additional charge)
- property management toll data can be included to the upgraded systems (additional charge)

Figure 5 – Geological map of Bavaria empeddet in the basic GisInfoService tool for the members of the Bavarian industrial association (© Bayerisches Landesamt für Umwelt, Bayerisches Landesamt für Vermessung und Geoinformation).

Conclusion

Bavaria has a lot of mineral resources. A main goal is to mine the mineral resources environmentally friendly. Bavaria is covered with a lot of protectorates which makes it difficult to use the location bound raw materials. With the help of the Bavarian industrial association and modern tools like GisInfoService it is possible to secure the supply for raw materials in Bavaria. We always have to keep in mind that raw material production is a temporary use which leads in the majority of the cases to biodiversity and recreation areas.

One employee in the sand and gravel industry for example secures 50 jobs in the building sector!

We are grateful thank our Bavarian administrations which support the raw material production industry to get the available geo-data from the authorities.

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PHENOMENON OF DEEP-SEATED HYDROGEOLOGICAL INVERSION PETROLIFEROUS BASINS

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KEY WORDS: Deep-seated Hydrogeological Inversion, depth fresh water, reservoir pressure, seismotectonics

The phenomenon of Deep-seated Hydrogeological Inversion (DHI) - appearance of thermal high-pressure almost fresh water under brines in petroliferous basins - has been found in a number of petroleum basins of different tectonic-geodynamic types. It is one of the most prominent example of system geologic phenomena investigation of nature and diverse manifestations of which is of the utmost significance for further successful development of Earth sciences in XXI century. Oil and gas genesis, mechanisms of different diapirism, mud volcanism and overthrusting in sedimentary basins, global regularities of the Earth outgasing nature of various enigmatic geophysic and geochemic anomalies – such is far from complete list of unsolved geological problems immediately concerned with the phenomenon of depth hydrogeologic inversion. Inversion waters of low mineralization in deep lying complexes within petroleum basins are polygenetic and hydrogeologic phenomenon is accompanied by mobilazation of those waters from different sources. Nevertheless in all cases it is followed by geochemical and geophysical tectonic-geodynamic signs of recent deep processes activization. Caused by interaction of different hydrogeodynamic, hydrogeochemic, petrologic, lithologic factors and accompanied by diverse geophysic and geochemic effects depth hydrogeologic inversion phenomenon is the glowing example of geosynergetic occurences because it reflects some fundamental peculiarities of development and self-organization of dissipative geosystems. It causes multiaspect character of this phenomenon with every aspect as a separate scientific and applied problem to be worthy of special consideration.

DHI has dual tectonic-geodynamical character. On the one hand, appearance of depth low-mineralized hydrocarbonate waters (with great alkaline reserve, increased partial pressures of carbon dioxide, methan, hydrogen, noncoherent microelements association including anomalous concentrations of B, Hg, REE, Cr, V, Ni, etc.) is the terminal manifestation of plum-tectonics and the very important geodynamic indicator. On the other hand, depth inversional waters have significant power, enthalpy and special physico-chemical properties (low viscosity, wide range of acid-alkaline characteristics). So they possess great geodynamic potential and is of considerable importance as the factor of tectonical evolution (sedimentary basin → rock-forming basin → petroliferous basin). Of special note is the role of depth fluids in lithosphere and inversional waters in stratisphere in thrusting, salt and clay diapirism, mud volcanism. The phenomenon of Depth Hydrogeologic Inversion is accompanied by increasing of seismotectonic activity. It is very important tectonophysical factor yet to be studied [Hubbert M.K., Rubey W.W., 1960; Hubbert M.K., Rubey W.W., 1959]. It is responsible for adiabatic jointing and dilatansion phenomen [Kirbi S.H., 1983].

Recent DHI and its paleo-manifestations (in hypogene allogenic alterations form) are of special significance in formation of petroliferous basins. Number of DHI phases and age of the last of them (coupled with the petroliferous basin stratigraphic, geoformation and structural-tectonic features) determine the number of petroliferous stages and series, stratigraphic, depth and phase-geochemical ranges of petroleum potential. Only petroleum basins with recent DHI manifestations possess the prospects of petroleum potential of deep-lying sedimentary units, rocks intermediate series and crystalline basement. The maximum wide ranges of petroleum potential of such basins are combined with variety of morphogenetic types of traps and pools (including diverse unusual types: veined, hydraulic and other pools). Presence or absence within certain petroliferous basin of DHI manifestation and determination of relevant basal hydrogeologic stage (with active exfiltration regime, injection processes, hydrochemical mixed character in zone of interaction between depth inversional waters and lythocatagenetic brines) determine strategy of hydrocarbons resources development. This phenomenon should be properly accounted in petroleum potential forecasting at zonal and local levels, oil-and-gas geologic zonation, realization of direct prospecting, deep drilling projecting. Petroleum fields with DHI manifestation and fields without such signs should radically differ from one another by nature, character and superposition of geochemical and geophysical target, anomalies. Inversion-hydrogeologic anomalies influence the central-basin gas resources essentially by mobilization of dispersed gas and involving it in usual gas pools formation. As for very popular now, but badly justified views about natural processes of oil and gas resources replenishment, it is conceivable only under the condition of recent DHI phenomenon with certain petroliferous zone or field.

So the phenomen of DHI bears a number of urgent problems connected with natural waters.

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THE GEOTHERMAL POTENTIAL IN EMILIA-ROMAGNA

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KEY WORDS: geothermal energy, low enthalpy, tectonic structures, Northern Apennines, Po Plain.

INTRODUCTION

An adequate energy supply has always been a fundamental prerequisite for economic development. In recent years, the safety of supplies and the reduction of pollution have also become major priorities. Hence the search for renewable and environmentally-friendly energy sources has become even more important.

Geothermal energy is a primary source of energy which, if properly harnessed, is renewable and environmentally-friendly.

Emilia-Romagna has no high enthalpy geothermal systems (i.e. T > 150°C) that can be used to produce electricity directly; however the presence of thermal springs and deep wells with positive heat anomalies point to low enthalpy systems which can be used for direct heat. For example, in Ferrara and Bagno di Romagna, low enthalpy geothermal reservoirs have been tapped into and used for district heating and spa resorts.

Other possible applications include industrial and agricultural uses.

Recent technological progress, the variability of the cost and the difficult of supply of oil and gas, the need to reduce the use of fossil fuels in order to cut pollution and our reliance on supplies from foreign countries have made the exploitation of geothermal energy at any temperature an attractive and viable alternative.

ANALYSIS OF DATA

Emilia-Romagna Region backed a geological study into the potential of geothermal energy in the Region as early as the 1980s (RER, CNR, 1982). One of the key conclusions of this study was that positive heat anomalies (thermal springs in the Apennines and positive heat anomalies measured in deep wells on the Po Plain) must be attributed to the tectonic structures.

According to the findings of this study, the presence of Apennine thermal springs can be explained by the deep circulation of meteoric water, which percolates down through the subsoil and rises again to the surface along faults (MERLO et al., 1988; COLOMBETTI and NICOLODI, 2005), while positive heat anomalies on the plain, nearly all recorded in wells located above the buried ridge known as the Ferrara Folds (PIERI and GROPPI, 1981), are attributable to deep circulation that reaches the carbonate sequence located a few hundred metres below the surface thanks to the presence of the positive tectonic structure of the Ferrara Folds.

Since the geological conditions which characterize the subsoil of Ferrara and Apennine thermal springs also exist in other parts of the region, there are very real possibilities of finding other geothermal fields.

Starting from the conclusions reached by RER, CNR (1982), available geological data on the tectonic arrangement of the Apennines, the Po Plain and the Adriatic coast were re-read (CERRINA FERONI et al., 2002; BOCCALETTI et al., 2004) and a preliminary map (Fig. 1) which compares the main tectonic elements of the region with localization of hot springs was compiled.

This map indicates that thermal springs are predominantly located in “tectonic windows” or in close proximity to regional fault zones. Many of these structures have shown recent activity (BOCCALETTI et al., 2004).

It is also interesting to note that all the main Apennine thermal springs are found in the hanging wall of the thrust responsible for the doubling of the crystalline basement (ARGNANI et al., 1997; BOCCALETTI et al., 2004), the uplift of deeper units (Mesozoic carbonate sequence, Oligo-Miocene Tuscan-Romagna successions) and the erosion of allochthonous units (Ligurian nappe) which are greatly reduced or even absent in this area (tectonic windows).

Areas of the plain with warmer deep waters are primarily found above the entire arc of the Ferrara ridge, between Reggio Emilia and Ravenna, along the coast between Cervia (Ravenna Province) and Rimini, i.e. above the northern extremity of the Adriatic Folds, and between Reggio Emilia and Fiorenzuola d’Arda (Piacenza Province), above the SE sector of the Emilia Folds. These buried structures, especially in the above-indicated sectors, also display evidence of recent activity (BURRATO et al., 2003; VANNOLI et al., 2004; BOCCALETTI et al., 2004).

PRELIMINARY CONCLUSIONS AND WORKING HYPOTHESES

From this preliminary analysis, it transpires that the areas of greatest interest for further in-depth analysis of potential geothermal reservoirs in Emilia-Romagna are those at the top of the structural highs with evidence of recent activity (areas 1-17 in the Fig. 2).

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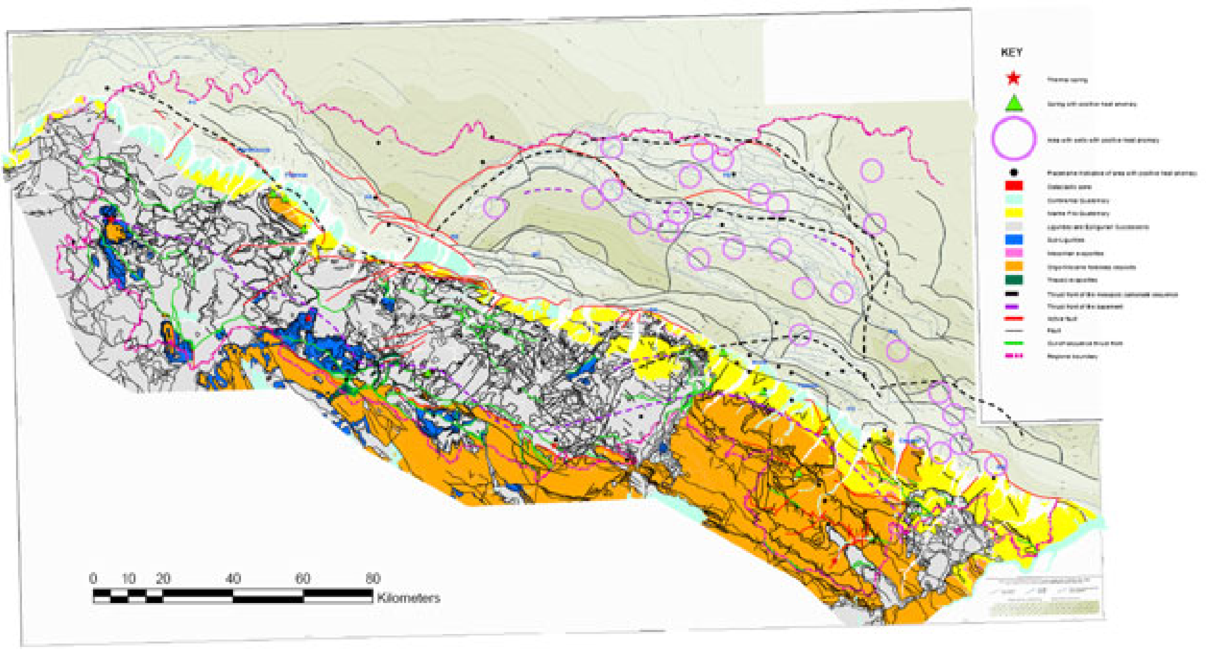

Figure 1: cartographic synthesis of data

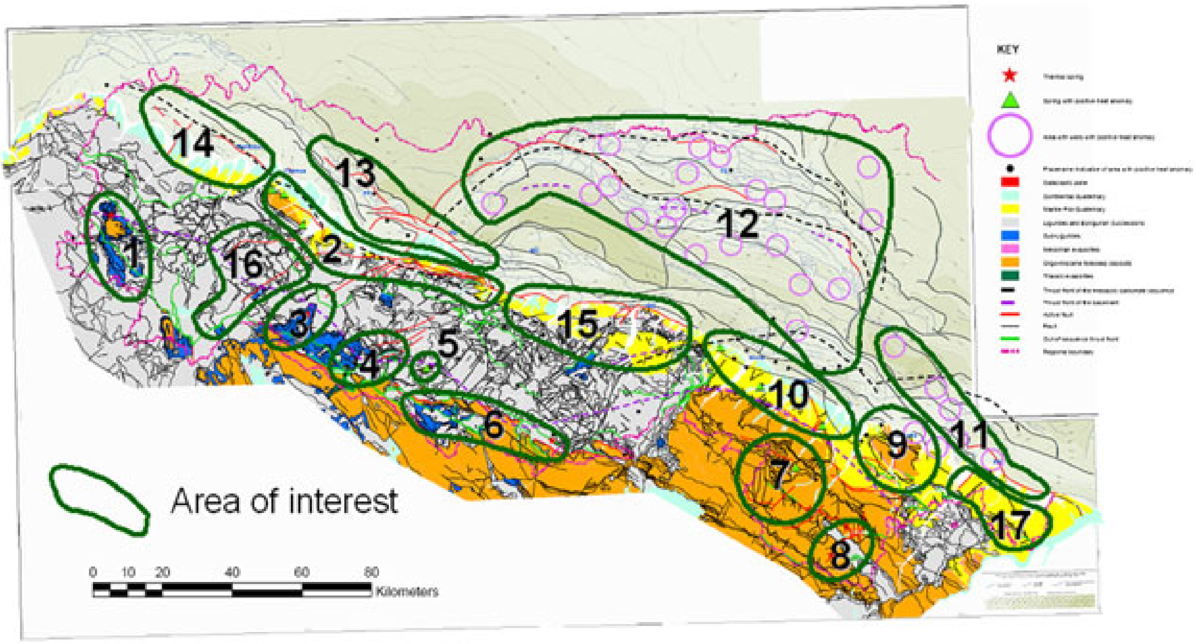

Figure 2: areas for more in-depth study

WATER RESOURCES OF DANUBE RIVER BASIN IN SERBIA – POSSIBILITIES FOR DEVELOPMENT AND INTEGRATION WITH OTHER EUROPEAN REGIONS

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KEY WORDS: Danube, water resources, water problems, Danube Master Plan, international projects

WATER RESOURCES

Danube river basin in Europe covers one third of the continent. Significant tributaries, such as In, Sava, Drava, Tisza, Velika Morava and others make the large hydrological basin of about 817 000 km^2. As the largest European main river road (2 783.4 km) links closer economic and the most attractive areas of the Europe (Gavrilović, 2002).Trans-channel, created by linking Rhine, Main and Danube rivers in the length of 3 505 km provides new opportunities for the development of transport, trade and other economic branches. Danube flows into Serbia near Hungarian-Serbian border to the 1 433 km from its mouth (80,7 m altitude), and leaving our country in the 845 km, at the mouth of Timok (28 m altitude. This is also lowest altitude point in Serbia. At its 588 km long flow through Serbia, it is border river to Croatia (137 km) and Romania (230 km).

Danube has 3 different sectors through Serbia: plain -Pannonian (from Bezdan to Ram); gorge- Đerdap Gorge; plain- (Kladovo to the mouth of Timok). In the entrance of Đerdap Gorge, Danube basin has an area of 560,000 km^2. On such large area, there are very different physical-geographical factors of water level, which gives the combined water regime of the Danube River. Water levels ranges from 1.5 to 3 m, and water discharges from 1 510 m/s^3 at Bezdan (Vojvodina) to 4 640 m/s^3 Veliko Gradište (near Timok). (Gavrilović, 2002). Analyzing the data, collecting by Republic Hydrometeorological Institute of Serbia, it could be concluded that the high water on the Danube is in April and the lowest in August and September. On this basis, the risk of flooding is the largest in spring, and the biggest pollution should be expected at the end of the summer and early autumn.

The biggest Danube tributaries, and the highest water potentials of the Danube Rivers basin are: Tisza (the longest tributary of Danube in Serbia), which brings in on Danube average 870 m/s^3 of water, Sava (the Danube water richest tributary), enters into the Danube 1685 m/s^3 of water, Tamiš (average 50 m/s^3 of water),Velika Morava (national longest river), which enters into the Danube 250 m/s^3 of water, and about 17.5 million t of sediments (Gavrilović, 2002).

Water potentials of the Danube River in Serbia are insufficiently used. By irrigation of land, Serbia is in the last place in Europe. Channel hydro system Danube-Tisza-Danube, the largest and unique Serbia is very little in use for irrigation. Only 1.6% (78,000 ha) of agricultural area is irrigated.

In previous years around 100 tourist boats with about 150 000 passengers have cruised the Danube through Serbia, and in the perspective is to increase theirs number. According to latest available statistics, in 2005., Serbia was transported over the Danube River 14,288,994 tons of goods, of which was 6,299,160 tons internal traffic, 4,647,086 tons of export and import and 3,342,748 tons of transit. (Serbian Chamber of Commerce, 2005.).The late eighties and early nineties years of last century, Serbia was transported over the Danube double of this goods quantities. Danube River presents European transport corridor and it was called "Corridor 7" t. It is interest in Serbia to improve navigation and transport over the Danube River.

WATER PROBLEMS IN DANUBE RIVER BASIN

WATER QUALITY

During the nineties years of XX century of Danube water quality in Serbia has been improved. Measurements, regularly done by Republic Hydrometeorological Institute of Serbia show that the objective criteria of water quality at the exit of the Danube from Serbia was significantly better than at the entrance. This is the result of specific economic and social situation in Serbia at this time. In fact, in this time, many factories, which were biggest polluters stopped working. Besides this, a significant role in pollution has dam of Đerdap artificial lake, which retains a lot of mud and toxic substances and represents some kind of "filter", and a large environmental problem in Serbia.

At the entrance to Serbia (Bezdan hydrological station) Danube water quality, by some indicators is out of class, and by several other parameters in the III / IV class, while at the mouth of Timok (the exit from Serbia) is mostly in II or III class. The most important parameters for water quality class determination are given in the table 1. and presented in electronic data base.

Table 1. Danube water quality

Hzdrological Stations	Dissolved oxygen	Perecntage of O_2 saturation	BPK-5	HPK	Saprobity degree	Suspended substance	Dissolved substance	pH	Waste substance	Color	Smell	Actual class	Required class
Bezdan	I	VK	III	I	II	III	I	II	I	I	I	III/IV	II
Apatin	I	VK	III	I	II	III	I	III	I	I	I	III/IV	II
Novi Sad	II	III	III	I	II	III	I	II	I	I	I	III	II
Zemun	II	II	II	I	II	III	I	I	I	III	I	III	II
Pančevo	II	II	III	I	II	IV	I	I	I	I	I	III	II
Smederevo	II	III	II	I	II	III	I	I	I	I	I	III	II
Dobra	II	III	II	I	II	II	I	I	I	I	I	III	II
Tekija	II	II	II	I	II	II	I	I	I	I	I	II/III	II
Radujevac	II	III	II	I	II	III	I	I	I	I	I	II/III	II

The situation would be more favorable, that some of the Danube tributaries, on whose water quality Serbia can not be much affected are not in bad condition quality (Sava, Tisza, Tamiš). So Tisza is out of class or in class IV, Tamiš is out of class, Sava is mostly in III class. Emission of nitrogen and phosphorus significantly contributes to Danube River pollution in downstream part. It is estimated that Serbia emissive about 72 000 t of nitrogen per year and 7 000 t of phosphorus per year, which represents 13% and 14% of the total amount of nitrogen and phosphorus in Danube River basin. These values are put Serbia on the 3rd place in the amount of nitrogen emission and in the 2nd place in the amount of phosphorus emission among all countries in the Danube river basin. Dam of Đerdap artificial lake at the Iron Gate is considered to be the environmental “black point” because of silt and toxic sediments accumulation. Hydrological research near hydrological station Đerdap I and Đerdap II show that every year Danube brings into Đerdap artificial lake between 8 million t in low water years, and 31 million t of silt in the high water years (Milanović, 2007.).

WATER POLLUTION

A major problem in the Danube sector through Serbia (especially through Banat Region) represents the rivers from Romania (Zlatica, Begej, Tamiš, Karaš, Nera) that are in the IV water quality class or out of water class at all border crossings. In recent years, several times was detected catastrophic pollution of Tisza from Romania (eg cyanide pollution in 2000., which was spread on the Danube and caused major consequences for the living world in the water.

In Serbia, large industrial centers are located near Danube, which is extremely unfavorable for water pollution. The dominated industries are: metallurgy-Smederevo; nonmetal production (Pančevo), inorganic chemistry (Novi Sad), basic organic chemistry (Pančevo, Novi Sad, Belgrade) construction materials production– several places in Vojvodina.

Industrial capacity in Novi Sad is usually located along the large Danube river banks and canal Danube-Tisza-Danube. There are 27 industrial branches, and most important are: Oil Refinery Novi Sad and food industry.

Belgrade and its wide surroundings is the most developed industrial zone in Serbia. In this wider zone is located 3 biggest production complexes of the chemical industry (Pančevo, Šabac, Barič), lignite production (Kostolac mine basin), energy production (Obrenovac).

Table 2 - List of buildings and plants certain degree of hazard to the environment in the vicinity of the Danube in Belgrade (Spatial Plan of Belgrade, 2000.)

Name	Municipality of Belgrade	Activity
Institute of Nuclear Science “Vinča“	Grocka	Reactors, radioactive waste
Landfill “Vinča“	Grocka	Municipal solid waste landfill
“Duga“- Color and varnish plants	Palilula	Color and varnish plroduction
“ICN Galenika“	Zemun	Pharmaceutical industry
Heating plant “Нови Београд“	Novi Beograd	Oil fuel tanks
Heating plant “Dorćol“	Stari grad	Oil fuel tanks
“Grmeč“ Belgrade	Zemun	Plastic production
“Oil refinery “ Belgrade	Palilula	Production of motor oil
“Grmeč Balkan“	Palilula	Chemical industry
“Tehnohemija“	Palilula	Storage of chemical products
„Petrolgas“	Palilula	Gas distribution

All settlements in Belgrade do not have sufficiently developed sewerage system and facilities for waste water purification. Considering that almost 40 % of the city area has no sewerage system, all waste water flows right into the Danube or Sava. Although belongs to the wider industrial zone of Belgrade, because of drastic air and water pollution Pančevo city is separated as one of the environmental black point in the Danube river basin. There are chemicals plants, almost on the shore of the Danube (oil refinery and nitrogen fertilizer production).
Downstream in Smederevo is the steal mill, and in the vicinity is the coal basin at Kostolac and power plants. The biggest problem there is to locate a place where the ashes from power plants could be deposited.

FLOODS IN DANUBE RIVER BASIN

In the last decade several floods has been recorded in Danube river basin. The biggest flood happened in the summer of 1999 g. when Velika Morava and its tributaries were flooded, and the entire region Šumadija in central Serbia was under water. During 2000. there was a flood on the river Tisza and Tamiš. Large floods have occurred in the spring of 2005. in Tamiš river basin, and it was the flooded about 50 000 ha of agricultural area (Milanović, 2008.). In 2006. Danube flooded in Smederevo, and there was a risk for Belgrade and Novi Sad. In the same time, Sava flooded some parts of Belgrade. Large number of road was under water, as well as settlements along the Save banks.

DANUBE MASTER PLAN IN SERBIA

In Serbia, are made two Danube Master Plan- for development of the Upper Danube area (includes the municipality of Sombor and Apatin), and Lower Danube (from Golubac to Danube exit from Serbia). One part of Master Plan is related to the navigation capacity increase (new marine construction, port, etc.) and the other part is related of the tourist development.
Tourist development is also supported by German Government Agency GTZ, which has helped the implementation of the project marking the bicycle paths in Serbian Danube banks, as part of the European corridor.
This Master Plan was made by Faculty of Economics, University of Belgrade in the period 2004-2007. and is called "Path of the Roman emperors." This is the first Master Plan in Serbia. The plan envisages connecting all the cities from the territory of Serbia where Roman emperors were born, from Sremska Mitrovica to Lebane. Namely, in Serbia was born 17 Roman emperors. On the territory of Serbia there are two Roman imperial city, and two imperial palace. There are a real archaeological pearls from prehistoric and ancient times along the right bank of the Danube, such as Sirmijum (Sremska Mitrovica), Singidunum (Belgrade), Viminacium (Kostolac), Lepenski Vir, the remains of the famous bridge, the Roman Limes, Trajan Plate (Đerdap), Diana (Kladovo), Felix Romulijana (Zaječar), Mediana (Niš) and Justinian Prima (Lebane). All these sites should be connected to a 600 km long route. Center of this route will be Viminacium, which is already used in tourist purposes. It is estimated that the issue of investment is about 260 million euros.
Danube Master plan of waterways to Serbia to 2025., predicts the next 20 years to increase river traffic for four times., This require the construction of the new bridges, modernization of the international porst, cleaning the bottom of river and the coast. For these projects need about 120 million euros.

OTHER PROJECTS FOR DANUBE REGION

All countries in Danube river basin have included in corporation through the Regional Environment Center for Central and Eastern Europe, established in 1990. This Center cooperate with governmental and non-governmental organizations and is active in the international regulation of environmental cooperation. Since 2003. in Serbia have been started more national and international projects related to the Danube. Some of these are: Evroregion »Middle Danube-Đerdap"; "The twinning of the cities" Grocka-Budafok; Environmental education program Kovin-Jaszbereny; Project Corridor Danube-Karaš-Tamiš: Čenta 2003", etc. The project "Iron Gate" began as a joint action of experts of 3 Danube countries - Romania, Bulgaria and Serbia in May 2000. This project is directed to the preservation, promotion and protection of the lower flow of the Danube. In the spirit of European projects, the cooperation is made in the field of culture, ie. there are ideas about the parks of culture along the Danube.

Interesting project, "The way to the Upper Danube pollution reduction," which was organized by Environmental Movement "Blue Danube" from Apatin and Green Network of Vojvodina in order to decrease pollution. It is supported by the Regional Environment Center for Central and Eastern Europe (REC) Office and started in 2004. The objectives are to promote integrated and better management of water through the application of EU standards and laws, improve knowledge about agriculture pollution, protection of moist habitat and pollution reduction. One of important spatial strategy in the Danube river basin is the VISION PLANET document, elaborate in the INERREG II project. Serbia has joined other countries in order to formulate a common strategy, principles and measures of spatial development in this area. Related to the protection of the environment, there is the idea of buying property by the state (or local community) for their protection, as well as the establishment of protected zones in the border areas and national parks.

CONCLUSION

According to several aspects, Danube is the most important river in Europe. Linking settlements and economy requests more attention for water problems solving, that are presented (especially water pollution). As the most important river in Serbia, a country which has continental position, its significance is even greater (nautical, transport, tourism, production of electrical energy). Tjis is also the area which can be the fastest integrated into other regions of the Danube in Europe. This can be achieved by implementation of Master Plan, development of trans-border cooperation and taking part to numerous projects (such as the Joint Danube Survey 1 and 2, supported by ICDPR).

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RESOURCES OF MINERAL AND THERMAL WATERS IN SERBIA

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KEY WORDS: resources, Serbia, waters, mineral, thermal;

INTRODUCTION

Republic of Serbia is located in the central part of Balkan peninsula and southern parts of Panonia vale. On the territory of Serbia, there are a considerable number of wells of mineral and thermal waters. Mineral and thermal waters are accumulated on certain depth in all regions of Serbia due to volcanic activity in the geological past.

Approximatelly two hundred and fifty locations with over one thousand three hundred natural springs of mineral and thermal waters are situated on Serbian territory. There is a evidence of their use in this part of the world from the begining of human civilization. These waters were mostly used in therapeutic purposes. Archeological sites in Serbia pinpoint that mineral welth is in use since second century. However, intensive and organized exploring of these waters in Serbia started at the end of nineteenth century.

CLASSIFICATION OF MINERAL AND THERMAL WATERS BY THEIR ORIGIN

Variety of mineral and chemical compounds and temperature of these waters is stipulate by very complex geological composition and other factors affecting appearance, qualitative, quantitative and other characteristics.

According to their origin, mineral waters in Serbia can be classified into three groups:

- volcanic mineral waters
- pannonian mineral waters
- infiltrative mineral waters

Volcanic mineral waters originate from the final phase of the development of volcano (2 to 3 million years ago) that overtook large areas of Serbia, especially its central part. This waters were accumulated in postvolcanic period.

Pannonian waters usually occur in the Pannonian Basin and its border area, and according to their origin they are separated into fossil waters, sea waters, and oil waters. All of these waters contain certain amount of sodium chloride.

Infiltration waters are, in fact, atmospheric waters which move from smaller to larger depth, where they are being partially mineralized and enriched with certain elements.

CHARACTERISTICS OF THERMAL AND MINERAL WELLS IN SERBIA

Waters from thermo mineral wells are rich in rare macroelements which are increasing their healthness: lithium, rubidium, strontium, sodium, copper, bromine, uranium, radium, selenium, cobalt, titanium, molybdenum, aluminum, iodine, calcium, lead, magnesium, chromium.

Temperature of these waters varies from 8^{o}C – 110^{o}C. Over 240 underground waters have temperature over 20^{o}C. Warmest water in Serbia are in spa Vranjska (92^{o}C), spa Sijerinska (to 80^{o}C), spa Jošanička (78,5^{o}C), spa Kanjiža (64^{o}C - 78^{o}C), spa Kuršumlijska (67^{o}C). Some spas have very hot and moderately cold water. Such is spa Sijerinska with 18 different wells and temperature of 16^{o}C to 71^{o}C, and also spa Vrnjačka with 16 wells (14^{o}C – 36,5^{o}C). The lowest water temperature has spa Torda (8^{o}C) and Prilički Kiseljak (10^{o}C).

APPLICATION OF MINERAL AND THERMAL WATERS

Diversity of their natural attributes enables very miscellaneously application but their potential in Serbia is not exploited sufficiently. Mineral and thermal waters are used in following purposes: balneology, for producing thermal energy and for drinking. Potential in recreative tourism is unquestionable. All spas in Serbia, their existence and activities related to the mineral and underground thermal water. Good results have been achived in treatment and rehabilitation from various deseases.

Mineral water is used for bottling in about 25 factories, mostly in those with small capacities. Application of thermal waters in energetic purpose is still insufficient. In terms of energy potentiality, thermomineral water can be applied in the economic sector as an source of the energy (for heating urban areas, for electric energy), also in industry (for heating certain elements in the technological process of production), and in agriculture (they can be practically used for cultivation of the vegetables and for heating the farms), etc.

Thermal water represents a very large potential for the use of geothermal energy as one of the cleanest forms of energy use from the aspect of preserving the human environment.

CONCLUSION

These waters represent a great natural wealth with great possibilities and potential and they can be used for further economic development of the country. A large number of underground phenomenon, and water deposit on the territory of Serbia is still insufficiently explored to be adequately utilized. Mineral and thermal waters in Serbia should be protected from various kind of contamination.

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GEOLOGICAL IMPLICATIONS OF THE GEOTHERMAL GROUND PROBE COUPLED WITH THE HEAT PUMP

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KEY WORDS: Geothermal energy; Heat pumps; Heat exchange; COP, Geothermal probes.

INTRODUCTION

The growing demand for energy is one of the greatest challenges facing the 21st century: rapid developments in technology in industrialized nations and the staggering rate of growth of developing countries mean that demand for energy is constantly increasing. Against this background, applied geologists are striving to use their knowledge to meet the growing global need for energy, not only through exploration to find new, untapped hydrocarbon resources, but also by valorizing and fully exploiting the energy naturally produced by the Earth. Geothermal energy is one of the possible alternative energy sources for sustainable development, given that it is clean, free, renewable and widely available.

People often confuse geothermal heat pumps with geothermal energy, while in actual fact the former have nothing to do with exploitation of thermal gradient. In fact, the systems looked at in the study are designed to transfer heat from a cool place to a warmer place, using electrical energy.

The main objective of this project was to identify and study those areas of geological knowledge that can improve the performance of geothermal energy systems with heat pumps. Indeed, there are a number of geophysical, geotechnical, geological and hydrogeological parameters that can be used to optimize such systems in order to maximise thermal yield and minimize environmental risks.

The study looked at heat exchange mechanisms, subsurface thermal stability and the so-called "thermal stress" triggered by the presence of geothermal ground probes, In addition, variation in ground temperature with respect to different depths and lithologies was also examined.

RESULTS

The study proved extremely useful in helping us gain an insightful understanding of case studies made available by Tuscany and Emilia-Romagna Regional Authorities through their geological surveys, which have driven research in this field. This work has culminated in a preliminary map of thermal yields in relation to lithology (for the moment covering only the Tuscany, where the project began initially) and has enabled us to suggest improvements in the application form for authorization of geothermal heat pump systems in the Tuscany region (Fig. 1). It emerged from the study that geothermal heat pumps today provide a highly energy-efficient and environmentally friendly heating and cooling system, as well as providing value for money.

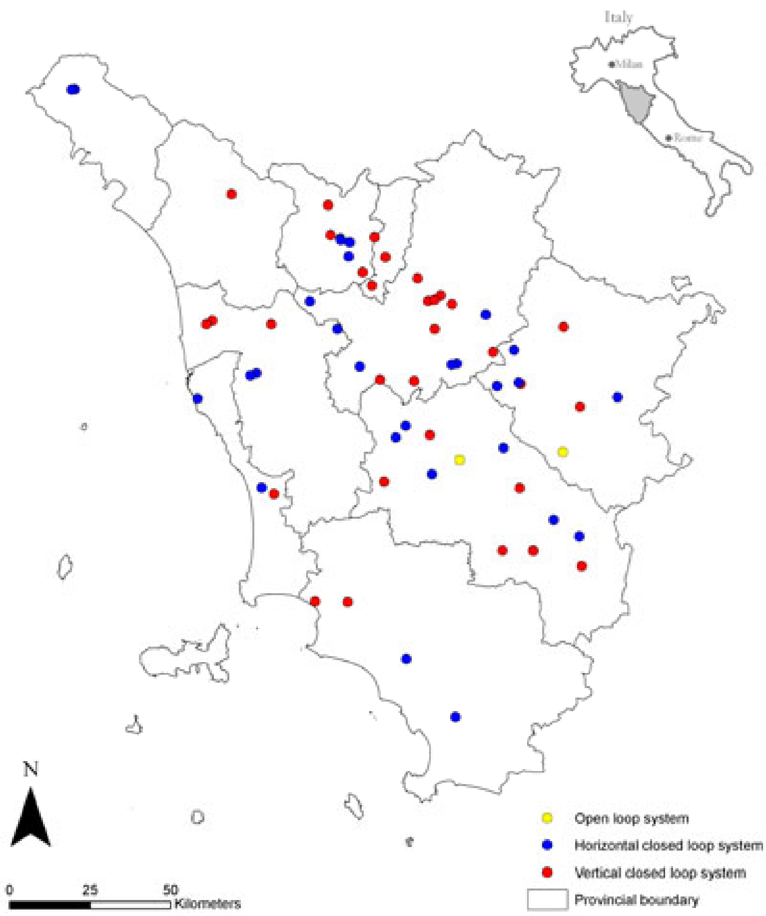

Figure 1– Distribution of the heat pump systems in Tuscany Region (Italy).

As regards horizontal closed loops, studying the thermal behaviour of the subsoil, we simulated heat propagation in relation to depth and different lithologies: these models allow us to forecast the "delay" with which the ground responds to surface heat variations and the impact of the dumping factor associated which such variations. In addition, the study focused on the thermal behaviour of the different lithologies under varying humidity content. The more diffused horizontal closed loop systems in Tuscany are extremely vulnerable, especially in the presence of clay. This lithology could suddenly turn from an excellent thermal conductor to an insulating material, preventing heat exchange between probe and ground. For vertical closed loop systems, heat exchange between probe and ground is not only influenced by the thermal behaviour of the ground in relation to the heat flow from the surface, but also and above all by the thermal conductivity of the lithology surrounding the probes. Thermal conduction processes are affected by the thermal conductivity of rock, which can vary significantly, ranging from values in the region of 0.4 W/Km for dry gravels to almost 4 W/Km for granite rocks.

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THE ENERGY OF THE EARTH'S INTERIOR. THE GEOTHERMAL ATLAS OF CATALONIA

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KEY WORDS: Catalunya, Geothermal Atlas, geothermal energy, high enthalpy, medium enthalpy.

ABSTRACT

With the goal to evaluate the potential of the high and medium enthalpy geothermal energy in Catalonia and to establish a methodology of study, a working group was created by the Institute for the Diversification and the Saving of the Energy of Spain (IDAE), the Institute Geological and Mining of Spain (IGME), the Catalan Institute of Energy (ICAEN) and the Geological Institute of Catalonia (IGC). Since July of 2007 until the date the existing data has been collected and incorporated into a data base for its analysis together with thematic cartographies. All the thermal data and cartographies will be compiled on "The Geothermal Atlas of Catalonia". Its publication is planned for 2010.

INTRODUCTION

Evaluating the potential of the geothermal energy is a strategic question to elaborate Energy National Plans.

With this aim a working group created by the Spanish Institute for Diversification and Saving of Energy(IDAE), the Institute Geological and Mining of Spain (IGME), the Catalan Institute of Energy (ICAEN) and the Geological Institute of Catalonia (IGC) was established in 2007 july. This group is the attendant also of the establishment of a methodology that can be widespread and applied in other regions of the State.

Some regions in Catalunya show favourable conditions for geothermal exploration namely Vallés-Penedés, Selva, Osona and Empordà depressions, and the Olot quaternary volcanic zone. Recently, private companies have requested exploration permits in some of them.

METHODOLOGY

The evaluation of the geothermal potential in Catalonia it is carried out following the methodology elaborated by IGME, ICAEN, IGC in call of the Catalan Ministry of Environment and Housing (Figure 1). This meeting was attended also for representatives of the Toscana Region (Italy).

<u>First stage</u> (1-2 years):

- Step one: Compilation of all existing data
- Step two: Reinterpretation and feasibility study.

<u>First decision-making</u>

<u>Second stage</u>: Pilot area exploration.

Figure 1 – Applied methodological sketch

The works of the step one started in July of 2007. In ordre to have the necessary scientific advice, an agreement protocol was signed between the IGC and the Institute of Earth Sciences 'Jaume Almera' (Spanish Research Council).

First works consisted in a compilation of the existing information issued from geothermal studies carried out in Catalonia during the 70th and 80th decades of 20th century, different publications, doctoral thesis, and temperature data available from the IGC subsoil database.

Complementary mapping were elaborated to help the interpretation of thermal data: structural geology, groundwater flow, gravity anomalies, aeromagnetic anomalies, sediment thickness and thermal springs

All the collected data were homogenized and compiled in a GIS, together with complementary cartographies to its interpretation.

This part of works was finished in June 2008.

Second step of first stage consists in the establishment of a model of crustal structure to obtain an appraisal of heat generation and heat flow.

As a result we expect to obtain the following maps:

- Map of crustal and litospheric thicknesses.
- Maps of expected temperatures at 10 kilometers and 20 kilometers of depth.
- Map of geothermal gradients.
- Map of heat flow.
- Maps of temperatures at a depth of 100 meters (only for the zones with sufficient data).

First stage of the project will be finished early 2009.

FOWARD WORKING

To start second stage of the project a preliminary division in geothermal regions would be made depending on its interest (its geothermal characteristics, as well as the degree of the available information)

Following geothermal interest criteria, exploration surveys will be done to acquire new data in selected regions.

As a result of the new data interpretation a pilot area could be defined.

In order to disseminate all the collected information during the first stage of the project we plan to publish the "Geothermal Altas of Catalunya".

Mainly inspired in geothermal Atlas published by the European Union (see references), the "Geothermal Altas of Catalunya" will supply the lack of knowledge in geothermic matter and will help to promote this renewable energy to general society.

The "Geothermal Altas of Catalonia" is planned to be publish in 2010.

ACKNOWLEDGEMENTS

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GROUNDWATER DRAWDOWN AND LAND SUBSIDENCE IN MASHHAD PLAIN

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KEY WORDS: aquifer, drawdown, groundwater, Khorasan Razavi, Mashhad, subsidence

ABSTRACT

Mashhad Plain is the most important and essential source of fresh water and also a significant industrial and agricultural pole in Khorasan Razavi Province. Nearly one billion cube meter of water is extracted annually from the groundwater source. Excessive use of groundwater in the plain has led to land subsidence issues. Among 35 banned plains in Khorasan Razavi, currently 12 plains experience critical situation, while Mashhad Plain is under overcritical conditions; the plain covers over the half population of the province and serves 14 million pilgrims annually. Groundwater drawdown has reached 40-60 meters during 30-40 recent years and this caused to dry the saturated aquifer stratum, which in turn led to subsidence and consequently longitudinal and vertical fractures in farms, roads, and ways. Several approaches were presented to stop subsidence.

INTRODUCTION

Population ever-increasing along with industrial and agricultural developments, e.g. in Mashhad region (fig.1), served as a tool for overexploitation of underground water, particularly in such river basins which are accumulated by low-depth unconsolidated sea or lake alluvial sediments, lead to land subsidence or sudden sinking of the Earth's surface (Poland, 1984). In definition (Doukas et al, 2004; Galloway et al, 1999), subsidence includes landslip or drawdown toward the lower levels of ground, along with small horizontal displacements as a result of geological phenomena such as solution, ice melting, sediment accumulation, eruption of igneous lavas from earth surface, or human activities like mining, water or oil exploitation (Amelung et al, 1999). Land subsidence effects microscopic changes in alluvial structure and soil tissues, deep and long features, in soil and destructs garden walls, local buildings, and roads and may also lead into alteration of water and gas pipe beds, and risk of flood and fire (Leake, 2002). In addition, sinking of poles and constructions and changes in land slope reverse-proportional to irrigation canals and reduction in groundwater beds capacity, saltiness of groundwater, increase in water acquisition costs, and presence of restrictions on strategic uses such as urban and industrial utilities may all occur as a result of subsidence. Subsidence often appears in two types of environments:

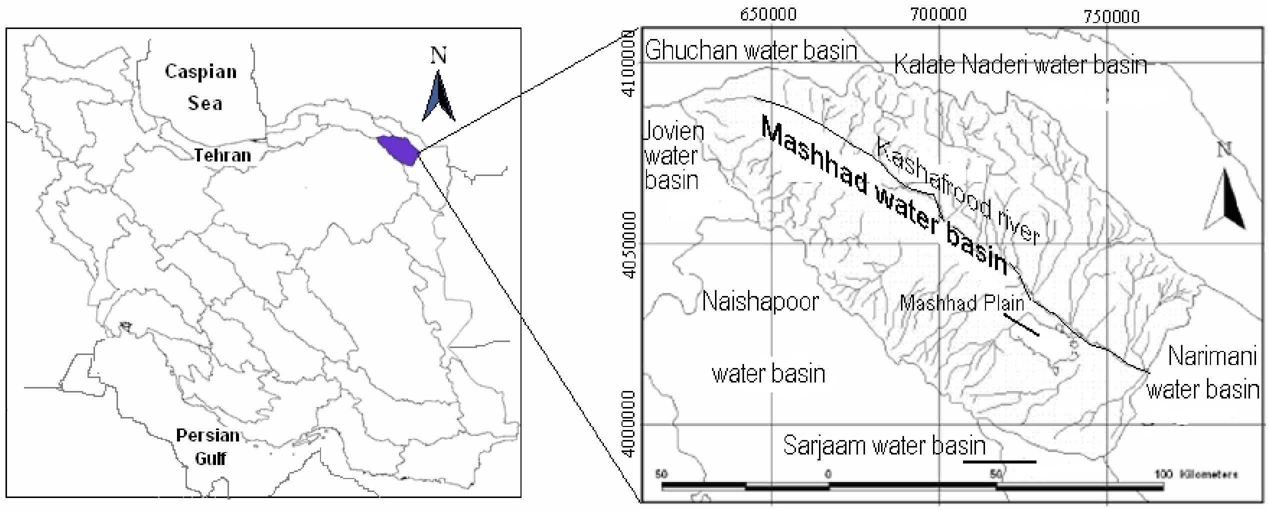

Figure1- the location of Mashhad plain in Kashafrood water basin

- Soluble stones (e.g. limestone, dolomite, gypsum, and salt) which are buried by unconsolidated sediments, or sinkholes piled by unconsolidated sediments whose stability relies on upward hydrostatic pressure of groundwater
- Young and fresh unconsolidated sediments and debris with high porosity including closed or quasi-closed sand and grit aquifers (with high permeability and low compressibility) along with clay layers (with low vertical permeability and high compressibility).

CLIMATE

Climate in Mashhad changes depending on region topography. Rainfall is different from one season to another and the highest precipitation may be seen from January to June. Precipitation reaches its higher levels in central and western areas in the form of rain and snow and snowfalls on high mountains such as Ala-dagh, Allahoakbar and Hezar-Masjed remain for several months. Climate study of the region classified it as arid and semi-arid. In general, there is a reduction in temperature in north – west to south – east direction. Lack of rainfall and geomorphologic and Hydrologic conditions has led to reduced number of large rivers in the province.

EXAMPLES OFSUBSIDENCE IN IRAN

The phenomenon is observed in different regions of Iran. The first report concerning subsidence in Rafsanjan and Kerman plains, Study of Subsidence in North – East Area of Kerman (Tofigh et al, 2005; Tabatabai Aghda 2006; Abbasnejhad 2002), was provided by The National Organization of Geology and Mine Explorations in 1997. Furthermore, subsidence in Kabudarahang and Famenin plains in Hamedan with large number of sinkholes, and Moeenabad in Varamin, and Shahryar Plains in Tehran Province (Geological Survey of Iran, 2004) are among other examples in this field. In Sistan district, drought reduced the level of groundwater and existence of intermittent layers of clay, silt, and les, in a down layer with 3 to 4 meters of thickness increased the subsidence speed in infrastructures. As a result, several cracks and faults were made in buildings and intermittent drought and rainfall were observed (Rahnama-Rad & Firuzan 1999).
Karimkhan Citadel in Shiraz square due to drainage of water and wastewater during Quajar era suffered from wall destruction and deviation of its tower. The walls were repaired but the deviation still remains (fig. 2, first author's observations). In Nazarabad Plain in Tehran Province, subsidence manifested itself as elevation of pipes and their

Figure 2- Deviation and damages to the tower and walls of Karimkhan Citadel in Shiraz (Rahnama-Rad, 1992).

detachment from surface and sanding in wells. A preliminary report, Study on the Factors contributing to Sanding and fractures of pipe casing in Nazarabad, was prepared in 2003 (National Organization of Geology and Mine Explorations, 2003).

Subsidence in Shahryar area in Tehran Province reached annual rate of 10 cm. Studies conducted by the National Organization of Geology and with collaborative effort of researchers in Cambridge and Oxford universities using InSAR statistical data, investigation of regional soil, study of groundwater sources and reduction in water level have been performed (National Organization of Geology and Mine Explorations, 2004). Evidences showed the formation of such phenomenon in other plains such as Arak, Nahavand, Khomein, Golpayegan, Natanz, Yazd, and Abarkooh.

GEOGRAPHY AND GEOLOGY OF MASHHAD PLAIN

The study area in Mashhad Plain includes Basin of Kashfrood River (fig. 3). The region lies in northern area of Khorasan Razavi and is limited to Hezar-Masjed Mountains (Koppehdagh) on north, Binalood Mountains on south, and Atrak basin on north – west. The total area of studied region in

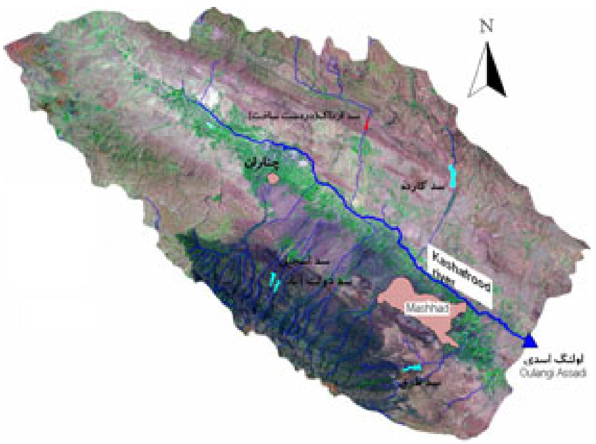

Figure 3- The location of studied area in Kashafrood basin

Mashhad reaching to Kal Tangal Shour Plain is 9909 square kilometers including 3351 square kilometers covered by plains and 6558 square kilometers covered by mountains. The length of basin is around 150 kilometers stretching from Abgorg lands, Dolo at 9-kilometer east of Ghoochan – Mashhad Road to Kal Tangal Shour. The highest point of the region is located on Mount Binalood (3300 m), while the lowest part lies in exit area of the plain (880 m). The land slope is in north-west to south-east direction. Climate changes depending on topography of the region. Rainfall is different from one season to another and the highest precipitation may be seen from January to June. Study of climate through Ambrose and De Martin systems classified the region as an arid area. Average annual rainfall is around 205 ml and 12 billion square meters (Hosseini, 2005). Lack of rainfall and geomorphologic and Hydrologic conditions has led to reduced number of large rivers in the province. However, permanent flow may be observed at the mouth of Kashfrood, Atrak, Kal Tnagal Shour, Nishabour, Kalsalar, and Shour Ghaen in north and north-west areas.

Graben plain of Mashhad with the width of, at most, 25 kilometers, quaternary alluvia, is considered as a graben from structural point of view (Manuchehri, 1994) limited to two horsts, two sierras, and three different areas, namely Koppedagh on north, suture zone and Binalood on south (Haghipour & Aghanabati, 1997).

Among the strata in this plain, stratum of Mozdooran is of great importance for groundwater. The stratum, formed by hard carbonate sediments, due to existence of pores can produce aquifers (Hosseini & Sadeghi, 2004; Darvichzadeh, 2001). Abundance of faults, mostly vertically active and sliding, shows the activity of this region (Haghipour & Aghanabati, 1997). On the other hand, faults play significant role in erosion and appearance of various strata, brittles, horizontal displacement in anticline and syncline axes which may lead to the detritions of strata and prepare the condition for water infiltration, karsts phenomena, and canyon valleys (White et al, 1995).

Sediments accumulations on older stones located on higher position in comparison with the base of the river show land elevation and active structure of the region. Various morphological shapes of the region include karsts shapes such as Canyon valleys, lappets, effects of surface solutions, caves, sinkholes, and karsts plains. The shapes may be observed in lime strata of Tirgan and Mozdooran and less frequently in Kalat and Chehl Kaman which probably indicate higher level of humidity in comparison to the past.

PROPERTIES OF ALLUVIAL AQUIFERS

Geophysical investigation of exploratory test holes and pumping reveals different quantity and quality of groundwater in various regions in Mashhad. The thickness of water layer around Mashhad Plain ranges from 20m in outer area to 150m around south mountains, and more than 250 m near Nazeriah. The thickness reduces as we move away from Kashafrood, in middle area of the plain, toward northern mountains. In general, alluvial sediments in Mashhad Plain are left by Kashafrood River in its branches (Regional Water Corporate of Khorasan Razavi Province, 1998).

CAUSES OF SUBSIDENCE IN MASHHAD PLAIN

Groundwater in Mashhad Plain is exploited through deep and semi-deep wells (fig. 4). In recent years, the number of wells has grown from 1300 wells in 1970 to 6008 wells in 2003.

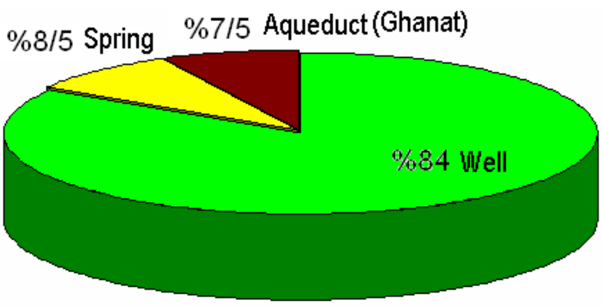

Figure 4- Percent of utilization of groundwater

Investigation of behavior of Mashhad Plain showed 60 m reduction in water level during the latest 40 years (fig. 5) (Amarghan Pizometer 15 km, west of Mashhad). Lachoometery reports in Organization of Geology and Mine Exploration and reports of National Surveying Organization on subsidence in farm lands located at 20 km north-west of Mashhad, using Interferometric techniques, showed 24 cm subsidence in a area with 8 km of width and 50 km of length (National Surveying Organization, General Office of Field Surveying, 2003). The rate is the largest throughout the country. In Hassan Khord Village on north-western area of the plain, reduced level of groundwater has resulted in cracks in fields and building (fig. 6.). Furthermore, on northern area of Mashhad – between Mashhad and Ghoochan – unusual subsidence was observed in Koppehdagh area.

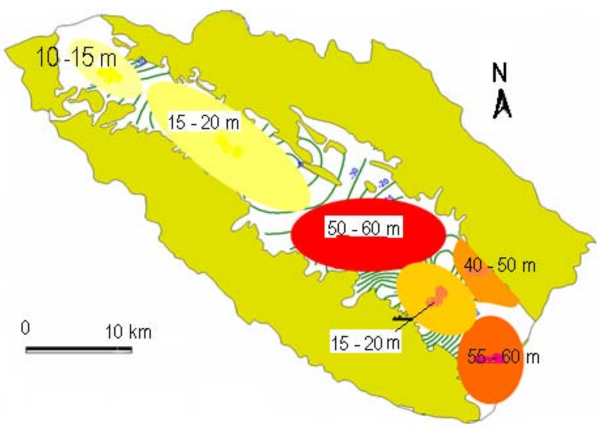

Figure 5- Investigation of behavior of Mashhad Plain showed 60 m reduction in water level during the latest 40 years

According to information obtained from Toos Geodynamic Station (15 km west of Mashhad), average annual subsidence of 7.5 cm has been recorded during the period from 1992 to February 2003. The slope, however, increased dramatically after February in 2003 and resulted in subsidence of 24 cm in 2004 and overall 60 cm in the region (Surveying Organization of Khorasan Razavi 2004).

Figure. 6- Wall damages and unclosed features in Mashhad earth's surface

CONFRONTING METHODS TO SUBSIDENCE

Water resources management plays key role for reduction in subsidence. The following is some suggestions to stop this phenomenon.

- Groundwater control through closing unauthorized wells and avoiding over-utilization
- Reduction in groundwater utilization
- Restrictions on sand and gravel extraction in rivers
- Alteration in cultivation and irrigation patterns
- Changing patterns of water consumption in industries
- Correct management of water resources

CONCLUSION

The studies performed up to now are a preliminary report for subsidence in Mashhad Plain. However, the issue is open to further investigation. According to available research and studies, subsidence in Mashhad Plain occurred as a result of excessive utilization of groundwater through unauthorized wells. To stop this, it is essential to encourage public cooperation which, in turn, requires national resolution.

Investigations suggested that the soil is more of sand and girt clay type. Thus, drainage and consolidation are performed due to existence of clay.

Groundwater flow usually follows surface follow and topographic slope. Here, the water flows from west to east and from south to middle areas of the plain. The exit is located at the east-end, near the Olang Asadi dam.

Unstable climate, along with high degree of evaporation and low precipitation all play significant role in worsening the conditions.

Nutrition resources (precipitation usually in form of snowfall) are limited and most branches are barred for damming. Previous studies on groundwater and hydrographs for several years show inappropriate changes and reduction in water level during the past 15 years as a result of high and low utilization. Hence, one can conclude that underground sources and precipitation underwent great changes.

In general, one can conclude, according to changes in groundwater, annual precipitation, and type of soil, that subsidence is barely the result of reduction in groundwater level. So we can say that, after multi-dimensional investigation, that unevenness of lands, and presence of enclosed groundwater and water lenses are the main reason for subsidence, especially in the region of Toos.

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IRON OXIDE-COPPER-GOLD DEPOSITS IN CHILE: CHARACTERISTICS OF THE MANTOVERDE DISTRICT

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KEY WORDS: mineral deposits, distal facies, paragenesis, magmatic fluids, environmental impact, heavy metals.

INTRODUCTION

Iron Oxide-Copper-Gold (IOCG) deposits and magnetite-apatite deposits, barren in Cu-Au, belong to the iron oxide (Cu-U-Au-REE) deposit class, which is primarily defined by their large Fe-oxide contents (HITZMAN et al. 1992; HITZMAN, 2000). The Chilean Coastal Cordillera hosts several IOCG systems, such as Mantoverde, which is one of the most important IOCG deposit worldwide. Mantoverde, located about 50 km SE of Chañaral harbor in northern Chile (Figure 1), is property of AngloAmerican Plc. Mining activities started in 1996 and its production has been focused on shallow leachable Cu-oxides ores. Mantoverde has estimated mineable reserves and resources of 410 Mt Cu-oxides with 0.58 % Cu and estimated hypogene ores of 440 Mt Cu-sulfides and gold with 0.56 % Cu and 0.12 g/t Au (Mantoverde Division, internal report, 2007).

IOCG deposits show similarities with the well-known porphyry copper deposits. They occur in similar tectonic settings, show spatial relationships with coeval plutonic complexes, have ore in comparable size, and they are popular targets for Cu-Au exploration. However, Cu-Au production from IOCG deposits causes less environmental impacts than that from porphyry copper deposits.

In this contribution, we summarized the main characteristics of Mantoverde, present the mineral paragenesis caused during the development of the hydrothermal system, disclose the sulfur isotope of sulfides and highlight the environmental impact during the Cu-Au mining.

DISTRICT GEOLOGY

The Mantoverde district is characterized by andesitic lava flows and breccias of probably Late Jurassic age, which are intruded by Early Cretaceous granitoids (e.g. LARA & GODOY, 1998). Both formed in a continental magmatic arc environment (e.g. LARA & GODOY, 1998; BERG & BREITKREUZ, 1983; DALLMEYER et al. 1996). The volcanic rocks form a structural block bordered by the central and eastern branches of the north-south trending strike-slip Atacama Fault Zone (AFZ, Figure 1). Both AFZ branches are connected by a 12 km long, N15°-20°W striking, 40-50°E dipping brittle structure, the Mantoverde Fault (MVF, Figure 1).

The MVF and other NW structures developed as left-lateral strike-slip structures during the duplex evolution of the AFZ (BROWN et al. 1993; SANHUEZA & ROBLES, 1999). Due to later extension, the MVF was reactivated as a normal dip-slip scissors fault together with the formation of new NNW faults. These structures produced the tectonic northeasterly-down-tilting of the district (e.g. SANHUEZA & ROBLES, 1999).

ORE DISTRIBUTION AND ALTERATION

Most orebodies in Mantoverde district (Kuroki, Mantoverde Norte, Mantoverde Sur and Franko) are spatially related to the MVF. Smaller ore zones occur at some distance to MVF and are related to subparallel NNW structures (Manto Ruso and Celso; Figure 1). Three main mineralized units are distinguished: (1) Cu-Au-bearing Fe-oxide-cemented hydrothermal breccias (2) Cu-Au-bearing Fe-oxide stockworks, around the breccias and (3) a mineralized tectonic breccia, which only occurs in the deposits linked to the MVF. The distrital distribution in Fe-oxide phases reveals an up- and outward zonation from magnetite-rich ores representing the more proximal portions, towards specularite-dominated ores in the distal portions of the hydrothermal system. Due to tectonic northeastern tilting and partial erosion of the district, magnetite occurs near surface and is exposed in the southern part of the district, whereas orebodies in the northern part are specularite-rich (e.g. SANHUEZA & ROBLES, 1999).

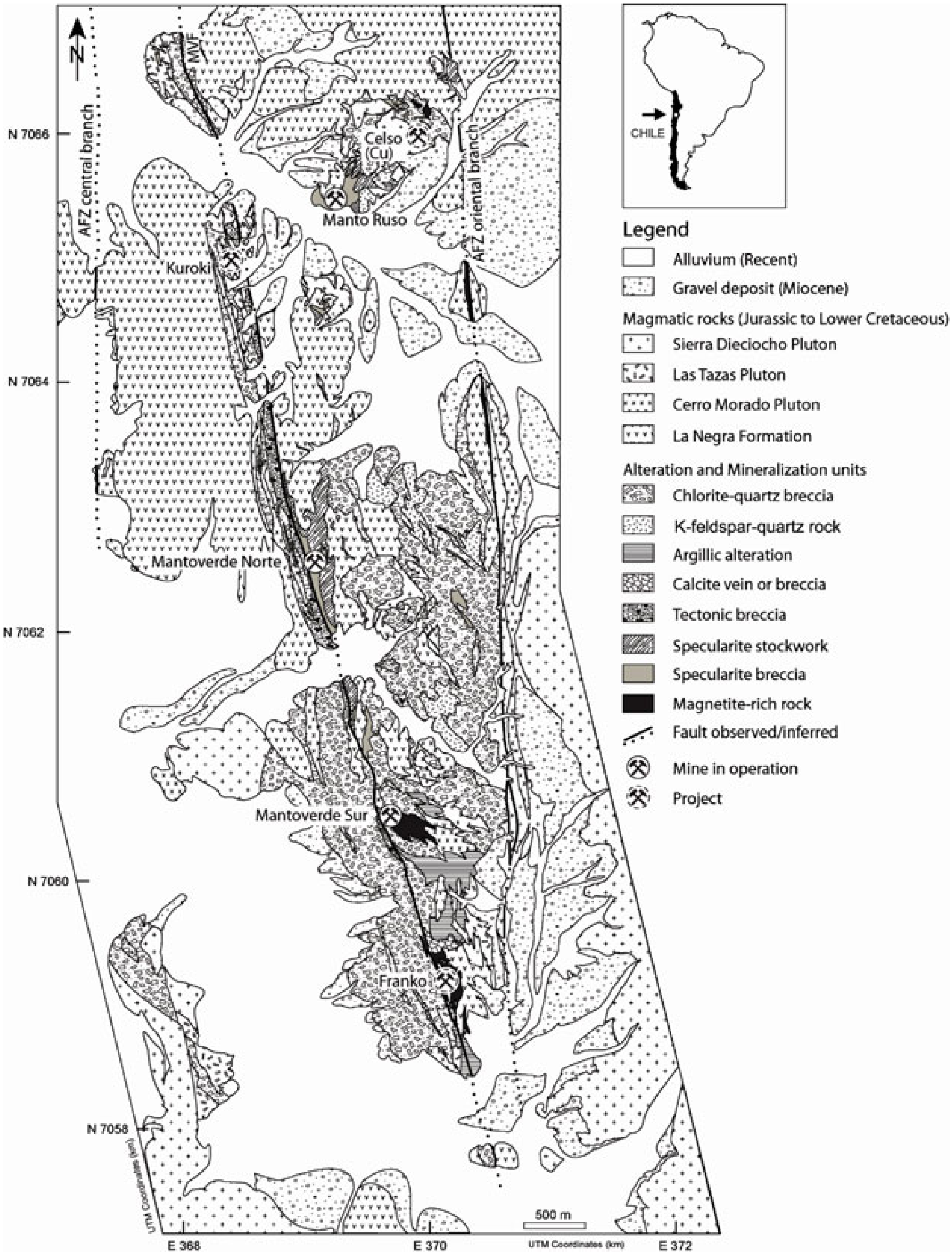

Figure 1 – Location and geological map of the Mantoverde district.

The Cu-Au-ore in the Mantoverde district is oxidized down to 200 to 250 m, except at Manto Ruso, where the oxidation front varies between 40 and 100 m. Common Cu-oxide ores are chrysocolla, brochantite, atacamite, malachite, and a mixture of Fe-oxides and Cu, which is called almagre. Underlying the zone, a poorly developed supergene-enriched zone with chacosite, covellite and bornite occurs. The hypogene sulfide zone at depth is characterized by chalcopyrite-pyrite.

Recently, studies on the hypogene ores showed that the bulk of the Cu-Au occurs at depth in magnetite-rich rocks between Mantoverde Norte and Mantoverde Sur pits.

The host rocks at Mantoverde suffered variably intense K-feldspar-chlorite-sericite-quartz-carbonate alteration, typical for distal facies of zoned IOCG-systems (RIEGER et al. 2008). Characteristic for the whole district is a chlorite-quartz-cemented hydrothermal breccia, in which the fragments are strong silicified (VILA et al. 1996). Calcite occurs as filling in veins, faults and breccias. Only in the southern part of the district, in Mantoverde Sur ore body, a pervasive argillic alteration is observed.

PARAGENETIC SEQUENCE

Paragenetic relationships allow distinguishing three hydrothermal stages: An early high-temperature Iron Oxide Stage, a Sulfide Stage, and a Late Stage (Figure 2). The Iron Oxide Stage caused the bulk of specularite-magnetite crystallization. It started with specularite precipitation followed by two magnetite generations, which in part resulted in mushketovitization. These Fe-oxides were associated to pervasive K-metasomatism, silicification, sericitization and chloritization. The latter occurred together with the second magnetite generation after pyrite-magnetite and allanite-magnetite.

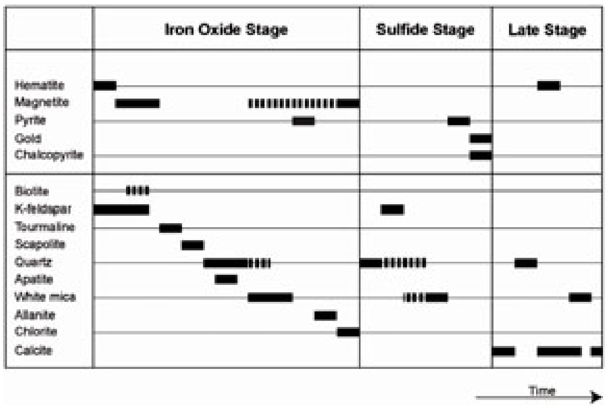

Figure 2 – Simplified paragenetic scheme for the Mantoverde District.

The Sulfide Stage, responsible for the Cu-Au mineralization, began with intense quartz, K-feldspar-quartz and sericite-quartz veining, followed by the main crystallization of pyrite and chalcopyrite. Both sulfides occur disseminated, in veinlets or fill spaces between magnetite and specularite. Gold contents in composite samples show a good positive correlation with Cu contents. In the magnetite-rich ores the Cu:(Au •10000)-ratio is around 3. In the specularite-rich ore this ratio is about 7, thus less gold concentration in respect to copper than in the magnetite-rich ores. The hydrothermal system ended with pervasive carbonatization and calcite ± specularite veining representing the Late Stage of mineralization.

RESULTS

ICP multielement analysis on 27 composites samples of mainly hypogene ore bodies of Manto Ruso and Mantoverde Norte/Sur were realized. Values under the detection limit were obtained by Hg (<5 ppm), Cd (<2 ppm) and Pb (<2 ppm), while As concentrations reached 42.4 ppm.

Sulfur isotope analyses were measured at the Stable Isotopes Laboratory of the University of Lausanne, Switzerland in sulfide samples from Manto Ruso (n= 6), Mantoverde Norte/Sur (n= 15). The $\delta^{34}S_{V\text{-}CDT}$ values from chalcopyrite and pyrite samples range between -3.0 and +9.4 per mil. Sulfides from Manto Ruso mine have $\delta^{34}S_{V\text{-}CDT}$ between +3.2 and +9.4 per mil ($\delta^{34}S_{V\text{-}CDTmedian}$ = +6.9 per mil), whereas those from Mantoverde Norte/Sur lie between -3.0 and +5.8 per mil ($\delta^{34}S_{V\text{-}CDTmedian}$ = +1.1 per mil).

DISCUSION AND CONCLUSION

The paragenesis described at Mantoverde district, which distinguish between an Fe-oxide precipitation with pervasive K-metasomatism and silicification, sulfide deposition and final carbonate alteration, is similar to those from other IOCG deposits in Chile and Perú and seems to be characteristic of the evolution of IOCG-systems (e.g. MARSCHIK & FONTBOTÉ, 2001; DE HALLER, 2006).

A northward zonation is observed in the sulfur isotopes signatures. Median sulfur isotope values of +1.1 per mil were obtained in sulfides from the southern part of Mantoverde district (Mantoverde Norte/Sur), which tends to more ^{34}S-rich values, recognized in the northern and shallow part of the district (Manto Ruso, $\delta^{34}{}_{SVCDTmedian}$ = +6.9 per mil). Previous interpretations of the origin of the sulfur source for Cu-Au-bearing sulfides in Mantoverde district showed that the mineralization was originated mainly by sulfur and metal bearing non-magmatic fluids (BENAVIDES et al. 2007). Taking into account that in Mantoverde district the main Cu-Au-hypogene ore body occurs in magnetite-rich rocks (Mantoverde Norte/Sur) and considering the sulfur isotopic signatures in this sector (present data), it is suggested that during the main mineralization, sulfur and probably metals have been supplied from a magmatic source. Contribution of non-magmatic sulfur took place in shallow and distal portions of the system (Manto

Ruso). Genetic models based on cooling and mixing of magmatic and non-magmatic fluids have been discussed for Chilean and Peruvian IOCG deposits (e.g. MARSCHIK & FONTBOTÉ, 2001; DE HALLER, 2006). The formation of IOCG deposits seems to be linked to sulfur and metal-bearing magmatic fluids (e.g. MARSCHIK & FONTBOTÉ, 2001; DE HALLER, 2006).

In the last decades the exploration of IOCG deposits in Chile has gained importance. They have similar Cu-Au-mineable resources, but much less acid generating pyrite contents than the porphyry copper deposits. In addition, the latter have a hypogene mineralogical assemblage that include gold sulfosalts and As-bearing minerals such tennantite-tetrahdrite and enargite (GILBERT & PARK, 1986). During the beneficiation process these As-(Hg)-bearing minerals are stockpiled together with other sulfides like pyrite. Pyrite oxidizes in contact with water forming acids, which mobilize these heavy elements into the groundwater. In the example of Mantoverde and other Chilean IOCG deposits, hazardous elements like As, Hg, Cd, and Pb in the hypogene ore occur in negligible concentrations. Therefore Cu-Au production from IOCG ore causes less environmental impacts and will be more economical.

Furthermore, Fe in IOCG deposits may be produced and sold for the steel manufacture, as shown by the newest developments in Chile, where magnetite and hematite is extracted from tailing impoundments of the large Candelaria mine (L. Alvarez, pers. commun.). In contrast, Fe in porphyry copper deposits, which occurs as pyrite, is lost for a profitably recovery.

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GIS-PROJECT OF THE FORECASTING-METALLOGENIC MAPS

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KEY WORDS: GIS, metallogeny, structure, volcanic belt, map, mineral resources, mineralization

INTRODUCTION

The basic tendency of development of modern geology is active introduction of GIS technologies. Results of their application are the various informatics and analytical systems in a monitoring mode of bases and banks of the geological data.
The purpose of the present GIS-PROJECT in the abstracts – metallogenic maps of new generation for forecasting Au-Ag epithermal deposits in the Northeast of Russia.
The GIS-PROJECT includes:

- Databases on Au-Ag-epithermal deposits;
- Program-technological complex.

The basic part of this complex - automated expert system is developed. The following tasks have been solved:

1. Preparation initial dates and cartographical information;
2. Creation of a cartographical database;
3. Description Au-Ag-epithermal objects into districts of territory of Northeast of Russia;
4. Development forecasting systems of a marcs estimation objects;
5. Creation a program complex for conducting a database;
6. Fillings database;
7. Drawing up of the GIS-PROJECT as a whole.

THE "GIS-FORECAST" SYSTEM

The "GIS-FORECAST" system on the one hand, the metallogenic map of new generation providing drawing up, visualization and preparation for the edition (on electronic and paper carriers) materials on forecasting Au-Ag-epithermal deposits of Northeast of Russia. On the other hand " GIS-FORECAST" conducting in a monitoring mode of databases: geological, metallogenic, ecological, geophysical, geochemical (Fig.1) and economic both other parameters and actualization metallogenic map on the basis of the principles developed for drawing up of digital maps models and databases, included in the GIS-PROJECT, in view of specificity of the maintenance metallogenic map.

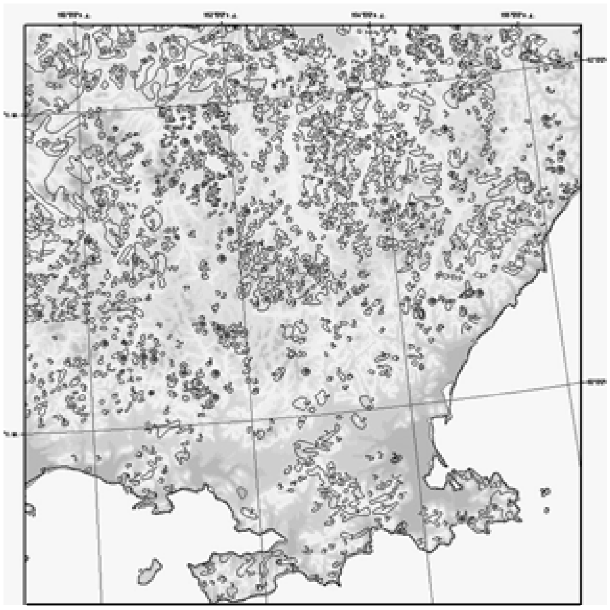

Fig.1. Fragment of digital map of geochemical Au anomalies in the GIS-Project (Magadan area, Northeast of Russia)

The "GIS-FORECAST" takes into account, that metallogenic map should reflect regional and local laws of accommodation of ore deposits - the main objects of prospecting works. So the set of factors participates in formation Au-Ag-epithermal deposits: environment of ore localization, on the one hand, and structure, properties, character of activity mineragenic agents with another. In the forecasting doctrine these factors can be named “ore controlling”. Systems of combinations, sets of factors make a forecasting image of a deposit.
The "GIS-FORECAST" maps Au-Ag-epithermal deposits of Northeast of Russia alongside with the various geological data, contains some layers of

the geophysical, geochemical, geomorphologic and economic information which reflect conditions of concentration and accommodation Au-Ag-epithermal mineralization (Fig. 1, 2). Such GIS-PROJECT allows approaching to forecasting in a new fashion. Novelty consists in an opportunity of the automated comparison of regional laws of accommodation of reference deposits and the perspective areas and sites in geophysical, geochemical, geomorphologic and geological fields, in view of main “ore controlling” factors.

According to state above, in the project the "GIS-FORECAST" the herein provided tasks consistently are solved:

1. An establishment “ore controlling” factors, their quantitative studying, an establishment of character and a measure of their connection as among themselves, and with each of the allocated factors. Graduation “ore controlling” factors, an borders establishment of their optimum favorable, neutral, adverse value. Ranging of factors by estimation of the its relative importance and borders of their influence.
2. Graphic reflection of accommodation of all “ore controlling” factors in them rang values in volumetric and plane model.
3. Revealing conditions of accommodation perspective on discovery Au-Ag-epithermal deposits of the areas and sites in geophysical, geochemical, geomorphologic and geological fields.
4. Comparison of the perspective areas to actually established accommodation of a mineralization (ore bodies, mineralizing zones, auras, anomalies, etc.) reference in details investigated Au-Ag-epithermal deposits in volcanic belts of Northeast of Russia.
5. An estimation of the new perspective areas on the basis of conterminous on to “ore controlling” factors of objects.

The theory and practice of forecasting convince that it should be quantitative. Quantitative forecasting in the present project is achieved by means of an estimation of influence regional “ore controlling” factors, modeling and comparison to analogues.

Efficiency of quantitative forecasting, as well as other kinds of forecasting, is defined by severity of selection: the perspective areas and reliability of definition of a degree of influence of each of “ore controlling” factors. Quantitative forecasting on the basis of construction of ranged lines allows proving allocation prime for statement of prospecting works of the most perspective objects (areas).

With this purpose for the project the "GIS-FORECAST" the technique of a mark estimation of the perspective areas and sites has been developed.

In the table original development of executors of the project, and also generalization and the analysis of the published given foreign and domestic researchers Au-Ag-epithermal deposits are used.

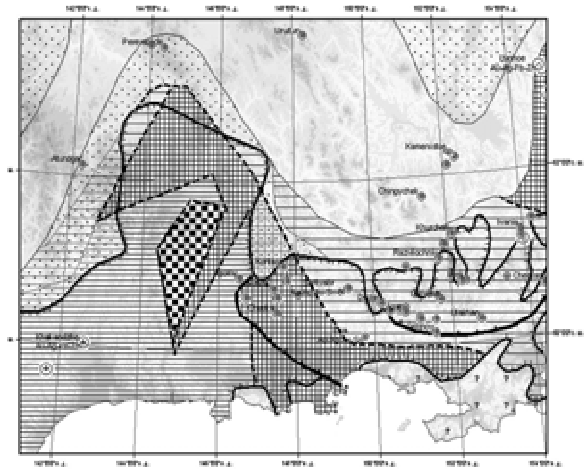

Fig.2. Fragment of geophysical interpretation (thickening of crust dip level) in the GIS-Project (Magadan area, Northeast of Russia)

A maximum quantity of points which on the offered system of marcs estimations can type a "ideal" deposit, - 75.4. The best deposits of Chukchi district achieve this size (see table). On groups of factors is most contrast geological and geochemical, less – metallogenic and geophysical.

In the calculation table as example of marcs estimations main several different scale “ore controlling” factors, well enough investigated and reconnoitered Au-Ag-epithermal deposits of Northeast of Russia are resulted. These factors are received with the help of the project of system GIS the Forecast. Any user of system can receive similar results on everyone, from more than 360 displays, the information about which (coordinates) is present in a database. The fullest a database (the electronic directory) is created on 45 deposits and displays which are in regular intervals placed on all researched territory. The data from this directory can be of great importance for the comparative analysis.

Rang a number reference Au-Ag-epithermal deposits the following (see table): the Kupol (75.1),

Valunisty (70.7), Kubaka (70.6), Juliet (70.1), Double (68,7).
The estimation of forecasting displays and the perspective areas, as a rule, is a little bit lower than estimations of deposits of corresponding minerals. The data in table are received mainly as a result of complex and versatile researches of this planetary rank structure (geological group "ore controlling" factors). As the initial data for a marcs estimation geological, metallogenic, geochemical and geophysical group "ore controlling" factors databases, maps and circuits of the GIS-PROJECT serve.

The calculation table of marcs estimation of ore controlling factors of the Au-Ag-mineralization

№	№ factors	1	2	3	4	5	6	7	8	9	Sum	10	11	12	Sum	13	14	15	Sum	16	17	18	Sum	Results
	Name of deposits																							
1	Kupol	5	5	10	3	5	1.6	4	1.5	2.5	**37.6**	2.5	10	4	**16.5**	2	10	2.5	**14.5**	2	2	2.5	**6.5**	**75.1**
2	Valunisty	5	4	8	3	5	1.2	4	1.5	2.5	**34.2**	2	10	4	**16**	2	10	2.5	**14.5**	1.5	2	2.5	**6**	**70.7**
3	Dvoynoy	5	5	10	3	5	1.2	3	1.5	1.5	**35.2**	2.5	6	4	**12.5**	2	10	2	**14**	2.5	2	2.5	**7**	**68.7**
4	Sopka Rudna	4	5	8	3	5	1.2	2	1.5	1.5	**31.2**	2.5	6	4	**12.5**	1.2	8	2	**11.2**	2.5	2	2.5	**7**	**57.5**
5	Kubaka	5	4	10	3	5	1.6	3	1.5	2	**35.1**	2.5	8	4	**14.5**	2	10	2.5	**14.5**	2	2	2.5	**6.5**	**70.6**
6	Karamken	4	5	10	3	3	1.6	3	1.5	1.5	**31.6**	2	8	1.8	**11.8**	1.2	10	2	**13.2**	2	2	2.5	**6.5**	**63.1**
7	Nyvlenga	5	4	8	3	3	1.2	4	1.5	2.5	**31.2**	1.5	10	1.8	**13.3**	2	8	2	**12**	2	2	2	**6**	**63.5**
8	Juliette	5	4	10	3	3	1.6	3	1.5	2.5	**33.6**	2.5	10	4	**16.5**	2	10	2	**14**	2	2	2	**6**	**70.1**
9	Korida	5	4	8	2.4	5	1.6	4	1.5	1.5	**33**	2	6	4	**12**	1.2	10	2	**13.2**	2.5	2.5	2.5	**7.5**	**65.7**
10	Lunnoe	5	5	8	2.4	5	2	3	1.5	2	**33.6**	2.5	8	4	**14.5**	1.6	10	2	**13.6**	2	2.5	2.5	**7**	**68.7**
11	Gornostay	5	4	6	3	5	1.6	4	1.5	2.5	**32.6**	2	10	1.8	**13.8**	2	8	2	**12**	2	2	2.5	**6.5**	**64.9**

Geological factors:

1. Volcanic formations hosting Au-Ag-epithermal mineralization;
2. The complexes of rocks hosting Au-Ag-epithermal mineralization;
3. Regional geological-structural division into districts;
4. Structures of volcanic fields;
5. Thickening vulcanite's (up to the base);
6. A structure of the base of vulcanite's.

Besides the volcanic formations hosting Au-Ag-epithermal mineralization, are shown on a geological map of Northeast of Russia of scale 1:1500000, submitted in the GIS-PROJECT. Accommodation of objects of forecasting concerning zones of tectonic and magmatic activization can be estimated on the corresponding circuit (Fig.2) from a cartographical database.

CONCLUSION

Development the mineral base of Russia in modern conditions of personnel deficiency is complicated without an effective utilization of computer technologies. Within the framework of separate tasks of the project it is developed methodical, mathematical and the software for realization the metallogenic analysis of territory. The variant of computer expert system and the - GIS-PROJECT of the forecasting-metallogenic maps is created. GIS consists of three various databases ore deposits and displays, adhered to a geographical cartographical basis of scale 1:2 500 000. The GIS-PROJECT is added 11 geological and metallogical maps and circuits. The greatest practical interest the information represents made as a result of work offered expert metallogenic systems. Work of system is claimed as the tool allowing operatively estimating prospect of concrete object. In this plan potential consumers of development can be territorial geological agencies, the prospecting organizations and mining companies. This system as the trainee, undoubtedly, will be claimed by teachers and students of geological faculties.

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TWO DIFFERENT STYLES OF GOLD MINERALIZATIONS IN THE VOLCANOGENIC MASSIVE SULFIDE DEPOSITS OF CORCHIA OPHIOLITE (PARMA PROVINCE, ITALY).

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KEY WORDS: Gold minerals, Sulfide Mineralizations, Corchia, Ophiolite, Parma, Italy

INTRODUCTION

Several historical mines of Fe-Cu-Zn sulfides are related with the Mesozoic ophiolites of northern Italian Apennine, between the regions of Liguria and Emilia Romagna. These mines are famed among the economic geologists and archeologists because they are known as a source of copper since the Bronze Age and because some of them possibly represent the earliest copper mines to be discovered in Western Europe so far (Maggi and Pearce 2005). Between the Middle Age and the 18th century, copper was extracted sporadically, becoming a major commodity during the Industrial Era. Therefore, from 1850 to 1910, a number of new deposits were discovered and intensively mined. After few decades of decline, mining activities started again during "Autarky" and lasted until the early seventies, when all the mines were definitively closed.

Only recently, the presence of gold minerals associated with these sulfide deposits has been reported, for the first time, in the the Corchia ophiolite, located in the province of Parma (Garuti and Zaccarini 2005, Garuti et al. 2007, 2008a). The gold minerals were found in the Donnini and Pozzo mining sites. In this contribution we report geological, mineralogical and geochemical information with the aim to better understand the origin of these unusual gold mineralizations, associated with ophiolite sulfide deposits.

GENERAL GEOLOGY OF THE NORTHERN APENNINE OPHIOLITE AND THE ASSOCIATED SULFIDES DEPOSITS

The Northern Apennine ophiolites are believed to be the remnants of the Ligurian Tethys. According to the interpretation by Piccardo (2008), the Ligurian Tethys represents the Jurassic analogue of modern ultraslow-spreading oceans. The formation and evolution of the northern Apennine ohpiolites, proposed by Piccardo (2008), comprise: (a) the rifting (continental) stage, characterized by extension of continental lithosphere and tectonic exhumation of lithospheric mantle, (b) the drifting (transition) stage, characterized by the inception of asthenosphere partial melting and MORB melt percolation through the overlying mantle lithosphere, and finally (c) the spreading (oceanic) stage, characterized by failure of the continental crust, sea-floor exposure of mantle tectonites and discontinuous MORB extrusion. The northern Apennine ophiolites are strongly dismembered and tectonized. However, their stratigraphy has been recognized and reconstructed. It consists of: (a) mantle tectonite, composed of partially to totally serpentinized peridotite, (b) gabbroic rocks, (c) pillow lava and (d) a sedimentary cover of chert and limestone.

The Fe-Cu-Zn deposits associated with the northern Apennine ophiolites have been classified as volcanic massive sulfides (VMS) and they occur at different stratigraphic levels in the ophiolite sequence. Stockwork-vein, massive and seafloor-stratiform ore bodies are associated with serpentinized mantle peridotite. Another group of these deposits consist of crosscutting stockwork or conformable stratabound ore bodies associated with the pillow lava, and seafloor-stratiform deposits located at the top of the volcanic pile, in contact with the sediments (Zaccarini and Garuti, 2008).

THE CORCHIA OPHIOLITE AND ITS MINERALIZATIONS

The Corchia ophiolite consists of a block, about 1.5 X 3.5 km in size, that comprises serpentinite and pillow lava embedded in a sedimentary mélange of Calpionella limestone and Palombini shale. Some granitic bodies display a tectonic contact with these ophiolitic rocks. The contacts between serpentinite and basalt generally suggest thrust of the mantle tectonite onto the volcanic pile.

However, the stratigraphic succession from serpentinite to pillow lava and sediments can be observed in the southeastern part of the Corchia ophiolite complex, where the ore deposits are located. The mineralization of Donnini and Cantiere Speranza are the most important deposits of the Corchia ophiolite. They were exploited from 1900 until 1943, when the mines were closed. They consist of several lenses of massive sulfides, variable in size, hosted in the contact between pillow basalt and marine sediments. Therefore, they can be classified as seafloor-stratiform deposits.

The ore body in Donnini forms an irregular lens of massive sulfide that was originally exposed at the surface and therefore covered with a thick gossan. The massive sulfides comprise pyrite, chalcopyrite with accessory sphalerite, showing a detrital texture in which angular fragments of sulfides occur in a ground mass of quartz, calcite, chlorite and clay minerals. Shells of microfossils replaced by sulfide, and anomalous concentrations of Au and U are characteristic of this type of ore (Garuti and Zaccarini, 2005). According to this geochemical anomaly, gold and uraninite were found as microscopic inclusions in pyrite. The sulfide mineralization underwent post-depositional reworking by submarine debris flow and accumulation in a topographic depression, followed by burial under a Palombini shale olistostrome.

The Cantiere Speranza mineralization consists of a massive sulfide layer steeply inclined (about 70-80°) southward, probably extended more than 100 meters along strike and 40 meters in depth, with a maximum thickness of about 5 meters (Adorni and Guelfi, 1997, Stuppini, 1998). The ore assemblage is composed of pyrite and chalcopyrite with lenses of massive Zn-Fe ore, mainly sphalerite with accessory pyrite. The massive sphalerite displays a microscopic texture that represents replacement of radiolarian shells or bacterial colonies. A great variety of microscopic and accessory minerals that accompany the Zn-Fe sulfide ore, such as acanthite, freibergite, siderite, smithsonite, Fe-Ca sulfate, barite, and also the rare mineral hydroromarchite have been reported (Garuti and Zaccarini, 2005).

On the basis of their paragenesis, shape and stratigraphic position it was possible to establish that these sulfide mineralization formed in an ancient sea bed, representing the equivalent fossil of the so called black smokers (Garuti et al 2008b).

Another type of sulfide mineralization has been recognized in the Pozzo mine, located few km far from the two mining sites mentioned above. In this area, the mineralization forms a lens of massive sulfide with a thickness up to 1.5 m and with a lateral extension of several ten meters. The massive sulfide is hosted in a block of strongly serpentinized mantle peridotite.

The sulfur isotope composition in the Donnini and Cantiere Speranza deposits show average value of 2.4 δ^{34}S‰, whereas the average δ^{34}S‰ composition in the Pozzo mine is 0.8 (Garuti et al., 2007).

THE GOLD OF CORCHIA AND ASSOCIATED MINERALS

Gold minerals were found at Donnini and Pozzo mines.

At Donnini, gold forms rare and minute grains, generally less than10 µm (Fig. 1) associated with the massive sulfides composed of pyrite, chalcopyrite and sphalerite with a gangue of quartz, chlorite and carbonates.

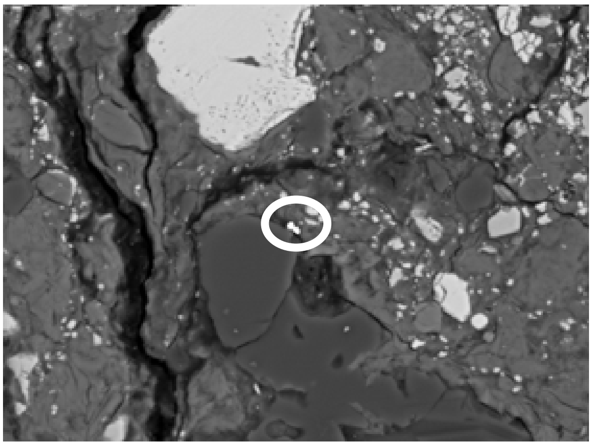

Figure 1 - Electron microscope image of a small gold grain (8 µm, visible in the center of the white circle, associated with silicates (gray minerals) and sulfides (white minerals). Donnini mine.

At Pozzo mine, the gold minerals (Fig. 2) occur as relatively bigger grains (up to 50 µm in size) and more abundant, compared with those found in the Donnini mine samples (Fig.1). They generally are included in chalcopyrite forming single phase or polyphasic grains, associated with magnetite, sphalerite and chlorite. The ore mineral assemblage of the Pozzo mine is quite unusual compared with the other sulfide mineralization related with ophiolites, being composed of pyrite, chalcopyrite and magnetite as major phase, accompanied by minor siegenite, sphalerite and molybdenite. The matrix consists of serpentine, talc, chlorite and Ca-Mg carbonates.

The gold grains found at Donnini and Pozzo mines, were analyzed by electron microprobe. They proved to be different also in term of composition. The gold minerals analyzed in the Donnini samples contain more than 80 wt% Au. Therefore they can be considered as pure gold (Fig. 3). The electron microprobe analyses of the

Pozzo gold minerals show that they contain appreciable amount of Ag. As a consequence the Pozzo gold can be classified as electrum (Fig. 3).

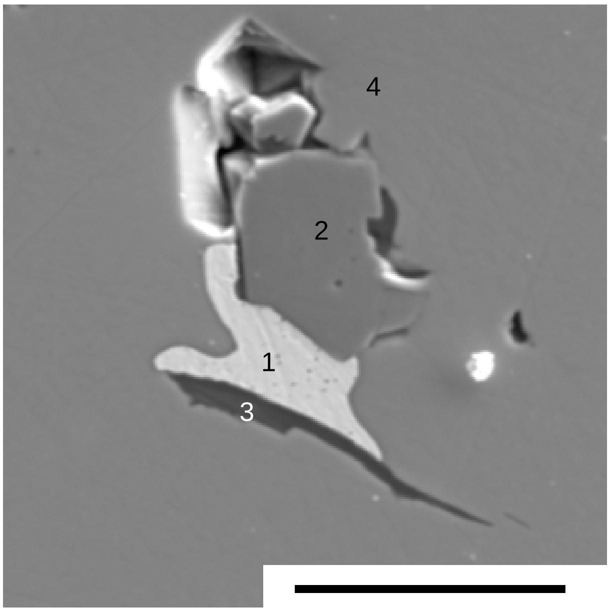

Figure 2 - Electron microscope image of a gold grain (1) associated with magnetite (2) and chlorite (3), included in chalcopyrite (4). Pozzo mine. Scale bar = 20 µm.

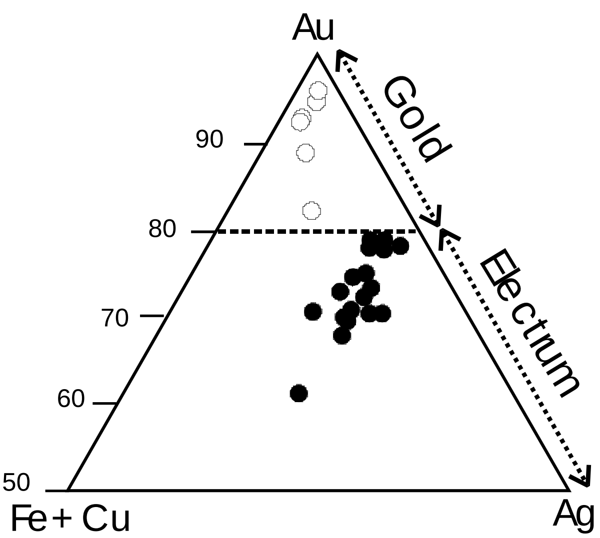

Fig. 3 – Electron microprobe analyses of gold minerals plotted in the Au-Ag-(Fe+Cu) ternary diagram. Open circle = Donnini mine, black square = Pozzo Mine.

CONCLUDING REMARKS

The geological observation coupled with the geochemical and mineralogical data presented in this contribution suggest that two different types of gold mineralizations have been recognized in the Corchia ophiolite.

The gold minerals in the Donnini mine formed at low temperature in submarine environment by loss of Ag during submarine weathering, in a way similar to that described for weathered gold nuggets in terrestrial placers and laterite hosted gold deposits. These observations point to the weathering process as the major factor controlling the concentration of gold in this mine and suggest that post-depositional processes of alteration were very active in the stratiform deposits.

The Pozzo mine is considered to be the metamorphic product of a magmatic sulfide mineralization, formed at high temperature in the mantle. According to this observation and with the available mineralogical data, we can argue that crystallization of gold in this mine started at high temperature, possibly during the formation of an immiscible sulfide liquid. The effects on the gold minerals produced by the metamorphic overprint are still not understood and need further investigation.

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GEOCHEMICAL CHARACTERISTICS OF THE HAMEHKASY-2 IRON DEPOSIT, WESTERN IRAN

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KEY WORDS: XRD, XRF, ICP-MS, EPMA, magnetite, deposit, Iran

INTRODUCTION:

The Hamehkasy-2 iron deposit is located in Sanandaj-Sirjan, metamorphic- plutonic zone in western Iran. Its coordinations are E48° 10.439′, N 34° 55.814′ and its average elevation is 2430 m on the Almogholagh mountains(Fig.1). It contains 22 million metric tons (Mt) of ore with a grade of 55 wt. percent magnetite. Hamehkasy deposit consists of two major economic orebodies (Hamehkasy 1 and 2) and several sub-economic minor orebodies. Hamehkasy-2 is the second largest orebody in this area and is located to the south of Hamehkasy-1 with 400 m distance apart.

The Hamehkasy-2 orebody, a vertical tabular to lens shaped body about 120 m long and maximum 20 m wide, shows a structural control with NW-SE strike.

The Hamehkasy-2 orebody consists of magnetite layers with concordant limonite interlayers. The individual layers range from 30 cm to 1.5 m in thickness. Thick limonite layers usually show internal layering. The main minerals in magnetite layer are magnetite with small amounts of hematite, actinolite, and tourmaline. Pyrite is found as small subhedral scattered grains and indicates its later formation than the host magnetite. In limonite layers, limonite is the main mineral, but late carbonate and quartz are filling fractures.

On a regional scale, the study area is an irregular rhomboidal block defines by several basement faults.

Host rocks in the studied area are mainly composed of Mesozoic metamorphic rocks such as phyllite (Hamedan phyllite), mica schist, calc-schist and some igneous rocks such as monzonite, diorite and meta-rhyolite. Small amounts of skarns and skarnoids are ubiquitous along the contacts between orebodies and igneous rocks (See Fig.1).

The wall rock adjacent to the hamehkasy-2 iron deposit has been affected by extensive and pervasive epidote alteration, giving the rock a light green or reddish green color due to hematite staining. Actinolite-albite-epidote alteration is particularly well developed in the area between the epidote alteration zone and fresh country rocks. The alteration halos around the orebody are up to 70 m in width.

Mineralogical analysis:

X-ray diffraction and electron probe microanalysis (EPMA) were used to determine the mineralogy of the iron ore. XRD analysis were carried out at resource geology Lab in SNU (Seoul national university) and EPMA analysis were carried out at KBSI (Korean Basic Science Institute), using a SHIMATZU -1610 instrument.

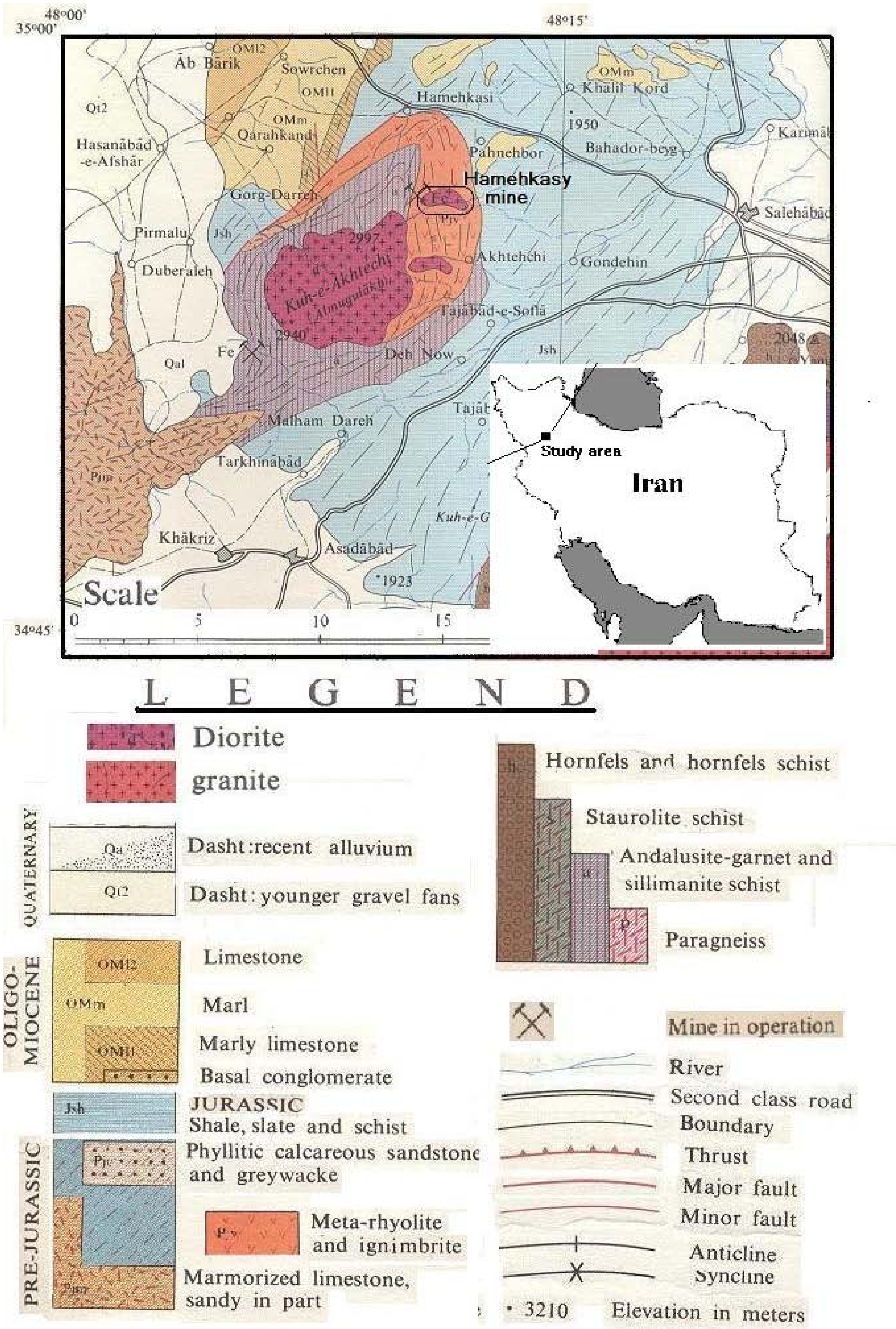

Fig.1. Geological map position of study area

Analyses of powder X-Ray Diffraction (XRD) and polished samples EPMA of Iron minerals in Hamehkasy -2 revealed the presence of quartz(SiO2)magnetite(Fe_3O_4 to $Fe_{2.93}O_4$ and $Mg_{0.04}Fe_{2.96}O_4$), hematite(Fe_2O_3), Montmorillonite-chlorite(Na-Ca-Al-Si_4O_{10}-O) and limonite($Fe^{+3}O(OH)$) in orebody(Fig.2).

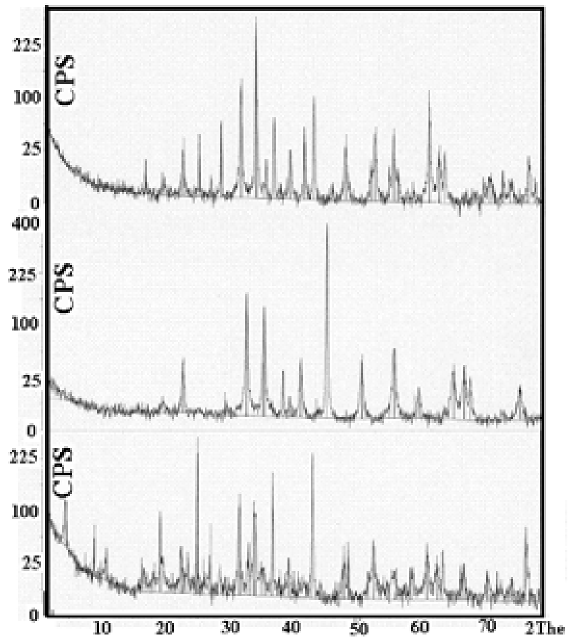

Fig.2. X-ray diffraction patterns for iron minerals from hamehkasy-2 iron deposit

Selected samples were analyzed by electron probe microanalysis(EPMA) to examined mineral morphologies and textures. Experimental studies in EPMA method show only negligible solubility of ilmenite in magnetite(Fig.3). Magnetite- ilmenite intergrowths are thus interpreted as products of subsolidus oxidation-exsolution of preexisting magnetite- ulvite solid solution.

Major elements were analysed using XRF method and trace elements were analysed using ICP-MS. Composition of cations in Magnetite and limonite at Hamehkasy-2 is dominated by Fe, with minor amount of Ca, Mg, Si, and Mn. Samples contain 95 to 97 wt% Fe, 0.7 to 1.7 %wt Si, 0.24 to 0.43 %wt Al, 0.03 to 0.05 %wt Ti, 0.11 to 0.16 %wt Mg, 0.27 to 0.33 %wt Ca, 0.02 to 0.15 %wt Mn, 0.01 t0 0.02 %wt P_2O_5.

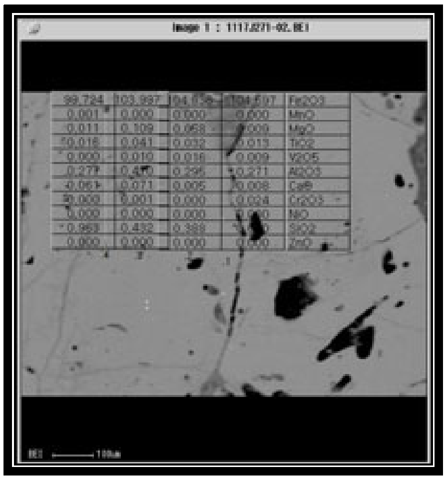

Fig.3. electron probe microanalysis of magnetite in the hamehkasy-2 ore deposit

Rare earth elements (REE) concentrations in samples of magnetite in Hamehkasy-2 are very low. Rare earth elements (La, Ce, Pr, Nd, Sm, Eu, Gd, Tb, Yb, Lu) concentrations in limonite samples are medium in quantities but concentration of Tb, Tm, Yb, and Lu in some samples are below detection limit. The maximum quantities for La and Ce in samples are 88.1 and 96.0 ppm, respectively. Maximum quantities for ∑ REE=207.8 ppm, ∑LREE=204.3 ppm, ∑HREE=3.5 ppm, mean La/Ce=0.917, ∑LREE/∑HREE=58.87 and $(La/Sm)_N$=53.1. Chondrite normalized REE contents of limonite samples reveal similar REE_N patterns, and they are characterize by medium REE contents and descending patterns especially in light REE (LREE) sections. General characteristics of REE patterns in Hamehkasy 2 are enrichment in LREE and slight positive Eu anomaly. Negative Dy anomaly is noticed in one sample.

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RARE-EARTH ELEMENTS CHARACTERISTIC OF MAGNETITE IN KORKORA-1 IRON DEPOSIT, WESTERN IRAN

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KEY WORDS: REE, XRF, ICP-MS, magnetite, deposit, Iran

INTRODUCTION:

The Korkora-1 iron deposit is situated in the Oromieh-Dokhtar volcanic belt, western Iran. The Korkora1 deposit is one of ten indices in the Shahrak mining district. This ore body is the largest deposit in the area and extracting now. Its coordination's are E47° 31/615$^{/}$, N 36° 21/730$^{/}$ and average elevation is 2420 m on the Shahrak slops.

The Korkora-1 iron deposit is hosted by stratified volcanic rocks such as rhyolite and dolerite and sedimentary rocks such as thick layered limestone and dolomite. The distribution of the volcanic rocks in the Korkora-1 area suggests emplacement within grabens or calderas(Fig.1). This orebody shows direct or spatial association with igneous rocks.

Faults surrounding the deposit can be classified as thrust and normal faults. In general, thrust faults were formed along the sedimentary and magmatic rocks with strike of N30-40 W. Faults of this type dip approximately 40^{o}N at the shallow level but are overturned to dip 25^{o}N at depth. In contrast to thrust faults described above, normal faults were mainly observed in the center-west of the district (see Fig.1). These mostly are normal faults with occasional displacement along strike.

This orebody is a semihorizontal lens to tubular body with 300 m long, 150 m wide and about 120 m thickness and consist of high grade massive to layered magnetite and hematite, with small amount pyrrhotite. The Korkora-1 iron deposit has calculated tonnage 120 million metric tons (Mt) of ore with a grade of 56% wt. percent magnetite. This deposit is concordant with its host rocks and it has gradational contact with wall rocks.

The style of wall-rock alteration in the Korkora1 deposit is a function of wall-rock composition, timing and paleodepth of exposures. Wall rock alteration associated with orebody in rhyolite is dominated by potassic assemblages that include potassium feldspar, quartz, and sericite. In sedimentary rocks re-crystallization and dolomitization are dominated.

THE REE GEOCHEMISTRY:

Representive samples of Korkora-1 magnetite body were collected and crushed. Nine magnetite samples were analyzed for major –oxide, trace, and rare-earth elements by the Resource Geology Lab in SNU (Seoul National University) Korea. Major –oxide contents were analyzed by XRF(Table 1), while the trace elements and REE contend were determined by ICP_MS. Samples contain 81.73 to 95.26 wt% Fe, 0.1 to 5.41 %wt Si, 0.29 to 1.95 %wt Al, 0.00 to 0.1 %wt Ti, 0.41 to 4.19 %wt Mg, 0.25 to 1.38 %wt Ca, 0.03 to 0.71 %wt Mn, 0.00 t0 0.61 %wt P_2O_5,and their REE contents very significantly: seven samples have similar total REE values:54K1, 64K1, 24K1,44K1, 1K1N, 21K1,54K1, While samples 34K1 and 43K1 have different total REE values. The high REE content in 43K1 sample was probably caused by the present of an undetected REE phase.

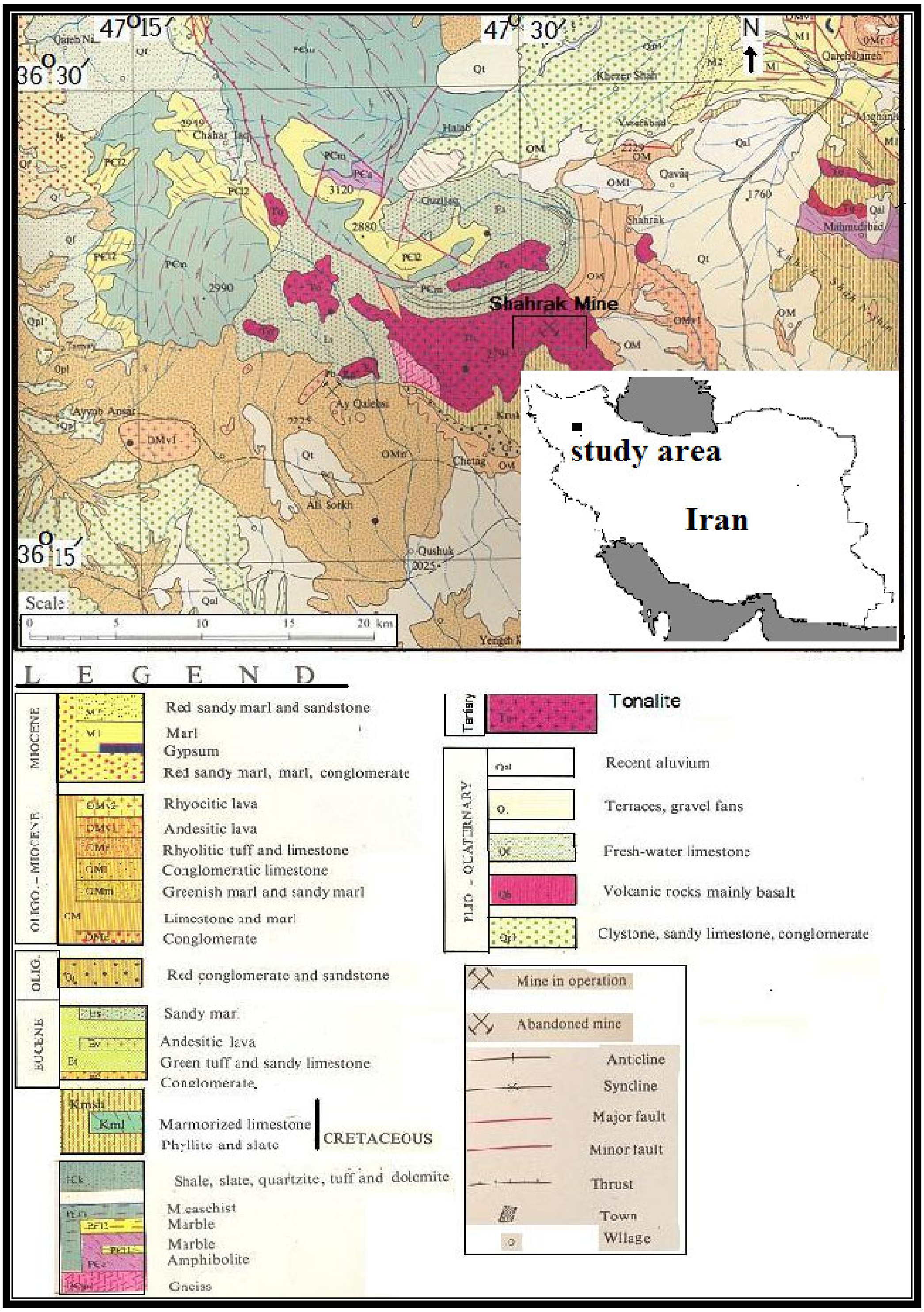

Fig.1, Geological map of the Shahrak area and(Korkora-1) mine.

Rare earth elements (La, Ce, Pr, Nd, Sm, Eu, Gd, Tb, Yb, Lu) concentrations in magnetite samples are very low and concentration of Eu, Gd, Dy, Ho, Tm, Lu(except Eu, they are HREE) in some samples are below detection limit. In REE distribution pattern contents of these elements were calculated by linear interpolation. XRD method is used for mineral determination.

The magnetite samples were collected from different parts and elevations from Korkora-1 deposit.

Table 1: Major oxide of the studied magnetite

	Sample	SiO2	Al2O3	TiO2	Fe2O3	MgO	CaO	Na2O	K2O	MnO	P2O5
		wt%	wt%	wt%	wt%	wt%	wt%	wt%	wt%	wt%	wt%
1	**24K1**	2.32	1.42	0.04	92.32	2.41	0.35	-	-	0.61	0.03
2	**45K1**	0.51	0.99	0.03	93.42	4.19	0.28	-	-	0.71	0.06
3	**34K1**	0.24	0.29	0.01	94.92	3.07	0.28	-	-	0.18	0.10
4	**64K1**	0.10	1.17	0.01	95.26	2.58	0.24	0.07	-	0.62	0.09
5	**44K1**	0.33	1.30	0.03	94.13	1.94	0.27	-	0.01	0.42	0.02
6	**43K1**	5.41	1.78	0.00	81.73	0.41	0.91	-	-	0.03	0.61
7	**1K1N**	2.78	1.95	0.03	88.44	2.25	1.35	0.08	0.08	0.28	0.00
8	**21K1**	3.19	0.69	0.10	85.61	0.44	0.37	-	-	0.11	0.18
9	**54K1**	0.18	0.92	0.03	93.90	4.08	0.25	0.01	-	0.71	0.07

The maximum quantities for La and Ce are 7.89 and 16.6 PPM in samples and mean La/Ce is 0.54. La/Lu is equal 6.5 and ∑LREE/∑HREE = 6.5.

The REE contents of samples were normalized to chondrite data. All samples reveal similar REE_N patterns, and they are characterize by low REE contents and descending patterns specially in light REE(LREE) sections. They are showing enrichment in LREE, slight positive Ce anomaly and negative Dy anomaly is noticed in one pattern. (Fig.1)

La/Lu , ∑LREE/∑HREE ratios, REE patterns and negative Eu-anomalies show LREE enrichment in all samples.

REE is occurred in two types of minerals in Korkora-1 iron deposit:

1) In accessory minerals such as monazite, bastanesite and /or xenotime. REE in these minerals were determined with perfect patterns of REE (Fig.2) and high quantities concentration of REE Up to 12 PPM for La and Ce. These minerals weren't determined by XRD method, Concentrations of them in all cases are below detection limit in this method. Accessory minerals are occurred as inclusions in magnetite crystals.

2) In magnetite ore: There is a sparse knowledge of the distribution and content of REE in magnetite in different rock and ore type. In magnetite Fe is found as two different Fe^{+2} and Fe^{+3} ions, REE with different charge can replace these ions in magnetite lattice but replacement is very limit, because Fe ions radius are differ in compare with REE ions.

REE in magnetite ore on Korkora-1 are determined with low concentration of REE in compare with type 1 and they haven't perfect patterns of REE (Fig.2). In all cases 3 elements (La,Ce and Nd) of REE have determined, even in one of them just Ce were found. REE in this mineral is enriched in LREE and patterns are not flat and they are descending to HREE and patterns are parallel to the type 1 and below them.

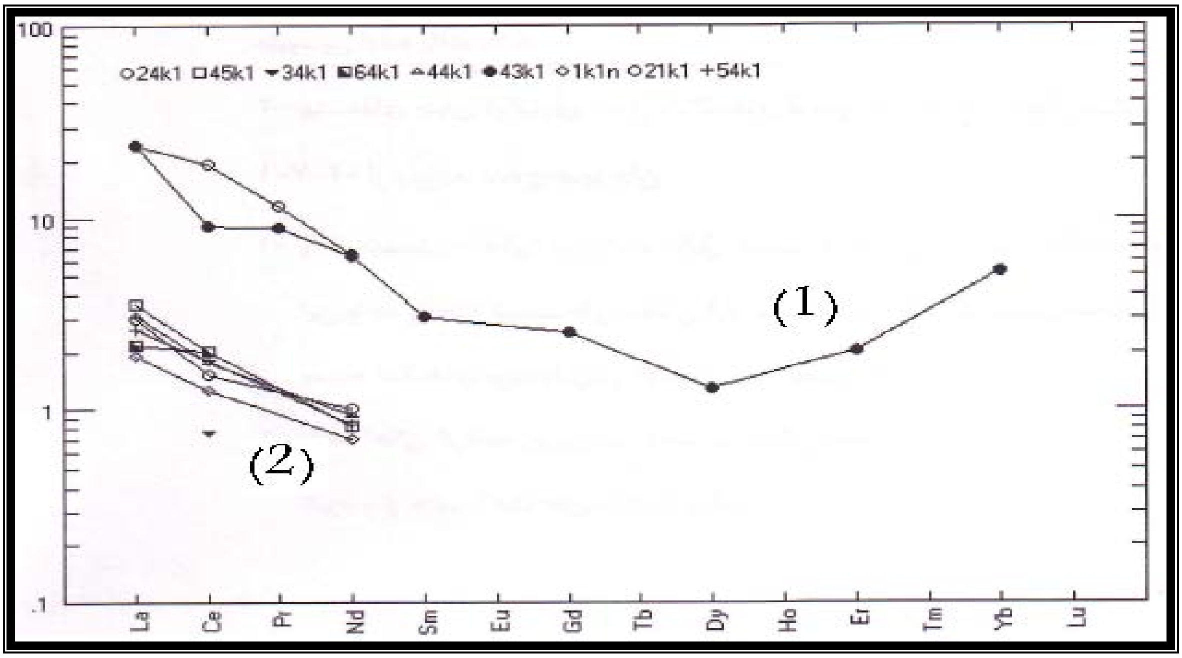

Fig. 2. REE spidergram for selected samples of the Korkora-1, normalized to the chondrite.(PPM) .

ACKNOWLEDGMENTS: the authors would like to thanks Dr Iraj Rasa from Shahid Beshty University –Iran for his scientific helps.

INTEGRATED APPROACH FOR ANALYSIS AND MANAGEMENT OF WATER RESOURCES IN THE LOWER DON RIVER BASIN

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KEY WORDS: integrated approach, Lower Don, modelling, decision support.

METHODOLOGY

In recent decades, it has become clear that sustainable and effective water use at a regional scale can be in the best way achieved by implementing the concept of integrated water resources management [GILMOUR J., LETCHER R., JAKEMAN A., 2005; LANINI S., COURTOIS N., GIRAUD F. et al., 2004; LETCHER R., GIUPPONI C., 2005; PARKER P., LETCHER R., JAKEMAN A. et al., 2002]. In systems theory terms, an integrated approach for catchment management means implementation of the systems approach. In this context the systems analysis of a problem of sustainable water use consists of the following stages:

- Complex estimation of a modern condition and features of water resources formation and use in region in view of social and economic tendencies.
- Development of actual problems, conflicts and priorities definition algorithm of a water use policy based on modern methods of multi-criteria decision-making under the conditions of uncertainty.
- Construction a set of complex scenarios to the land and water use for considered nature-technical system in view of socio-economic and climatic tendencies.
- Development of water resources formation and transformation mathematical model.
- Development of economic-ecological model of water economy complex.
- Statistical processing of simulation experiments, comparison of various scenarios and policies of water use.

Fig. 1 represents the general principles of how decision support system works [SELYUTIN V., BERDNIKOV S., 2005]. The top layer presents three aspects of work with scenarios. The scenario generator is an algorithm used to create various scenarios. Parameters of scenarios are defined by experts. The generator of nature conditions simulates effect of stochasticity. The blocks that represent the process of modelling are located in the middle layer. The key block here is the system of models which describe movement of material substances (water and pollutant fluxes), and also dynamics of socio-economic indices. For executing experiments it is necessary to have a set of scenarios, each of which is characterized by the probability of realization. As a result, we get a set of stochastic realizations, upon which probability distributions for a vector of a condition of considered system can be built. The bottom layer reflects interactive character of the offered approach. After the statistical analysis of experiments results, priorities can be changed and other decisions can be accepted. Later this process can be reiterated.

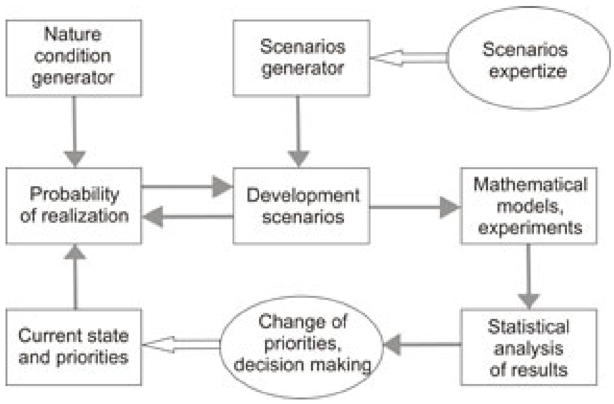

Figure 1 – Integrated modelling system of water resources forming and use.

The approach based on scenarios allows taking into account factors of uncertainty. At modelling scenarios the following stochastic processes are defined: growth rate of manufactures volume; volume of water consumption; dump waters volume. Depending on the current actions on preservation of the environment, the order of changing of the parameters responsible for efficiency of water resources use and ttreatment facilities capacity also are set.

WATER RESOURCES OF THE LOWER DON

There is a wide range of water and land use patterns in the Lower Don river basin. Water resources are one of the factors limiting social and economic development in this area with droughty climate. Thus, there is a real problem of multi-criteria and uncertainty in strategic planning on territorial complexes of the Lower Don. Problem solving is based on scenarios of a social and economic situation in the region, tendencies of the industry and an agriculture development, dynamics of the population and so forth.

In water economy system of the Lower Don, the main consumers of water, which carry out a withdrawal from natural sources, are industry, agriculture and municipal services. The polluted water makes approximately 20% of the total volume of dump water, where the share of municipal services is 66%. Sewage of the industrial enterprises and municipal services undergo cleaning (up to 90%), and the polluted water of the agriculture is not cleaned.

On the basis of the analysis of social and economic position of the Rostov region, and existing long-term plans of economic development, scenarios of water and land use have been developed [SELYUTIN V., BERDNIKOV S., KULYGIN V., 2006]. In modelling the tendency of water consumption, volume dynamics were considered separately for each type of activity where the significant amount of fresh water is consumed.

Scenario	Manufacture dynamics	Water use dynamics	Pollutions dump dynamics
Developments (A)	6% (+)	3% (+)	2% (-)
Regenerative (B)	3% (+)	1% (-)	3% (-)
Competition (C)	4% (+)	1% (+)	1% (-)
Transformation (D)	6% (+)	3% (+)	1% (+)
Restrictive (E)	3% (+)	1% (-)	0%
Conservative (F)	4% (+)	1% (+)	1% (+)

Figure 2 – Developments scenarios of water economy system of the Lower Don and trends (% in year). ("+" - positive trend; " –" - negative trend)

For this purpose industry (as a whole), agriculture (separately: irrigating systems, the main channels, fish-breeding ponds), municipal services were allocated, and also were taken into account losses on evaporation in numerous ponds of no-engineering type. Scenarios were also detailed by the main sources of dumps at the dump water modelling. Industry (as a whole), an agriculture (separate - irrigating systems), communal services have been allocated. The storm rainfall from the urbanized territories has been estimated.

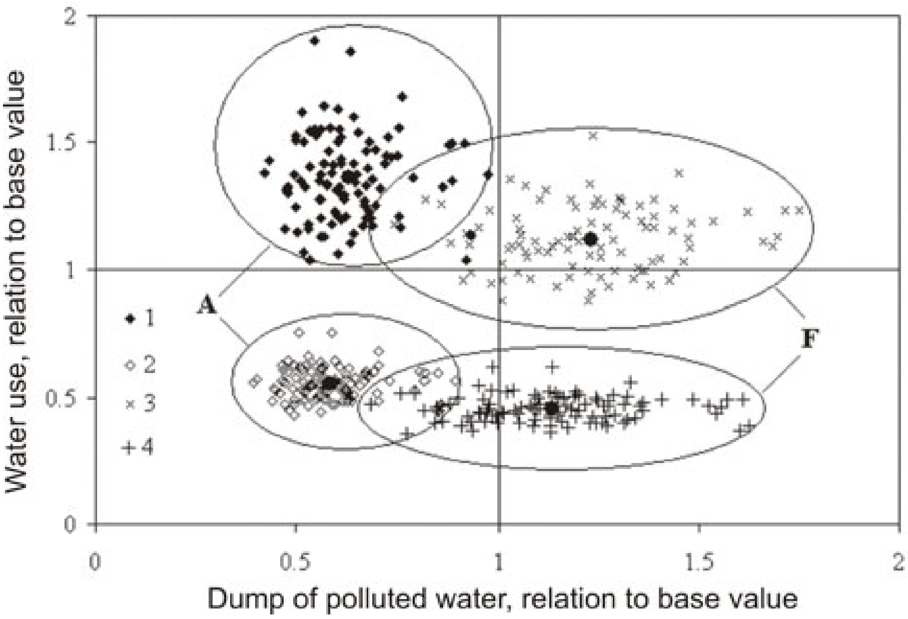

Figure 3 – Scenarios calculation for water economy system of Lower Don in 2015. 1 – scenario A0; 2 – scenario A1; 3- scenario F0; 4 – scenario F1.

RESULTS

Fig. 3 shows comparison of two most contrasting scenarios - A and F. The scenario A is that of sustainable development, while F is estimated as moderately pessimistic. Two variants were considered for each scenario - the basic A0 and F0, based on existing technologies, and scenarios A1 and F1, taking into account technological progress and ecological innovations.

In scenarios calculations results for ten years' period each complex scenario A and F are characterized by a cloud of the points describing a final condition of ecological-economic system. Results are present in relative units. Starting point (base year 2005) is (1; 1). Ellipses allocate results of separate realizations of scenarios A (A0, A1) and F (F0, F1).

Only substantial growth of investments in protection and rational use of land and water resources, combined with “ecologisation” of industry, leads the ecological-economic system in a state of sustainable development, trajectories of which on Fig. 2 correspond to area {x <1; y <1}. The final conditions, generated by scenario A1, are mainly in this area. Scenario A0 provides development of water-capacious industries, but does not result in reduction of volumes of fresh water use. The greatest ecological risks of water pollution are connected with scenarios F0 and F1.

For a quantitative estimation of water economy system of the Lower Don development scenarios one can use an approach based on comparison of distribution function of certain characteristics, which come as a result of repeated script runs. It is possible to carry out an integrated estimation of influence of various factors and processes on formation of water quality in the whole of interval of their variability by comparing distribution functions.

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COMPATIBILITY BETWEEN ENERGY DEMAND, SOCIAL EQUITY AND ENVIRONMENT PROTECTION

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KEY WORDS: Energy sources, Environment, Sustainable development

INTRODUCTION

In today's consumer society, an increase in energy consumption is considered to be a positive index of a country's development, however, is an indefinite increase in consumption possible? In other words, can there be sustainable development that allows economic growth and improves the wellbeing of society as a whole without damaging the environment and without exhausting our planet's energy sources?

To accomplish this result, we need to manage and plan all the available energy sources both to allow use by future generations at prices that are affordable for all, and not just for a privileged minority, and to guarantee everybody, now and in the future, economic wellbeing, social equity, environmental protection and human wellbeing, which depends not merely on material living conditions, but also on living in a pleasant environment and on the conservation of the artistic and cultural heritage linked to the history and traditions of populations (Brighenti, G. et al., 2006, Bruntland, H., 1987, Fanchi, J.R., 2000).

ENERGY CONSUMPTION AND EVOLUTION OVER TIME

Until the 19th century, most sources of energy were renewable (in 1850: timber 70%, coal 19%, hydraulic power and other sources 11%, therefore approximately 81% of energy came from renewable sources) (Brighenti, G., Macini, P., 2007).

This situation evolved over time and the panorama has now completely changed: there is currently an absolute prevalence of non-renewable sources, primarily fossil fuels (oil, natural gas and coal) and nuclear fuels.

Renewable resources include solar energy (used to produce both heat and electric energy), hydraulic energy (used almost completely to produce electricity by exploiting both variations in potential energy due to altitude changes, and river and sea currents, waves and tides), wind energy, geothermal energy and biomass **.**

In 2005 primary energy consumption was about 12.000 Mtoe (tonnes of oil equivalent). and could be broken down into the following main categories: oil 37%, natural gas 23%, coal 27%, nuclear 6%, hydroelectric 6%, other renewable sources 1% (EIA, 2008**)**. These consumptions are primarily concentrated in developed areas and newly industrialised countries as shown in Figure 1.

REGION	2005 Primary Energy Consumption (%)	Per Capita 2005 Primary Energy Consumption (toe)
North America	26	7,0
Central & South America	5	1,3
Europe	19	3,7
Eurasia	10	4,4
Middle East	5	3,1
Africa	5	0,4
Asia & Oceania	32	1

Figure 1 – World total primary energy consumption *(EIA, 2008).*

If current trends continue, between 2005 and 2020, the demand for energy should increase (due to both an improvement in the population's wellbeing and an increase in the population) by 1.7% per year and grows to about 14.500 Mtoe. (ENI, 2008)

However, assuming that by 2020, the world's mean consumption per capita is equal to the current per capita consumption in Europe and that the performance of thermoelectric power stations in developing and newly industrialised countries is equal to the current efficiency of industrialised countries, the result would be 27.000 Mtoe, about three times the current world consumption.

FUTURE AVAILABILITY OF ENERGY

The evaluation of the energy available currently and in the near future varies greatly according to the source consulted, due to both the incompleteness of the data available and the doubtful origin of the sources themselves.

The following approximate values have been deducted from the information provided by the

Energy International Administration (EIA), Oil companies and Mining industries, etc.:

Non-renewable sources - As for fossil fuels reserves (oil, natural gas and coal), figure 2 provides a rough estimate of fossil fuels reserves in 2005.

	Oil	Natural gas	Coal°
Actual reserves	150	140	490
Ultimate reserves	275 - 250	280	-
Non conventional	1950*	not exactly estimated**	-

*Figure 2 - Fossil Fuels Reserves (Gtoe): *very thick oil, tar sand, oil shales, very deep offshore oil fields etc; ** The world wide amounts of carbon bound only in gas hydrates is conservatively estimated to total twice the amount of carbon to be found in all known fossil fuels on Earth (Brighenti, G., 2007); ° most coal reserves are situated in US, Russia, China and India) (EIA, 2008).*

When will fossil fuel reserves run out? Past estimates, according to which reserves would be rapidly exhausted, have always been proved wrong by the facts. Many experts now believe that since the price of energy rises if demand exceeds supply, new investments will be made to search for unknown reserves and production techniques and therefore the quantity of economically extractable minerals would increase and would allow use of part of the vast unconventional reserves.

As for nuclear fuels, according to some researchers, the availability of nuclear fuel cannot be taken for granted, especially if there is a steep increase in world demand due to an expansion in nuclear power programmes. These scientists believe that high concentration uranium reserves to be fairly limited. The threat of a shortage of minerals will only be overcome by passing from nuclear fission power plants to nuclear fusion power plants, whose commercial use has however encountered technical difficulties that cannot be overcome in just a few years (Clô, A., 2008, Fanchi, J.R., 2000, Trainer, T., 2007).

Renewable sources - The main sources of renewable energy currently available are hydraulic resources, commercial and non-commercial biomass and, especially in some particular sites, high and low enthalpy geothermal energy. In recent years, there has been a significant increase in the use of wind energy, whereas solar energy (especially photovoltaic and thermal production of energy) does not currently make a significant contribution, despite being interesting in particularly well-suited locations, for both specific uses, especially in the cases of highly polluted areas and isolated users; the solar energy option is most interesting when heat is used directly (Fanchi, 2000).

As regards the future contribute of main renewable sources (hydraulic energy, commercial and non commercial biomass and geothermy) it is necessary to point out that at present conventional hydraulic resources are the most important sources of renewable energy (80 - 85%), but, at least in developed countries, the forecast of their future growth is not great; but other non conventional sources of hydraulic energy may be also sea and rivers currents, waves and tides that can be used to drive electric generators too.

Moreover biomass can be converted into synthetic fuels, but only a small fraction of liquid and gaseous fuels demand may be met by biomass; indeed large-scale plantation are unrealistic because the areas required would be too great and non-plantation sources, such as crop and timber wastes, can give only a small contribute (Trainer, T., 2007).

In the case of geothermal energy, recent evaluations indicate that the total energy contained in the earth's crust is in the order of 12,89 10^{16} toe (Dickson, M.H., Fanelli, M., 2005), but the traditional technology of heat and power production from geothermal sources involves the presence of a natural hydrothermal system, i.e. a relatively shallow permeable reservoir (usually fractured rocks) saturated with water and/or steam. If the reservoir fluids can be produced economically, then water and steam can be used for direct utilization or for power production. Unfortunately, the largest part of the hottest rocks is impermeable with no natural recharge, or their permeability is so low that these rocks (known as Hot Dry Rocks - HDR) cannot represent an economic reservoir up to now (Brighenti, G., Macini, P., 2007); at the present time the world production of traditional geothermal energy is only 8.000 MWe (electric MW) in thermoelectric power station and 15.000 MWt (thermic MW) utilized for direct use of heath.

ENVIRONMENTAL DAMAGES

As regard fossil fuels, one must distinguish between global environmental damages due to energy production, which might have an effect on the entire ecosystem, and localized damages which have a marked effect only on the site of production and transformation of the energy resources. These latter damages are particularly sensible in areas of strong industrial or urban concentration.

Moving on to other localized environmental damages, one must distinguish between the damages due to usage and the damages produced directly by the operations of the upstream and downstream hydrocarbon industry.

As far as the damages due to the use of hydrocarbons are concerned, they are mainly due to water and soil pollution by liquid spills and to atmospheric pollution that is mainly concentrated in urban or industrial areas.

Concerning the production, with its upstream (exploration, drilling and production) and downstream (transport, refining, distribution) branches, one should bear in mind that the upstream operations produce only limited damages. Amongst these, major impact during exploration derives from the possible use of explosives in seismic surveying, while during drilling and production, environmental damages can be caused by uncontrolled well blow-outs with serious danger to people and the surrounding environment (sea or land).

The downstream activity presents pollution and noise problems. The main environmental damages are the possible large onshore and offshore oil spill, due to the breakage of pipelines or of oil tankers shipwrecks, and possible accidents inside the refineries.

As far as effects on the entire ecosystem are concerned, a part of the scientific community believes that the principal danger deriving from the utilization of fossil fuels comes from the greenhouse effect, caused by several greenhouse gases (chiefly by CO_2) produced during the combustion and discharged into the atmosphere.

In the case of use of nuclear energy just one incident in a nuclear power station could have devastating global consequence for a very long time, moreover till now there is no definitive solution to the storage of radioactive wastes.

Renewable sources can also harm the environment. As far as hydraulic power is concerned, with the exception of rare disasters caused by the collapse of dams or by landslides (for instance: Malpasset, Vaiont), the most serious damages are caused by the modifications to rivers regime, by the changes to the transportation of fine suspended particles along the entire collection basin and by the change to the microclimate.

Energy production from biomass can lead to the destruction of forests, the appropriation of vast areas of land previously destined to food crops and the impoverishment of soil caused by the production of energy also using refuse and animal dung traditionally used to maintain the fertility of soil.

The usual damages connected to the use of modern geothermal power plants are not high and consist in the local drawbacks caused by the presence of industrial plant not popular with residents, especially in areas with a high environmental or tourist value .

Lastly, as far as wind energy is concerned, the drawbacks are minimal and consist in the occupation of large areas and, according to some environmentalists, the damage to the landscape and the noise that can harm wildlife.

CONCLUSIONS

Many experts believe the availability of fossil fuels and especially hydrocarbons to be limited and that they will run out within a short time. This type of forecast has been made many times and has always proved to be wrong. It is currently thought that the increase in the price of energy will generate an increase in efforts to identify new reserves and an improvement in production techniques that would make the use of new fossil fuel deposits, including some non-conventional reserves, economically interesting. It goes without say that the price-cost balance requires time as the search for new reserves and the development of new techniques require lengthy timeframes, hefty investments and, above all, a reasonable certainty as to their profitability. On this front, it must be remembered that as these large investments would often be made in areas that are politically unstable; when evaluating a reserve, the reasonable certainty of long-term availability and consequently the political stability of the area in which it is located is of paramount importance. Furthermore, the increase in the price of one energy source could make another economically viable and therefore cause an increase in global energy resources.

It would therefore be reasonable to say that, although fossil fuels will be available for a long time yet, their use generates both local pollution (during the upstream and downstream phases and in large industrial areas and in large urban settlements) and planet-wide pollution, including the particularly harmful increase in the concentration of carbon dioxide in the atmosphere that some experts consider to be the main cause of the greenhouse effect, which would cause severe environmental unbalance.

To avoid such damage, CO_2 can be removed from the atmosphere by trapping it in the subsoil (in depleted hydrocarbon reservoirs or in deep aquifers), by dissolving it into the oceans, or by replacing fossil fuels with other forms of energy that do not produce CO_2 (Brighenti, G., 2006) such as nuclear or renewable energies.

The first solution requires procedures that greatly increase the cost of the electricity produced. It would therefore be appropriate to verify whether, in the presence of a limited budget, it is a priority objective or it is better to perform other works that are more necessary and urgent for human survival (Lomborg, B., 2008).

As far as the other available energy sources are concerned, we have seen that the use of nuclear fission power stations generates radioactive wastes, that are harmful for very long periods, whose removal from the ecosystem entails high costs that, when added to the cost of producing the energy, make the affordability of the process problematic. The hazards for the environment nevertheless persist due to both the potential accidents (with long-term effects) and the increase in radioactivity around power stations.

Of the renewable sources, a significant contribution can be provided by hydroelectric and geothermal power plants that do not generate pollution and can be adapted to the energy demand, however at least in industrialised countries, much of hydraulic resources have been exploited, whereas the earth's heat content offers useful contributions only in countries with favourable geothermal situations.

Biofuels could also constitute a good substitute for fossil fuels, especially in the transport sector, however their production could increase the cost of foods and, by leading to deforestation, reduce the amount of carbon dioxide absorbed by plants.

Lastly, solar and wind energy are able to produce large amounts of clean energy but at low concentrations. In addition to requiring vast spaces in which to install solar panels and windmills, these systems, together with wave and tide energy, produce energy in a discontinuous way and, as to date we have no way of storing large amounts of energy, they can only be used in combination with other conventional sources.

To conclude, it can be said that the solution to the energy problem should be evaluated not only from a purely economic standpoint, but should be seen in the social and ecological perspective of sustainable development, taking into consideration the advantages of developing also partially renewable resources at lower environmental risk (clearly disregarding the excessive NIMBY syndrome) (Rudduck, N., Khurana, A., Congreve, M., Lourens, J., 2005).

In any case, it would appear to be clear that, if we wish to achieve a solution that is acceptable from an equity and environmental conservation standpoint, it is necessary to abandon the effluent society model, thus drastically reducing energy consumption in industrialised countries, a solution that is difficult to accept as it would cause a great upheaval to the current social system and particularly to the living standard of working and middle classes.

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COMPUTER-AIDED SYSTEM ANALOG FOR GOLD ORE DEPOSITS OVER THE WORLD: THE SELECTION OF CLOSEST ANALOGUES AND COGNITIVE GRAPHICS

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KEY WORDS: information-analytical system, gold ore deposit, object-analogue, cognitive graphics, express evaluation of deposit, method of analogy, database.

SUMMARY

The problem of selection of geological object (deposit), which is most similar in some criteria to target object, is always interested to researchers. By method of analogy the evaluation of unknown properties for object under study is possible while using the closest analogue among well investigated reference analogue objects. Taking into account the huge opportunities of cognitive properties of graphic information, the necessity of its using is proved at express evaluation of deposits as by the reference analogue object the evident representation of attributes and geological situations is provided for unknown one on poor studied object. This approach allows to deepen our knowledge about objects under study by their comparison to well investigated objects-etalons and carry out preliminary geological-economic express evaluation. By the method of analogy, user can always evaluate unknown properties of the considered object under study, as for example, ore formation type, economic-geological evaluation of the deposit on the basis of known properties of the selected analogue.

The authors have developed the computer-aided information-analytical system ANALOG since 2002. It provides the selection of object-analogue with quantitative evaluation of similarity between analogue and object under study on any set of attributes, including visualization of its characteristic properties. The information basis of decision making is the fact database, involving information about 247 gold ore deposits of the World. The system is intended for express evaluation of gold ore objects by method of image-associative analogy according with the selected object-analogue.

For the first time the system for express evaluation of gold ore deposits according with the selected object-analogue is added with the graphic database containing geological materials, necessary while analysis of deposits, but which cannot be presented in a text or digital form. Taking into account the wide development of internet-technologies, the technology of creation of the enclosed HTML-files was selected for data management system. It has provided the storage of unlimited number of raster images.

THE INFORMATION BASIS OF THE INFORMATION-ANALYTICAL SYSTEM ANALOG

While economic-geological analysis of gold ore deposits the first priority is for determination of ore formation type and mineralization scale. Therefore the system for characterization of ore deposits should contain parameters necessary for performance of these tasks.

The information basis of the system is the fact database developed taking into account own results of authors and an experience of application of previous databases. By now the database includes data on 247 gold ore deposits over the world in the system of 894 attributes unified into 26 groups (Table 1).

An analysis of selected groups of the attributes has showed that they can be of following type: logical (yes/no); digital (integer or real); symbolic (string of characters of definite length); text. A part of attributes can take on values from fixed sets. Since it is desirable to reduce the amount of stored information and accelerate the procedure of the search, these attributes were encoded by enumerating their possible values. Lists of the values for these attributes are stored in reference files. Since information on some attributes is not always available, a specification “no data” is introduced for information which was not determined.

There are two functions of computer graphics - illustrative and cognitive. The first one is used in scientific researches, including fundamental. Now we decide to use the second one, which allows to researcher to make active ability to think by complex spatial images. Illustrative function of computer graphics allows to embody knowledge in more or less adequate visual form only that is

No **	Groups of attributes
1	Regional geological structures guiding the spatial distribution of auriferous provinces
2	Structures of the ore region and cluster
3	Geological formations that compose the ore field
4	Folded structures of ore fields and deposits
5	Faulted and fault-block structures of ore fields and deposits
6	Elements of structures that control the location of the largest orebodies and pipes
7	Orebody morphology and bedding
8	Host rocks
9	Host rock metamorphic facies
10	Formations and facies of metasomatites in aureole
11	Minerals of the hydrothermally altered rocks
12	Ore minerals
13	Gold paragenetic associations in ores
14	Gold geochemical associations
15	Ore texture
16	Gold grade
17	Gold particle size
18	Host rock age
19	Mineralization age
20	Typical elements of primary and secondary halos
21	Geophysical anomalies (position in gravity field)
22	Geophysical anomalies (position in magnetic field)
23	Geological parameters of commercial significance
24	Geochemical halo parameters
25	Presence of admixtures and by-products in the ore
26	Deposit Coordinates. Channels of Information.

* - author M.M.Konstantinov.
** - nomer of the group of the attributes in database.

*Table 1 – Groups of attributes for description of gold deposit *Scheme of functionality operation.*

already known, i.e. already exists or in the world environmental us, or as idea in researcher's head. Cognitive function of computer graphics helps us in certain graphic representation to receive new knowledge, i.e. yet not existing even in expert's head or, at least, to promote intellectual process of reception of this knowledge.

Whereas the huge opportunities of cognitive properties of graphic images, the authors have started the creation of database consisting of raster images for etalon objects for information-analytical system of express-evaluation of gold ore deposits, based on search of object-analogue.

Such database, involved facts and graphics, is designed as a component of system ANALOG, which developed by the authors in 2002-2006.

METHODS OF COMPARISON OF THE OBJECT UNDER STUDY WITH THE OBJECTS FROM DATABASE IN THE SYSTEM ANALOG

The comparison of the object under study with the objects from the selected set is carried out for each selected group of the attributes.

Let $n_1, n_2, \ldots, n_q$ - be numbers of the attributes in each selected group, $xi = (x_1, x_2, \ldots, x_{ni})$ is representation of the object under study x by the attributes from the group with number i; $yi = (y_1, y_2, \ldots, y_{ni})$ is representation of the object y from the selected set by the attributes from the group with number i. Let us assume that L closest analogues for the object under study from the selected set are required.

Procedures of analysis depend on the form of representation of data on the objects.

The measure of similarity between the objects in accordance with the attributes from the group with number i is the measure constructed on the basis of the Gover's measure (Davis, 1990):

$$G^i(xi, yi) = 1 - \frac{1}{ni}\sum_{k=1}^{ni} G_{ki}(x_{ki}, y_{ki}),$$

$$G_{ki}(x_{ki}, y_{ki}) = \frac{|x_{ki} - y_{ki}|}{R_{ki}^{\max} - R_{ki}^{\min}}$$

where **$xi = (x_{1i}, x_{2i} \ldots x_{ni})$; $yi = (y_{1i}, y_{2i} \ldots y_{ni})$; xi, yi** – the description of objects **x, y** by **ni** attributes of group **i**;

$R_{ki}^{\min}, R_{ki}^{\max}$ are respectively the minimum and maximum values of the attribute with number ki throughout the whole set of the selected objects.

An estimation of average similarity over the all selected groups of the attributes is obtained on the basis of the estimations determined for each group:

$$\overline{G}(x, y) = \frac{1}{m}\sum_{i=1}^{m} G^i(xi, yi),$$

where m is the number of the groups selected at the beginning of the user session.

Value of $\overline{G}(x, y)$ ranges from 0 to 1. The closer to 1, the more similar are the objects. This estimate is used for selection of the L closest analogues of the object under study.

The set of these L objects is represented in the form of the table where:

- the first column contains names of the groups of the attributes;
- the second column contains names of the attributes; the third column contains description of the object under study;
- descriptions of the closest analogues are given in the next columns disposed in order of descending similarity;
- the first row is numbers of the objects;

- the second row is values of the measure of similarity.

This table is used for analysis of the result.

REPRESENTATION OF THE RESULTS IN THE SYSTEM ANALOG

On figure 1 it is the functioning scheme for information-analitical system ANALOG.

The system forms the table of coefficients of similarity between the estimated object (under study) and its closest analogues (referense deposits) for each group of the attributes (Fig.1, left table).

These coefficients are represented also in the graphic form (Fig.1, left graphic).

Graphs $G^i(xi,yi)$ of contributions for the selected objects are plotted as L curves drawn through m points each (L is the number of the closest analogues, m is the number of the selected groups of the attributes).

The measure of similarity with each analogue is indicated.

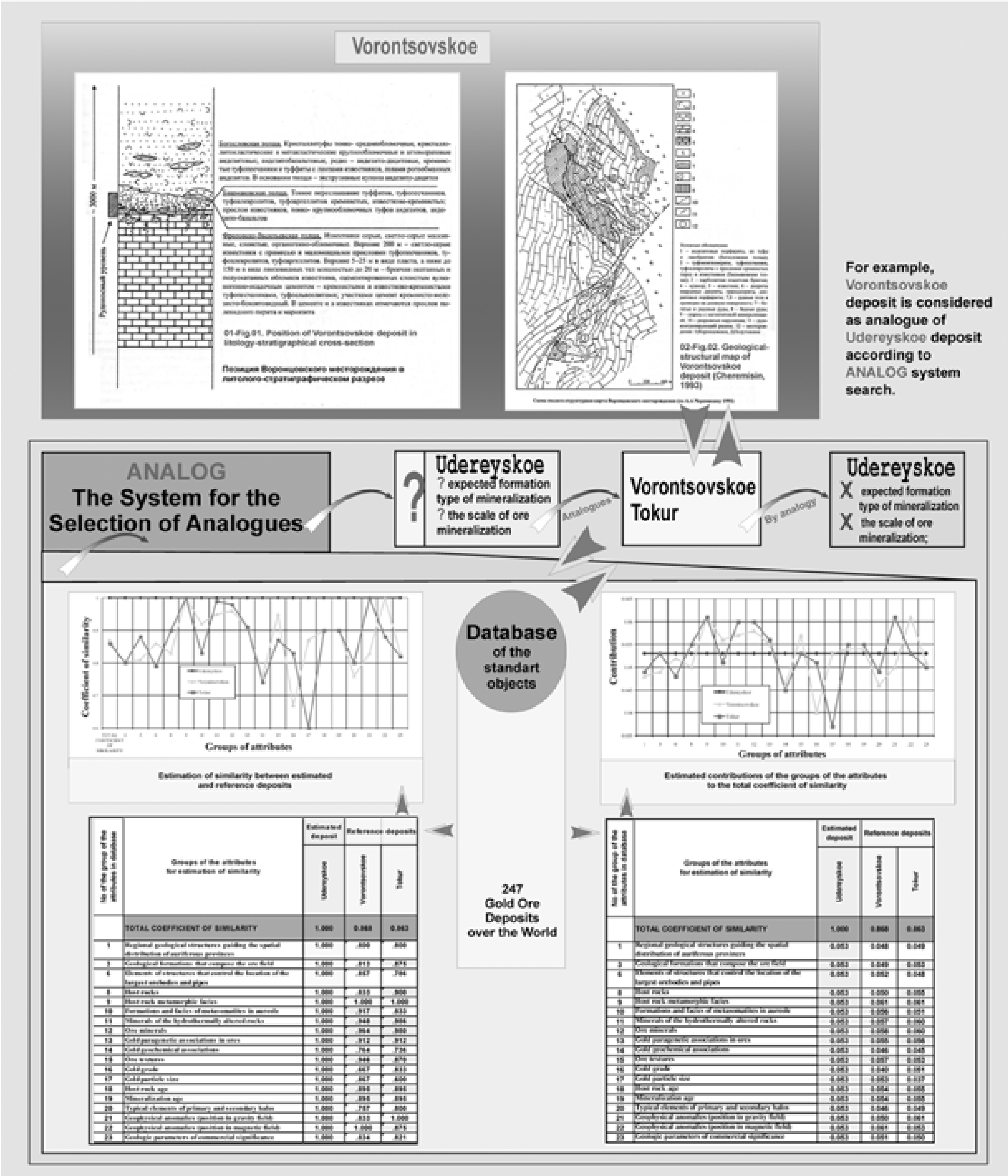

Figure 1 – The functioning scheme for information-analitical system ANALOG.

The same information is represented in the table with the header ‘Estimated contributions of the groups of the attributes to the total coefficient of similarity’ (Fig.1, right table).

$$V^{i}(x,y)=\frac{G^{i}(x,y)}{m\cdot\overline{G}(x,y)},$$

where $V^i(x,y)$ is the estimated contribution (significance) of the group of the attributes with number i to the total coefficient of similarity of the objects;

$G^i(x, y)$ is the coefficient of similarity of the object under study x with the standard object y in accordance with the group of the attributes with number i;

m is the number of the selected groups of the attributes;

$\overline{G}(x,y)$ is the average coefficient of similarity between x and y over the all groups of the attributes.

Graphs $V^i(x,y)$ are plotted for the all selected objects as L lines drawn through m points each (L is the number of the closest analogues, m is the number of the selected groups of the attributes) (Fig.1, right graphic).

SOFTWARE OF THE SYSTEM ANALOG

The developed software of the system ANALOG (ANALOG.exe) operates on the basis of .Net Framework 1.1 what allows to use it as network application.

The database of the system is stored in the standard format *.mdb and can be displayed by MS Access applications.

If coordinates (longitude and latitude) of the objects selected as analogues are given in the database, the visualization block is linked, and the map with information about the position of selected object-analogues is displayed.

For user’s convenience, the results of express evaluation are stored in a file of the format .xlt what permits its processing through MS Excel (independently on operation of the system), and the results can be represented for report in conventional user-friendly form.

After the selection of the closest analogues the user has opportunity to browse information at fact and graphic database (Fig. 2).

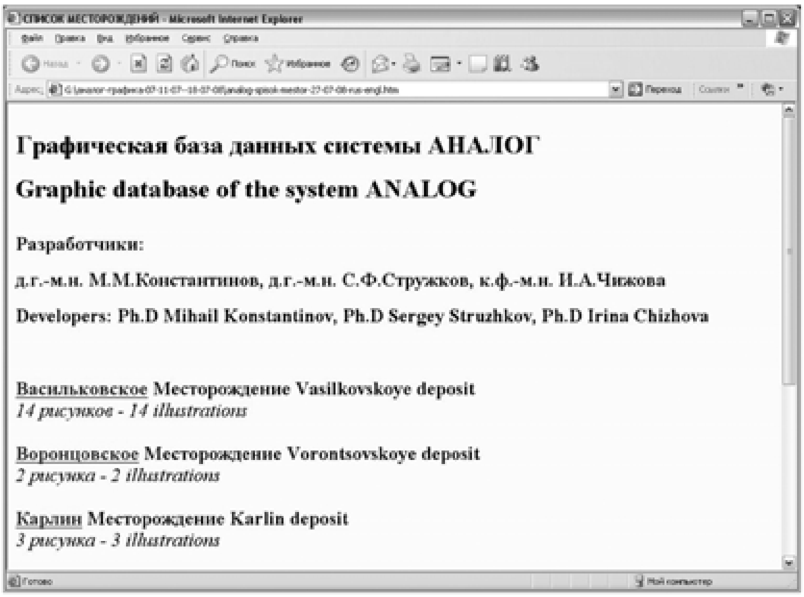

Figure 2 – The interface for graphic database of information-analitical system ANALOG.

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THE HISTORICAL COPPER DEPOSITS OF EMILIA ROMAGNA, A KEY TO PALEOGEOGRAPHIC INTERPRETATION OF THE LIGURIAN OPHIOLITES.

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KEYWORDS: Ore deposits, Copper, Ophiolites, Nortehrn Apennine, Emilia Romagna.

HISTORICAL BACKGROUND

Some copper deposits in eastern Liguria were already known since 3500 years BC (Maggi and Pearce, 2005). Analogous deposits occur in Emilia Romagna. Although there is no factual indication that they were worked in pre-historical times, certainly, deposits located in the province of Modena were well known in the Late Middle Age, as testified by an ancient written document undersigned by Sir Guglielmino of the late Matteo da Montecuccolo, on June 11th Anno Domini 1343 (Violi Guidetti 1968):
"...Que in venis inventis et que inveniri vel reperiri poterunt in terris Medolae et Bochaxoli, ex quibus aurum, argentum, ramum, stagnum, plumbum, ferrum vel aliquod metallum de predictis haberi, percipi et extrahi poterit…"
Further documents report on the negative attempts of exploitation of these deposits through several centuries up to the Industrial Era (1850-1910), when systematic mining was undertaken in deposits of eastern Liguria. After a short period of decline, mining activities started again during "Autarky", before World War two (Moretti, 1937; Porciatti, 1940), and lasted until the early seventies, when the mines at Vigonzano and Ferriere (western Emilia Romagna) were definitively closed. To day, the mining sites are completely abandoned, and collapsed galleries, open pits and ruins of old plants for the treatment of the copper sulfide ore are the only vestiges, witness of the past prosperity.

GEOLOGY AND MINERALOGY

The ophiolites of Emilia Romagna are coeval with ophiolites of eastern Liguria, and represent dismembered fragments of the oceanic lithosphere underlying the western limb of the Jurassic Tethys (the Ligurides). The associated copper deposits pertain to the category of sulfide deposits known in the international literature as "Volcanic Massive Sulfides" (VMS) that occur within volcano-sedimentary sequences and show consistent space-time relationships with extrusive magmatic activity. The VMS deposits associated with the Northern Apennine ophiolites formed by hydrothermal processes related with sub-oceanic basaltic volcanism active in Upper Jurassic times, during opening of the Piedmont-Ligurian basin.
The VMS deposits of Emilia Romagna occur in ophiolite blocks exposed from NW to SW along the Apennine orogenic chain (Fig.1). The most important mines are located in the provinces of Piacenza, Parma, and Modena.

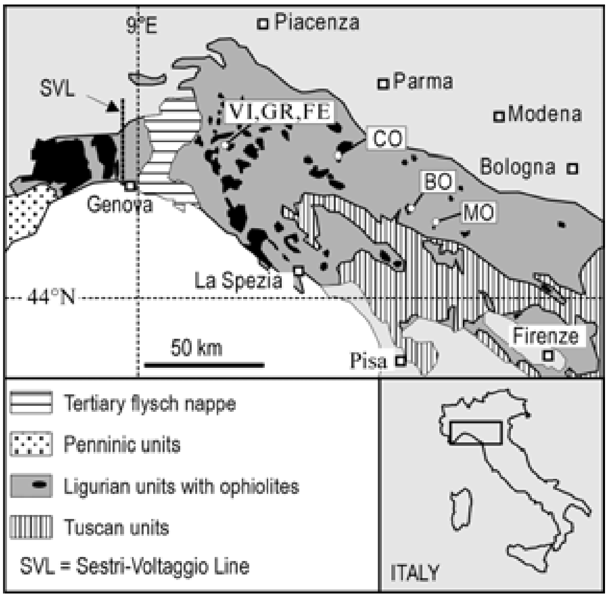

Figure 1. Geological setting of the Northern Apennine ophiolites, and location of major copper deposits of Emilia Romagna. VI = Vigonzano, GR = Groppallo, FE = Ferriere, CO = Corchia, BO = Boccassuolo, MO = Montecreto.

Copper exploitation is known to have taken place also in the province of Bologna (Bisano, Sasso

Nero), although no surface evidence of the past mining works have been preserved.

The VMS deposits of Emilia Romagna are characterized by different setting and stratigraphic position within the ophiolite sequence (Fig. 2). Garuti et al. (2008) have described two major types of deposits: 1) Stratiform ores located at top of pillow basalt unit, covered with sediments (Corchia), 2) Sulfide ores within stockwork veins cutting across the serpentinite basement (Vigonzano, Groppallo, Ferriere), and the overlaying pillow basalt (Boccassuolo, Montecreto).

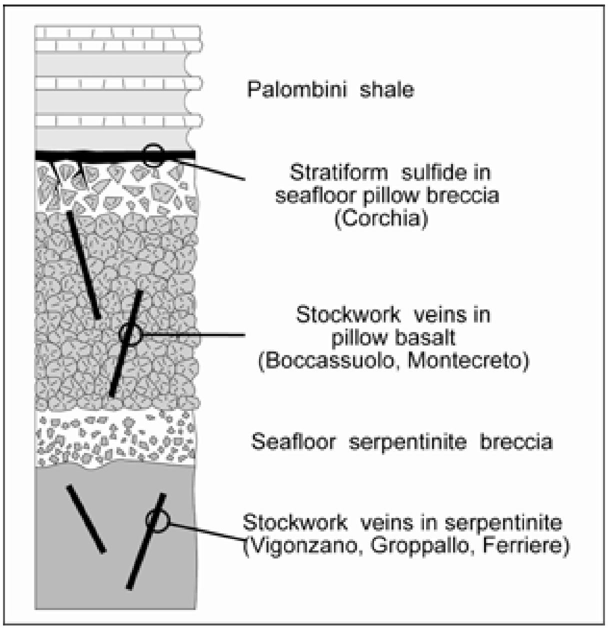

Figure 2. Idealized stratigraphy of the sulfide copper deposits in ophiolites of Emilia Romagna (After Garuti et al., 2008).

All deposits are characterized by the common assemblage pyrite, chalcopyrite, minor sphalerite and pyrrhotite, and a suite of accessory Fe-Cu-Co-Ni sulfides. Gangue minerals are quartz, chlorite and carbonates (calcite, siderite, ankerite), accompanied by Fe-Ti oxides (magnetite, hematite, ilmenite, rutile), epidote, titanite, apatite, zircon, with minor tremolite, actinolite. Datolite occurs in some hydrothermal veins of Boccassuolo (Zaccarini et al., 2008).

In spite of the monotonous sulfide mineral assemblage, the VMS of Emilia Romagna display significant variations, depending on their geological setting. Sulfide texture in stockwork veins is consistent with crystallization and grain coarsening under hydrothermal conditions (Zaccarini and Garuti, 2008). In contrast, sulfides in the stratiform deposit of Corchia display distinctive textures indicative of the replacement of microfossils and reworking by sedimentary processes (Fig. 3). The sulfide frequently displays clastic texture produced by accumulation of sulfide debris in a matrix of detrital quartz, chlorite and clay minerals (Garuti and Zaccarini, 2005).

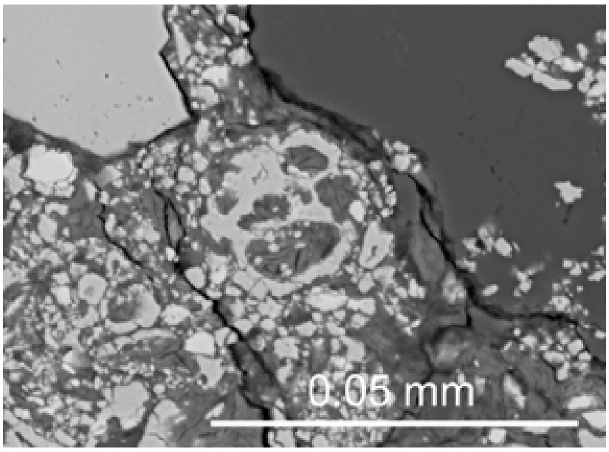

Figure 3. Microphotography of foraminifera shells replaced by pyrite within sulfide debris from the stratiform ore deposit of Corchia.

The ore of Corchia is characterized by the systematic appearance of Au and U anomalies up to 3.07 and 3.5 ppm, respectively, supported by the finding of specific phases (native gold, electrum, silver, achantite, freibergite and uraninite (Garuti and Zaccarini, 2005).

Results of chlorite geothermometry obtained for stockwork deposits are mainly in the range (200°C - 360°C) with a frequency peak around 240°C, compatible with hydrothermal processes (Fig. 4A).

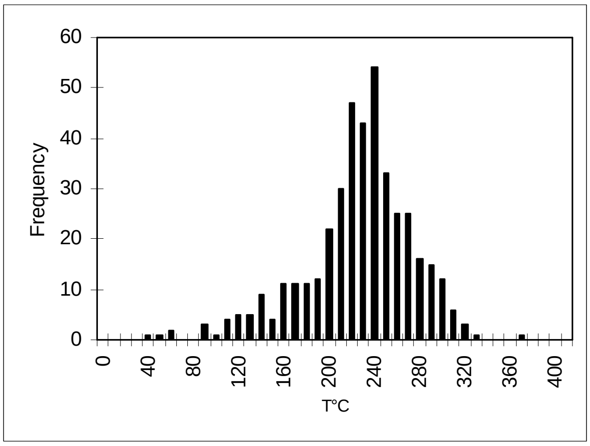

Figure 4A. Distribution of chlorite temperatures calculated in stockwork veins of Emilia Romagna sulfide deposits.

Temperatures calculated from the sulfide ore of Corchia have a maximum frequency at about 180°C (Fig. 4B), possbly indicating interaction of the hydrothermal solution with colder seawater in a submarine environment (Zaccarini and Garuti, 2008).

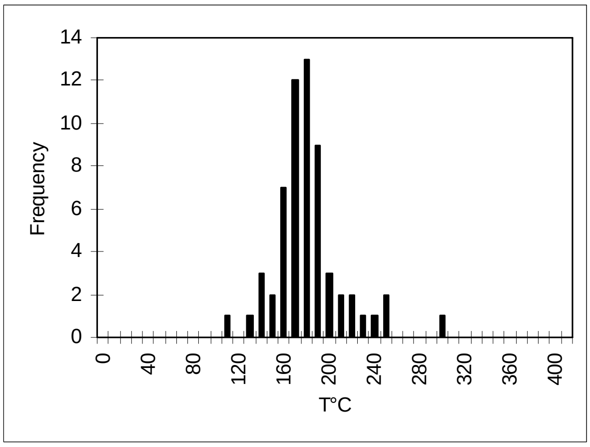

Figure 4B. Distribution of chlorite temperatures calculated for the stratiform deposit of Corchia.

Sulfur isotope composition of sulfide minerals (Garuti et al., 2007) varies from an average $\delta^{34}S‰$ of +5.7 in serpentinite-hosted veins to +8.5 in veins crosscutting basalt. The value of +8.5 $\delta^{34}S‰$ is consistent with inorganic, thermochemical reduction of seawater sulfate at an age of 165 Ma (Fig. 5). The lower $\delta^{34}S$ values observed in serpentinite-hosted veins may indicate mixing with mantle-derived sulfur having near-chondritic composition ($\delta^{34}S‰ = 0.0$).
The stratiform deposit has an average $\delta^{34}S‰$ of +2.1. The whole range of data, however, extends from +5.8 down to a negative value of -2.9. Enrichment in the light isotope ^{32}S, in this case, is believed to have resulted by the action of Sulfur Reducing Bacteria.

GENETIC IMPLICATIONS

The scenario envisaged is consistent with the conclusion that the VMS deposits associated with the ophiolites of Emilia Romagna formed by convective circulation of hydrothermal solutions derived from seawater penetrated at depth during opening of the Ligurian ocean. The sulfides precipitated from hot, metal-charged solutions ascending through the rock substrate (stockwork-vein deposits), and venting on the seafloor (stratiform deposits). The deposits of Vigonzano, Groppallo, and Ferriere provide evidence that hydrothermal convective cells were already established within serpentinized mantle, before significant extrusion of basalt. Hydrothermal activity continued after the emplacement of the pillow basalts, giving rise to the basalt-hosted stockwork deposits (Boccassuolo and Montecreto) and deposition of stratiform sulfide on the basaltic seafloor (Corchia). Biogenic and sedimentary reworking of the stratiform sulfide suggest that the deposit underwent long-time exposure in submarine conditions, before burial under pelagic sediments.

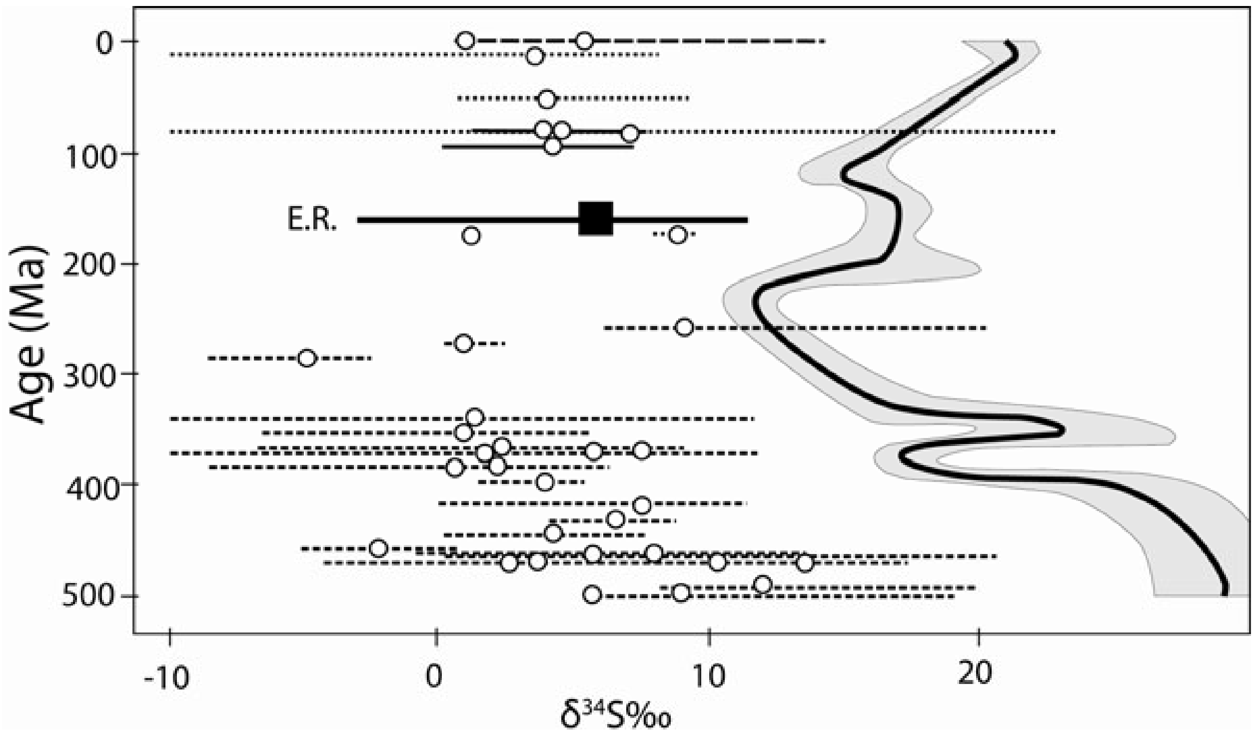

Figure 5. Evolution of $\delta^{34}S$ in Phanerozoic to Modern VMS deposits and coeval seawater sulfate. Symbols and lines indicate mean and ranges of variation of VMS deposits (data from Hutton, 1999): black square = Emilia Romagna (E.R). The heavy line and grey area indicate the evolution with age of the seawater-sulfate after and Claypool et al. (1980).

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INTEGRATING AND CORRELATING BETWEEN WELL LOGGING ANALYSIS AND LABORATORY MEASUREMENT FOR BAHARIYA FORMATION AT SOME WELLS, NORTH OF WESTERN DESERT, EGYPT

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Key Words: Well logs, Core analysis, Petrophysical Data

Well name	Phi core	Phi log	Sw core	Sw log
BED1-5	0.38275	0.1135	0.1834	0.467333
BED10-A	0.13509091	0.16	0.1952727	0.216667
BED1-6	0.114	0.125667	0.4535	0.355333
BED1-2	0.16025	0.164	0.266	0.268
BED1-3	0.15733333	0.162	0.2286667	1
BED-9	0.1572	0.168	0.3495	0.25

Table no.(1) obtained result from core and logs

ABSTRACT

In oil exploration, the core analysis is so expensive, so the well logging analysis is better than the core because is low expensive but the difference in the accuracy of both of them. The relation between effective porosity and water saturation of both of them is applying for some of wells in the north of western desert, Egypt. This values coincidence reflects that the core samples were good representative for the formation, also the accurate data obtained from log tools with their corrections, and finally the process by which the data was processed.
The values of effective porosity and water saturation are not big difference but the big differences are in the wells which has bad hole condition and the nearly one to the true values is well logging data in these case.

Introduction

The main target horizons were the Upper Cretaceous Bahariya Formations. The Cenomanian Bahariya Formation is particularly sand-rich in the south and southeast of the Abu Gharadig Basin. The formation is mainly composed of coastal deposits in the BED-3 Field and has an average thickness of some 250 m. It is normally subdivided into three informal units, labelled 'Upper Bahariya', 'Middle Bahariya', and 'Lower Bahariya', but it is a relatively minor reservoir.
The Badr El Din-3 Field (BED-3 Field) was discovered in 1983, and began production in 1990. It is located in a narrow WNW-ESE horst on the flank of the Mid-Basin Arch of the Abu Gharadig Basin and 20 km east of the superficially similar BED-2 Field (Figs. 1 and 2). Hydrocarbons are found at several Cretaceous levels, the most important of which is the Albian Kharita Formation. It contains two gas reservoirs, one of which has an oil rim. Oil is contained in the Cenomanian-Turonian Abu Roash "C", "E" and "G" Members.
Minor gas also occurs in the Cenomanian Bahariya Formation.

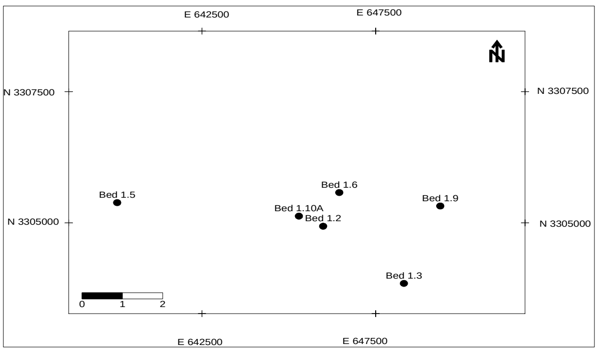

Fig .(1) LOCATION MAP FOR THE STUDY WELLS.

METHODOLOGY

A complete evaluation has been made of six wells in the BED-1 field are penetrating Bahariya formation Badr El Din field (BED 1-2,, 1-3, 1-5, 1-6 and 1-10A).Log derived net/gross, porosity and saturation have been averaged, using all the available log and core data. The integrated study of both well-logging and laboratory measurements (Table.1) revealed the following concluding remarks. Prior to the correlation process, depth matching has been done between the core depth and the logging depth to check the depth shift

Methods of Shale Determination :

A – Gamma-Ray method :

Gamma-ray log is one of the best tools used for identifying and determining the shale volume. This is principally due to its sensitive response for the radioactive materials, which normally concentrated in the shaly rocks.
Correction of Shale Volume :
The values of (χ) obtained previously must be corrected by valid formulae to obtain the optimum shale values usable in the log interpretation. The first formula is :
Clavier et al., 1971)
The second formula is :
(Steiber, 1973)
The usual approach for deciding which of the resulted shale volumes to use is to find the minimum values of the results. The minima have to be chosen, because most of the errors for any method tend to increase the apparent shale volume.
Then, the different zones were classified into clean, shaly and shale zones, depending on the following bases:
- If Vsh < 10 %This means clean zone ,
- If Vsh is from 10 to 35 %This means shaly zone , and
- If Vsh > 35 %This means shale zone.

DETERMINATION OF TYPES OF POROSITIES

1- Total Porosity (φ_t):
A – Sonic log:
i – In clean zones:
ii – In shaly zones :
B – Density log:
i – In clean zones:
ii – In shaly zones :
C – Neutron log:
i – In clean zones:
Neutron logs directly give the porosity values (φCNL) in the clean zones.
ii – In shaly zones :
In the shaly zones, neutron porosity can be corrected for the effect of the implied shales. The corrected porosity, as derived from the neutron log, can be thus manipulated according to Allen's equation (1965
For clean and shaly zones, the values of porosity obtained from sonic, density and neutron logs are termed φS, φD and φN, respectively.
It must be noticed that, the values of φN and φD represent the total porosities (primary + secondary), while the values of φS represent the primary porosities, in case of shaly and carbonate rocks.

Effective Porosity (ΦE):

This type of porosity depends on the connection between the rock pores with each other to form channels facilitating the paths of fluids through matrix. There are two ways to calculate the effective porosity:

DETERMINATION OF TYPES OF WATER SATURATIONS

1-Total water saturation:

Extensive studies by Simandoux (1963) on artificial media composed of sand and shale have suggested that, In recent years, there are equations that have gained the widest acceptance in the evaluation of water saturation in Porosity distribution map:
The porosity increases toward south and south west directions and decreases toward north and north west directions fig.(3).

Water saturation distribution map:

The water saturation increases toward north and North West direction and decreases toward north and north west directions fig.(4)
By correlating the hydrocarbon saturation values obtained from core analyses with that obtained from logs it was found that, their values are mostly coincident with each other for Bahariya Formation at almost wells.
While for Bahariya Formation at Bed-3 well this correlation shows a different behavior. The hydrocarbon saturation values obtained from core analyses at this well are generally higher than their values obtained from log analyses nearly 100%
The differential values of clay content in the studied reservoir affect the reading of measured resistively (Rt), and this reflect the difference in saturation from zone to another. This is obviously observed in the studied zone. Also this variation may be due to the bore hole conditions that may affect the resistivity readings which in turn affect the saturation values obtained from the log analyses.
The characteristics of such sandstone reservoirs can be summarized as follows:
The thickness of the net sand ranges from 0.9 m to 91 m with an average effective porosity ranges from 0.08 % to 0.2 % (for the net sandstone), and the water saturation value ranges from 0.11 % to

0.54 % for the net sandstone.

From the above, we can see that, Bahariya Formation in the study area can be considered as a good reservoir rock due to its petrophysical characteristics. It is a porous formation, mainly porous sands and sandstones. (from both core and log analyses), it has wide areal extent with fair porosity over the study area. So it is recommended to use the Petrophysical laboratory measurements to confirm the routine log analysis.

Different types of porosity against depth crossplot:

In figure (5), the wells are arranging from east to west direction. The two values are matching and relating to each other especially from east and the values mostly are taking the same values and the two curve begin to separate each other after bed-6 well where the core value is more higher than the log values and these may be because the bad hole condition and in this case the log values are more accurate .

Relation between water saturation from logs and core:

In figure (6), the wells are arranging from east to west direction. The two values are not matching and not relating to each other especially from east and these may be because the bad hole condition and in this case the log values are more accurate and realistic.

CONCLUSION

A complete evaluation has been made of six wells in the BED-1 field are penetrating Bahariya formation Badr El Din field (BED 1-2,, 1-3, 1-5, 1-6 and 1-10A).Log derived net/gross, porosity and saturation have been averaged, using all the available log and core data. Then, the different zones were classified into clean, shaly and shale zones,

For clean and shaly zones, the values of porosity obtained from sonic, density and neutron logs are termed φS, φD and φN, respectively.

It must be noticed that, the values of φN and φD represent the total porosities (primary + secondary), while the values of φS represent the primary porosities, in case of shaly and carbonate rocks. The two values of porosity for core and logs are matching and relating to each other especially from east and the values mostly are taking the same values and the two curve begain to separate each other after bed-6 well where the core value is more higher than the log values and these may be because the bad hole condition and in this case the log values are more accurate . The two values are not matching and not relating to each other in case of water saturation especially from east and these may be because the bad hole condition and in this case the log values are more accurate and realistic .So , the values of effective porosity and water saturation are not big difference but the big differences are in the wells which has bad hole condition and the nearly one to the true values is well logging data in these case.

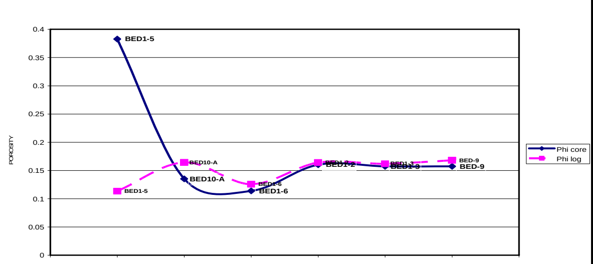

FIG (5) CORRELATION BETWEEN CORE AND LOG POROSITY

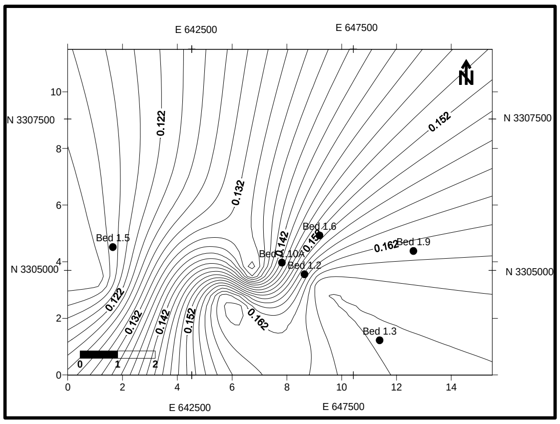

FIG .(3) POROSITY DISTRIBUTION MAP OF BAHARIA FORMATION FOR THE STUDY AREA

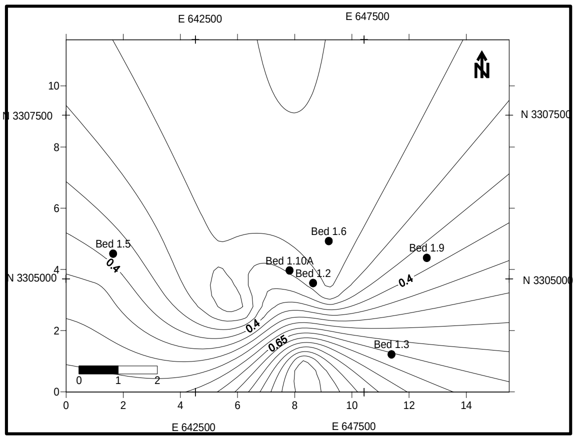

FIG.(4)WATER SATURATION DISTRIBUTION MAP FOR BAHARIYA FORMATION FOR THE STUDY AREA

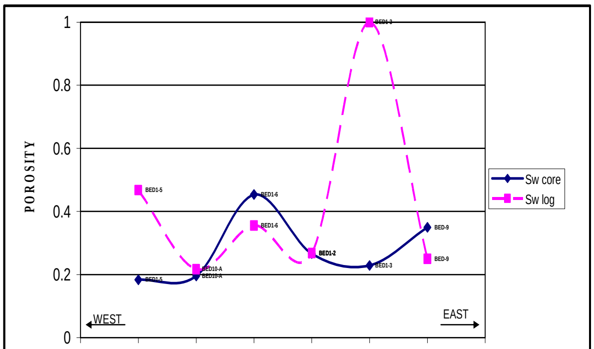

FIG (6) CORRELATION BETWEEN CORE AND LOG WATER SATURATION

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GEOGRAPHIC INFORMATION SYSTEM OF MINERAL RESOURCES OF THE REPUBLIC OF CROATIA – A TOOL FOR A SUSTAINABLE USE AND PROTECTION OF NATURAL RESOURCES

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KEY WORDS: GIS, mineral resources, mineral potential, ArcGIS

INTRODUCTION

The main purpose for creation of Geographic Information System of Mineral Resources of the Republic of Croatia (GIS MS) is to give major guidelines for regional and detailed research. Also, it is a base for decision-makers as a tool to make long-term plans for sustainable use of mineral resources, and to reduce the impact of exploration on environment and inhabitants.

GIS MS

The GIS MS is based on a relational database with entries for more than 4000 deposit sites and occurrences of metallic and non-metallic mineral resources, and energy resources. The result of GIS MS is a Map of mineral resources of the Republic of Croatia, which exists as a scientific project created with financial support of Ministry of education, science and sports. The data are entered into the database via entry forms. Separate forms are made for general data about sites or occurrences, geological data, data of quantity of exploitable reserves, and documentation (studies of mineral resources, scientific papers, books, maps etc.).

Conceptual and logical model of the database were made according to “Instructions for creation of Cadastre of Occurrences and Deposits of Mineral Resources” using method ESRI ArcGIS. Data-entry forms were primarily made in MS Access (Figure 1). Today, in its final stage, it is transferred into MS SQL Server 2000 relational database. Main feature dataset is called KMS (Karta Mineralnih Sirovina – Map of Mineral Resources). It consists of 4 layers as feature classes and tables (Figure 2). One layer is a point feature class, which is used to display information about deposit sites and mineral occurrences. Each type of mineral resource is given a distinct symbol which is shown on the map. Other data about each point can be shown as a label, or in a table. Other three feature classes are polygons, used to present mineral potential of metallic, non-metallic and energetic resources.

Spatial data are arranged for display in measures 1:5000 to 1:300000, projection Gauss-Krüger zone 5, Bessel 1841 ellipsoid, using central meridian 15^{o} east of Greenwich.

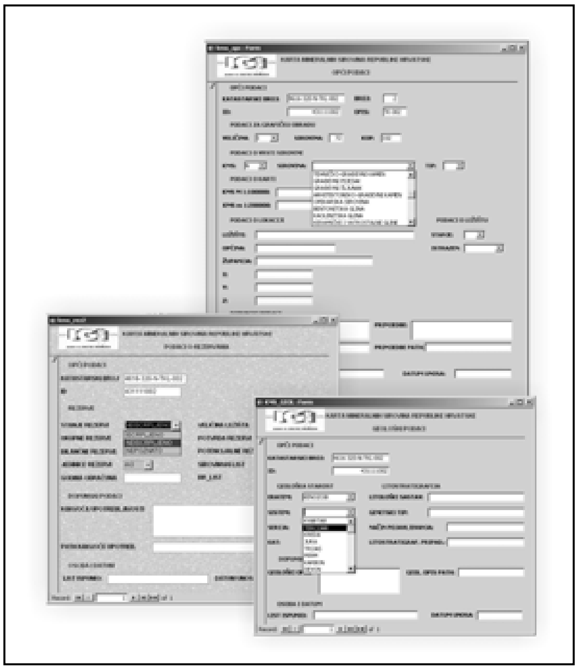

Figure 1 – Various data-entry forms in the database for Map of mineral resources.

A MAP OF MINERAL POTENTIAL

Maps of mineral potential are created as a compilation of data from Map of Mineral Resources combined with lithological and formational geological maps (Figure 3). These maps are used as a basis for management and decision – making for land use, impact on environment (like health or landscape) sustainable management of mineral resources and their protection for future, and creation of strategy for management of mineral resources.

The data of the mineral potential is overlain with other data that represent restrictions, such as cadastral plans, roads, railroads, settlements, rivers, spring sanitary protection zones, national parks, nature parks, protected landscapes, areas for current exploitation of minerals, etc. Each restriction has different rules that have to be applied. Final result is 70-95% reduced area that is favorable for possible exploitation of mineral resources.

Up to the moment such maps (as GIS projects) are finalised for several counties: Dubrovačko-Neretvanska, Međimurska, Splitsko - Dalmatinska, Šibensko - Kninska, Primorsko - Goranska Varaždinska and Zagrebačka County.

MAJOR MINERAL RESOURCES IN CROATIA

Only several mineral resources are currently continuously exploited, having a significant economical value.

Dimension stone is exploited in a relatively large number of quarries in Istria and Dalmatia (predominantly Cretaceous limestones); Building stone is exploited in all regions of Croatia as carbonate, igneous and metamorphic rocks. Production of gravel and sand is located along the alluvial plains of two major rivers, Sava and Drava, in the Pannonian Basin.

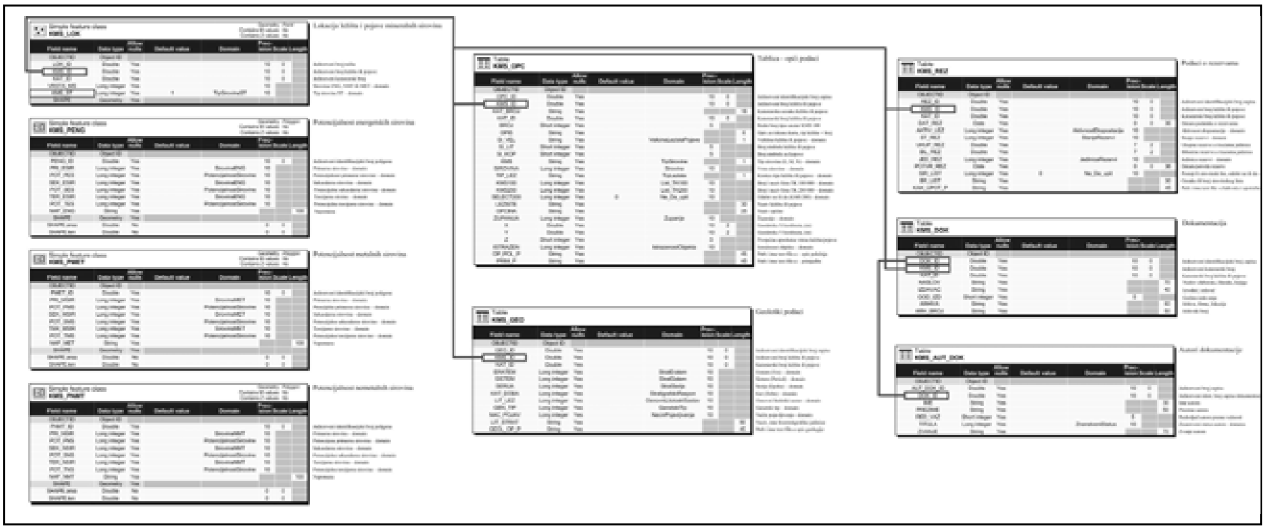

Figure 2 – Simplified diagram of the database model for GIS MS

In the karst area, gravel and sand are produced from deluvial deposits in karst depressions. Deposits of brick clay are mostly situated in Pannonian part of Croatia.They consist of Quaternary loess, loess-like and fluvio-lacustrine sediments. Marl, used for production of cement, is quarried out and used in Slavonia, Istria and Dalmatia. Gypsum can be found in Dalmatia and Lika along the contact with Permian clastic sediment complex. Carbonate ores for industrial processing are quaried in Slavonia, Lika, Dalmatia and Istria. Quartz sand, as the most important resource for glass production, is exploited from Pontian alluvial sediments in Moslavina and Slavonija. Hydrocarbons (oil and gas) are produced in 35 oil-fields and 17 gas and gas condensate fields (approximately 830 boreholes). The whole oil production and most of the gas production comes from Pannonian basin. The rest of gas production is located in the Adriatic Sea. Over 90% of oil reserves and more than 80% of oil production is located in three greatest oil fields – Molve, Kalinovac and Stari Gradac. Hydrocarbon production covers approximately 50% of energy consumption in Croatia. There is a big potential for use of geothermal energy in Pannonian basin, but is only scarcely used. Five fields have temperature range from 120 to 170 ^{o}C, and five more with temperature range from 65 to 100 ^{o}C. Only two fields are used as energy source. Geothermal wells with temperatures below 65 ^{o}C are used for balneological and recreational purposes in 14 spas and recreational centres.

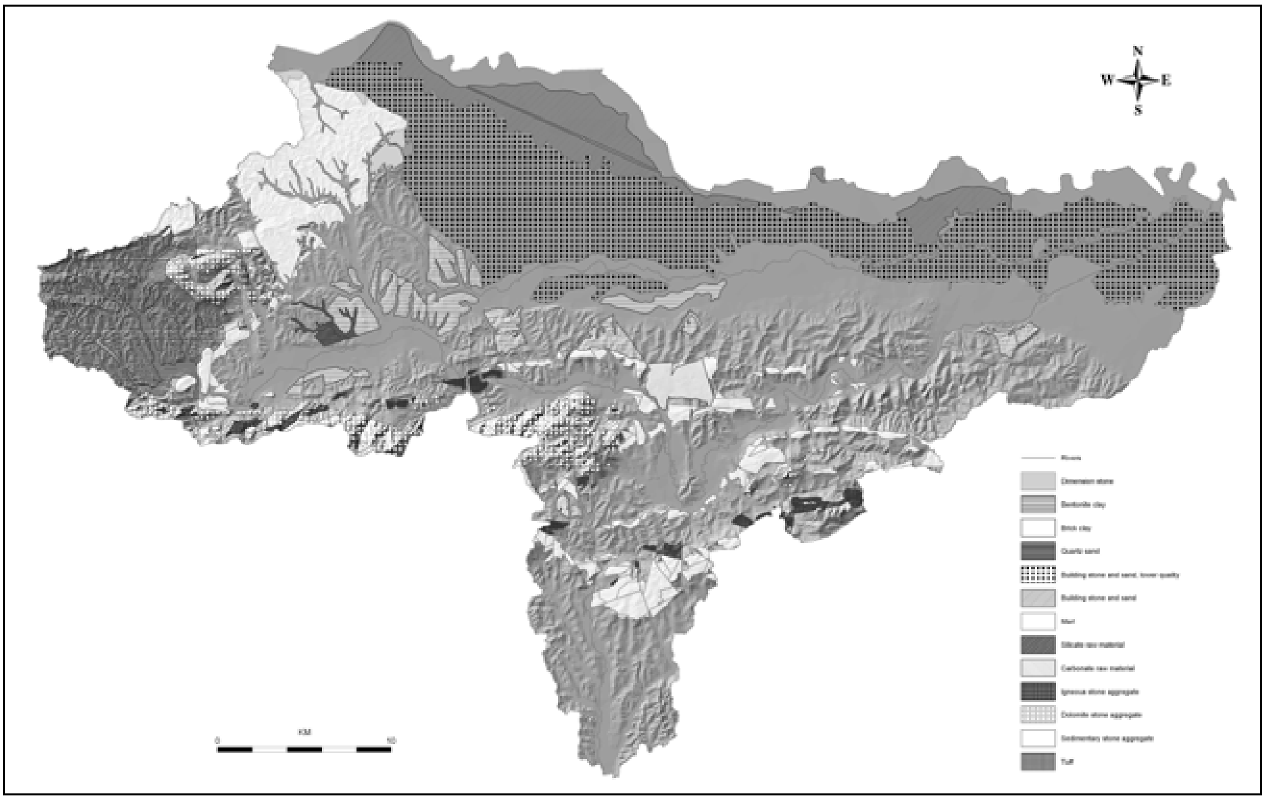

Figure 3 – A map of mineral potential for Varaždinska County based on data for 170 deposit sites and lithostratigraphic map.

OTHER MINERAL RESOURCES

Other mineral resources, which are exploited occasionally, or in small quantities, are ceramic and fire clays (can be found in Pannonian Basin area, Hrvatsko Zagorje, but also in the Kordun and Banovina area); bentonite clays (in Maovice-Štikovo area, Dalmatia, in Upper Jurassic Lemeš beds, and in Hrvatsko Zagorje area in clastic sediments of the Middle Miocene), quartzites (Lemeš beds); in the Pannonian Basin quartzites are located near Velika in the Papuk Mt.); tuffs and tuffites (can be found in Pannonian part of Croatia – Krndija, Papuk, Psunj, Kalnik, Hrvatsko Zagorje and Outer Dinarides – Drniš, Knin, Brušani); the largest tuff deposit in Brušani near Gračac was never researched into details, or exploited), and bauxite (now used in nonmetallic industry).

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APPLIED GEOINFORMATICS IN THE MAINTENANCE OF GEOLOGICAL RESEARCH ON PRECIOUS AND BASE METALS

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The field of reproduction of a mineral raw material base (MB) is the basic scope of application of an applied GIS technologies, methods and techniques of the mathematical (statistical) analysis of the data, and also technologies of computer processing, storage, analysis and geoinformation representation.

The experience of support of MB reproduction of diamonds, base and precious metals in the Russian Federation shows applied geoinformatics at the present stage of the development unites the various methodologies for the purposes of storage, processing and representation of the geographical information in a convenient and informative form for geologists-experts.

The basic used methods are:

- - statistical analysis;
- - digital cartography;
- - development of the bases and databanks;
- - creation of full-scale geographic informationsystems and of information-analytical computer systems on their basis;
- - maintenance of the forecasting and searching works(including development of computer systems of forecasting on the basis of banks of models of reference objects, 3D technologies application for the paleoenvironment analysis of the ore deposits localizations etc.).

The system of supporting the exploration work for precious and base metals elaborated in TSNIGRI uses currently GIS ESRI ArcView3.3 and DBMS Microsoft Access of any actual version. For performing a number of specific operations with geospatial data software products ArcGIS 9.2,EasyTrace 7.9 Pro, CorelDraw13 are also used. The choice of software is conditioned by the level of popularity of the software products, which may be installed on any PC.

The main system includes a number of subsystems: IAS of maintenance of medium- and long-term programs of geological research of the interior and exploration for mineral resources, a bank of models of metallogenic taxons of different rank; IAS of the deposits of diamonds, precious and base metals; UIAS "Resources of Russia"; supporting GIS for licensing of the usage of the interior; IACS "The fund of reserve areas of the interior"; the electronic knowledge base "Geological models of the deposits of diamonds, precious, base metals and ferrous materials, alloying metals and non-metals" and the computer technology of exploration activity, prediction and estimation of the deposits of precious and base metals.

THE MANTLE-CRUSTAL ORE-FORMING Cu-Ni SYSTEM OF THE PECHENGA ORE DISTRICT (FENNOSCANDIAN SHIELD)

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KEY WORDS: mantle-crustal ore-forming system, Cu-Ni deposits, 3D model.

Correlation of geological, geophysical, and metallogenic data for the adjacent areas of Russia, Norway, and Finland made it possible to suggest that the Pechenga ore district is an isolated segment of the Pechenga-Imandra-Varzuga metallogenic zone (Fig. 1 a,b). In the northeast the district is bound by the Titovsk-Ambarn'ya fault, in the southeast - by the Litsk-Aragubsk fault, in the northwest - by the Inari-Kirkines fault system, and in the southwest - by a system of poorly known faults of the northwestern strike. It should be emphasized that the main tectonic elements of the Pechenga ore district are clearly reflected in the regional gravity field.

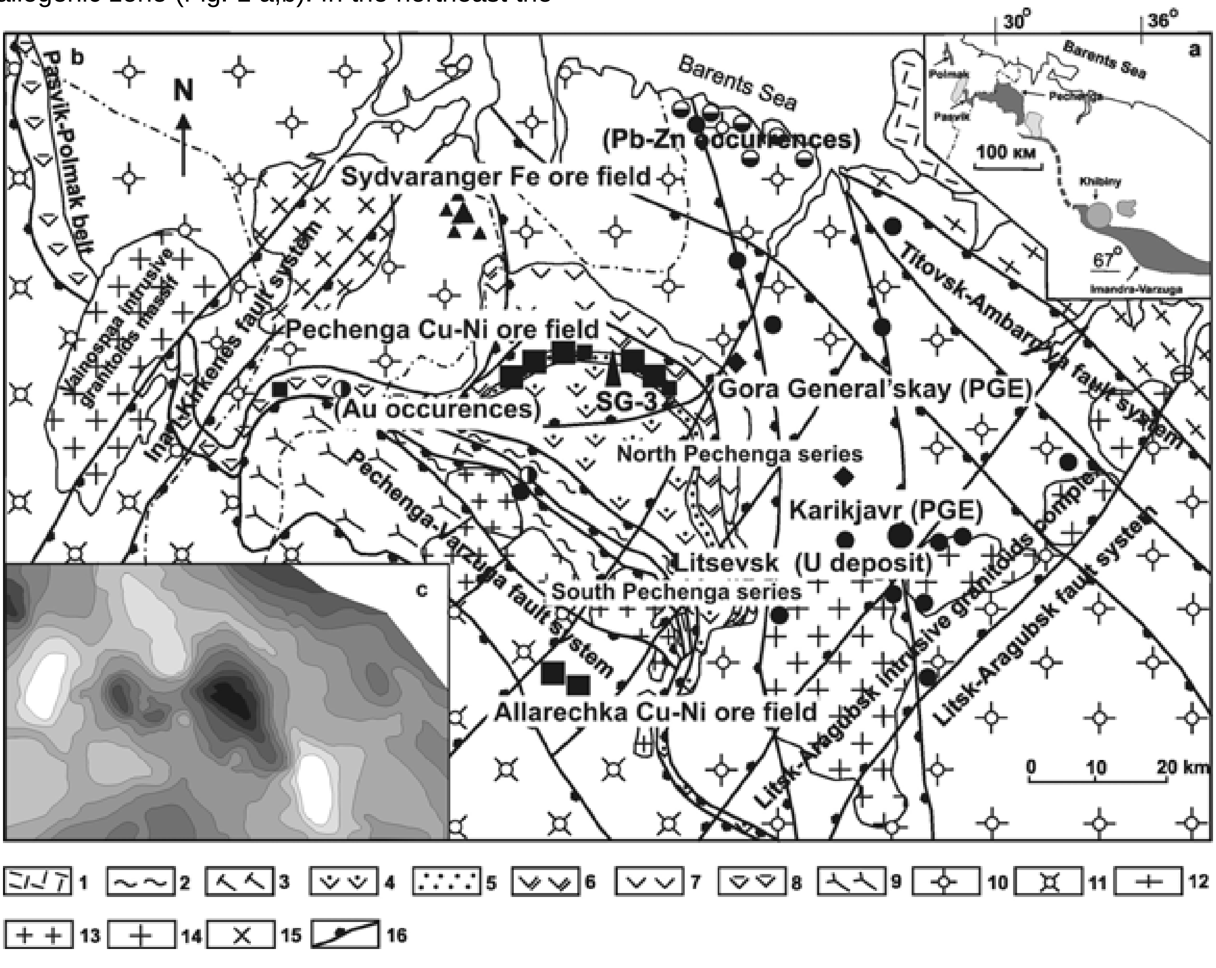


Figure 1 – Geographic position (a), schematic geological map (b), and gravity field (c) of the Pechenga ore district (Kazansky et al., 1994).

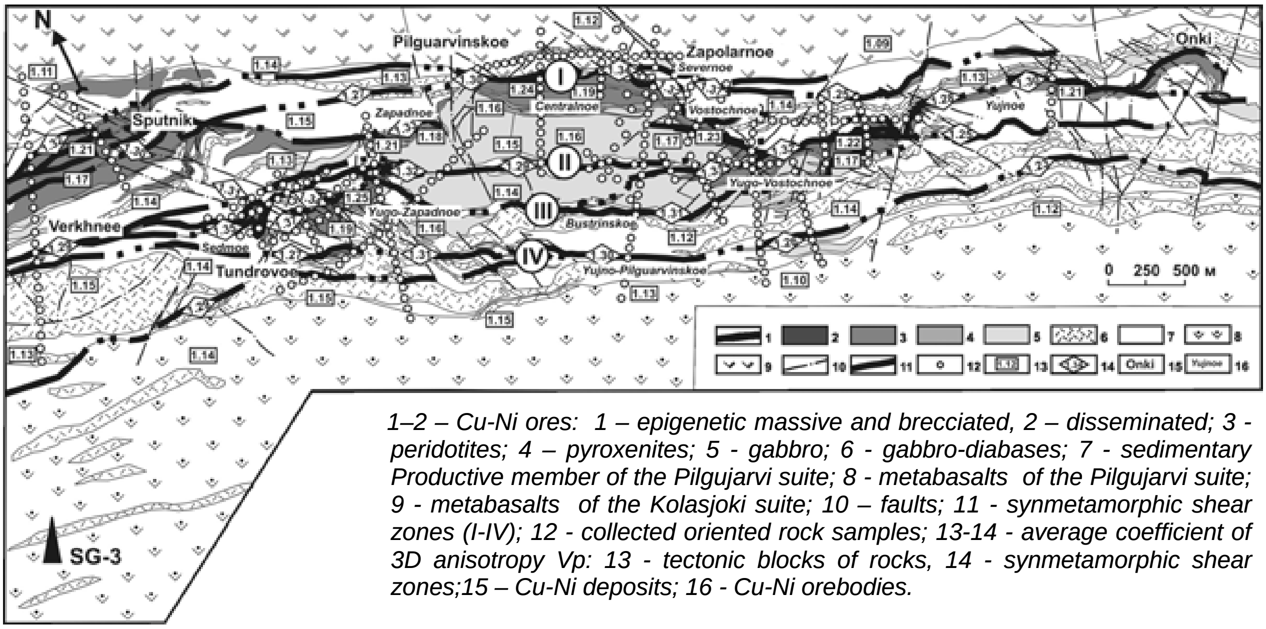
1 - Late Proterozoic sedimentary rock; 2-8 - Early Proterozoic. 2,3 – South Pechenga series: 2 - metavolcanic and metasedimentary rocks, 3 - metavolcanic rocks; 4-6 – North Pechenga series: 4 - metabasalts and metapicrites, Pilgujarvi suite, 5 - sedimentary Productive member hosting Ni-bearing gabbro-wherlite intrusions, 6 - metabasalts and metandesites, metasedimentary rocks Kolasjoki, Kuetsjarvi, and Ahmalahti suites; 8 – South Pechenga and North Pechenga series undivided; 9 - crystalline schists (Tal'ya suite), 10-12 – Archean: 10 - gneisses, migmatites, granites, amphibolites Kola-Noregian block, 11 - gneisses, cristalline schists Inari block, 12 - strongly granitized gneisses, Murmansk block; 13-15 Early Proterozoic granitoids: 13 - intrusive granitoids, 14 - rhemorphic granitoids; 15 – faults. SG-3 - Kola superdeep borehole.

The Pechenga structure corresponds to a positive gravity anomaly which embraces both the Northern and the Southern limbs and the adjacent area of the Inari block. Negative gravity anomalies coincide with the Litsk and Vainospaa granitoid massifs, and they are symmetric about the positive anomaly. Smaller anomalies of the gravity field are associated with the rheomorphic granitoid domes (Fig. 1 c).

Within the suggested boundaries the Pechenga ore district, besides the Pechenga and Allarechka Cu-Ni ore fields, incorporates the Archaean banded iron ores of Sydvaranger, the Early Proterozoic PGE and Ni occurrences of the Gora Generalskaya, Karikjavr, the Late Archaean-Early Proterozoic radioactive mineralization of different types (Litsevsk), the hydrothermal Pb-Zn veins of probable Riphean age, and enigmatic Au-Ag mineralization discovered at deep levels of the SG-3 borehole and surface.

The Pechenga ore field encloses world-class Cu-Ni deposits dated at 2.0 Ga and is confined to a Paleoproterozoic structure of the same name. As a costituent of the Pechenga-Imandra-Varzuga belt, the orebearing Pechenga structure was taken into account in all geotectonic, geophysical and metallogenic models of the northern Fennoscandian Shield (Gorbunov et al., 1999; Hanski, 1992; Mitrofanov et al., 1998; Skuf'in, Theart, 2005, etc). There is consensus that mantle processes and sources dominated the origin of the Pechenga Cu-Ni deposits. Along with this, the deposits are hosted by a thick volcano-sedimentary complex, which developed on a rifted Archean basement from 2.3 to 1.8 Ga (Fig. 2).

The basis for the interpretation the Pechenga ore field as a dislocated Paleoproterozoic fault-bound volcanic center lies in the integrated 3D model of the Pechenga ore district (Kazansky et al., 1994). In this



1–2 – Cu-Ni ores: 1 – epigenetic massive and brecciated, 2 – disseminated; 3 - peridotites; 4 – pyroxenites; 5 - gabbro; 6 - gabbro-diabases; 7 - sedimentary Productive member of the Pilgujarvi suite; 8 - metabasalts of the Pilgujarvi suite; 9 - metabasalts of the Kolasjoki suite; 10 – faults; 11 - synmetamorphic shear zones (I-IV); 12 - collected oriented rock samples; 13-14 - average coefficient of 3D anisotropy Vp: 13 - tectonic blocks of rocks, 14 - synmetamorphic shear zones;15 – Cu-Ni deposits; 16 - Cu-Ni orebodies.

Figure 2 - Relation between a layered gabbro-wherlites intrusion, Cu-Ni ores bodies and synmetamorphic shear zones of the Pechenga ore field. (Compiled by K.Lobanov using data of G.Gorbunov et al., 1999).

study, the Pechenga ore district was regarded as an isolated segment of the Pechenga-Imandra-Varzuga belt with a special combination of Paleoproterozoic tectonic structures, rock associations and mineral deposits. Geological constraints of the model were formulated using structural, lithological, petrological and geochronological data from the surface and the Kola superdeep borehole SG-3. However, they were not sufficient to calibrate the vertical axis of the model. The solution was found in the formalization and correlation of borehole and surface data using two parameters: rock density and anisotropy of P-waves. The computer-based technology insured calculation of gravity profiles from the morphology and size of formalized elements and comparison of calculated profiles with observed gravity profiles. Correlation of Vp values made it possible to assess intensity of synmetamorphic deformations.

In the frames of the 3D model, the Northern limb of the Pechenga structure where Cu-Ni ores are concentrated, was presumed to be a sheared fragment of a volcanic caldera and its Southern limb – a combination of a steeply dipping imbricated monocline with overshrusted granitoid domes. The vertical extent of the Pechenga structure was estimated at about 10 km. It was also assumed that the present erosion level of the Pechenga ore district may be considered as a horizontal section of a mantle-derived ore-forming system of central type.

The Cu-Ni deposits not only occupy a regular position in the Paleoproterozoic volcano-sedimentary complex. The Ni-bearing gabbro-wherlite intrusions are genetically linked to ferropicrites of the Pilgujarvi formation overlying the Productive member (Hanski, 1992). Within the Northern limb, three quarters of Ni-bearing intrusions and Cu-Ni deposits are concentrated within the so-called "structural trench" oriented across the general strike of the Pechenga structure (Gorbunov et al., 1999). The Productive member also reaches maximum thickness in the structural trench. There were several attempts to discover Cu-Ni ores along the extension of the Pechenga structure in the Pasvik belt (Hodges, 1995) The exploration boreholes penetrated several gabbro-wherlite bodies at the bottom of the Productive member. The bodies have the same petrological characteristics as in the Pilgujarvi intrusions and only traces of Ni and Cu.

This inference allows to relate the Pechenga Cu-Ni deposits, overprinted by metamorphism, to the volcano-plutonic types and provides a new insight into their setting, environment and origin. Summing up of structural, petrological, mineralogical and geochemical data suggests that at the upper levels the Cu-Ni ore-forming system developed in two stages: 1) emplacement of mantle-derived gabbro-wherlite sills into heterogenous Productive formation, their differentiation and generation of magmatic Cu-Ni ores; 2) dislocation and metamorphism of gabbro-wherlite sills and deposition of remobilized Cu-Ni ores in synmetamorphic shear zones.

There is no evidence of a continuos extension of the Cu-Ni ore-forming system below the Pechenga structure. Along with this, two signatures of the Cu-Ni ore-forming system may be deducted at deeper levels from seismic and petrological data (Isanina et al., 2000 etc), namely: a Vp/Vs anomaly at a depth of 20-25 km, similar to that under the Norilsk ore district and assumed to be intermediate magmatic chamber, and a Moho boundary uplift, reaching the maximal height of 34 km under the Pechenga structure, which may be interpreted as a relict mantle plume (Fig. 3).

The central part of the Pechenga ore district has been selected for more detailed seismotomographic studies using some geological, geophysical, petrological and additional seismic data. It was established that under the Pechenga structure, the upper boundary of the Moho surface is located at minimal depth of 34-41 km. Based on recent metallogenic information, we regard this Moho uplift as a relict mantle plume which dominated Early Proterozoic geological events (Fig. 4).

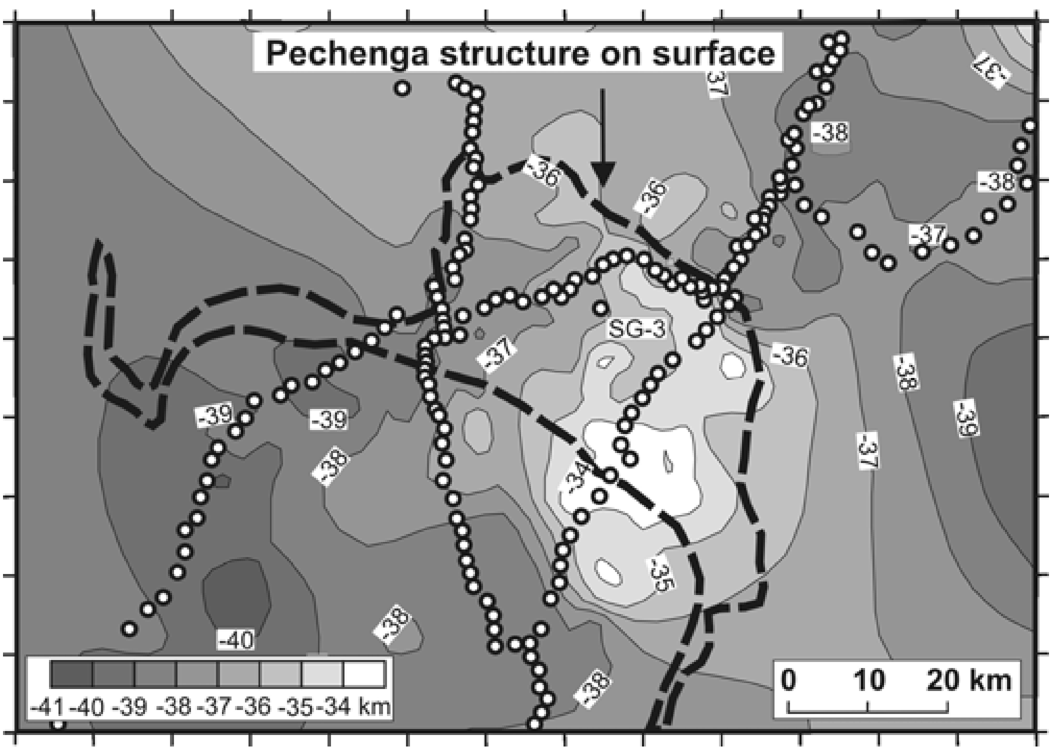


Figure 3 - Depth of the Moho discontinuity relief (in km) under the Pechenga structure (Kazansky et al., 2002). Dotted lines seismic profiles.

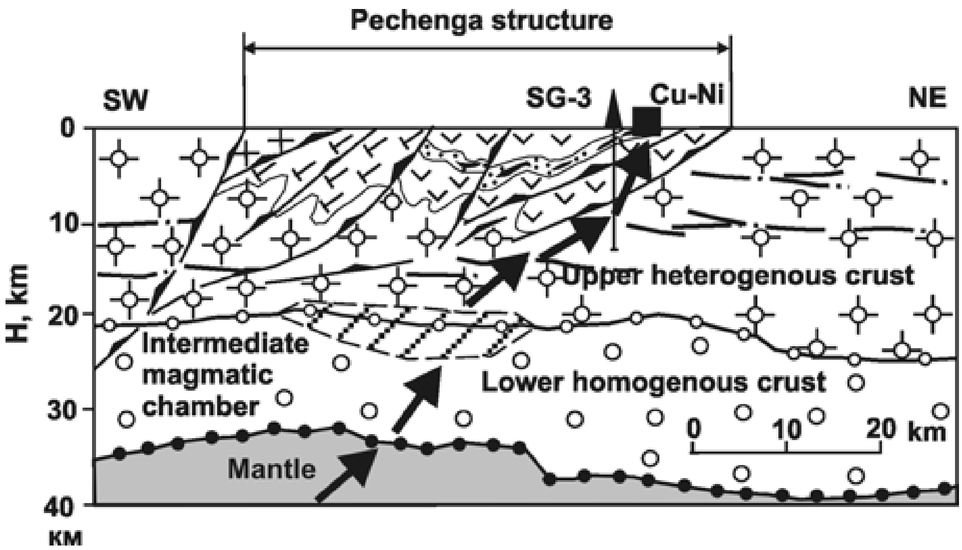


Figure 4 - Relation between mantle and crustal structures of the Pechenga ore district (Lobanov, Kazansky, 2008).

The analysis of the available seismic, geological, and petrophysical data provides the basis for distinguishing three types of first-order seismogeological boundaries: the base of the Earth's ancient continental crust, interface between the lower homogeneous and upper heterogeneous layers of the crust. All of these boundaries affect the metallogenic zoning of the Pechenga ore district. Seismogeological boundaries are more important. The distribution of ore deposits of the Karelian cycle correlates with this boundary.

There are sufficient proofs that Paleoproterozoic rocks of the Pechenga ore field experienced tectonic deformations accompanied by zonal metamorphism. An impact of the low-temperature metamorphism on gabbro-wherlite intrusions and associated Cu-Ni deposits is a characteristic feature of their genesis (Gorbunov et al., 1999). If the suggested interpretation of the Pechenga structure as a deformed fault-bound volcanic center is sound, one may relate the Pechenga Cu-Ni deposit to the volcano-plutonic type and the corresponding ore-forming system to the mantle-crustal type (Kazansky et al., 2008; Kazansky, Lobanov, 2008).

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GREEN SANDSTONE FOR THE STONE BRIDGE IN REGENSBURG

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KEY WORDS: Regensburg, green sandstone, weathering, water absorption, porosity, density, uniaxial compressive strength, biaxial bending strength.

ABSTRACT

The “Steinerne Brücke” (Stone Bridge) was the only bridge crossing the Danube in the world heritage city of Regensburg, Eastern Bavaria, for hundreds of years. The construction completed in 1146 with 15 arches and spanning 308 meters mainly consists of green sandstone. For the complete restoration until 2014 about 600 cubic metres of Regensburg Green sandstone are required. In 1994 and 1995 thirteen core drillings exploring the green sandstone area around Regensburg were sunk by the former Bavarian Geological Survey. Analyses of seven rock varieties show that two of them are suitable. Six locations for quarrying green sandstone are proposed.

INTRODUCTION

Regensburg Green Sandstone was used as building stone and natural freestone for a lot of famous buildings in Bavaria, e.g. for the Munich Residency, the New and Old Pinacotheka in Munich or the Cathedral and the “Steinerne Brücke” in Regensburg.

A lot of these and other buildings constructed of Regensburg Green sandstone show more or less the effects of different kinds of partial weathering above all caused by acid rain and road salt. In many instances restoration works were already realised, in the case of the “Steinerne Brücke” an extensive remediation is still required. The protection of this historical building is inhibiting using other rock types.

All of the former quarries where Regensburg Green sandstone was mined are abandoned – the last active quarry near the village Ihrlerstein about 20 km southwest of Regensburg (GBo 01a/01b, see Figure 1) was shut down a few years ago – and concrete information about commercial reserves is missing.

To satisfy the needs of badly wanted replacement material the former Bavarian Geological Survey (“GLA”) was charged with the exploration to find minable deposits of Regensburg Green sandstone resistant as possible to weathering.

Rock samples were taken of the quarries, of appropriate outcrops and areas as well as of cores of the thirteen drillings with maximal depths of 49 meters. With about 860 test specimen numerous petrophysical and geochemical parameters were determined in our laboratories.

GEOLOGICAL SETTING

The investigated region is located in the Upper Palatinate, Eastern Bavaria. The Upper Cretaceous (Cenomanian) unit Regensburg Green Sandstone appears in an about 40 x 15 km north-south trending area near Regensburg. It is divided into two stratigraphic sequences: the Upper and Lower Regensburg Green Sandstone.

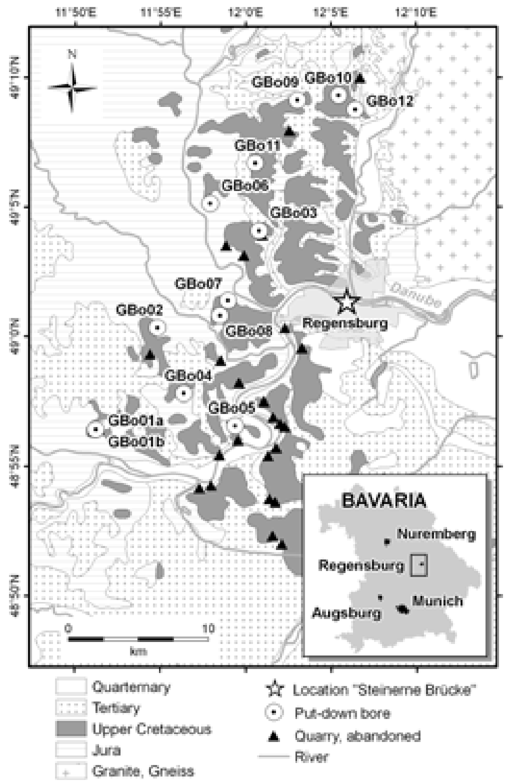

Figure 1 – Sketch map of the investigated area.

The Lower Green Sandstone is dominated by sandy, calcareous and deep green glauconitic layers. It is either underlain by Upper Jurassic limestone or by the terrigenous Schutzfels Beds, kaolin-bond and clayish quartz sands and gravels filling fissures, dolines and caves of the variably karstified Malm. In some places the transgressive boundary between the lower Green Sandstone and the Malm is marked by a basal conglomerate composed of reworked Jurassic limestone fragments within a green sandstone ground mass. Towards the younger deposits sedimentation conditions changed leading to the more calcareous and marly Upper Green Sandstone, which is superimposed by the Eibrunn Marl (Upper Cenomanian) and the Reinhausen Beds (Lower Turonian).

ROCK DESCRIPTION

The stratigraphic unit of the Upper Green Sandstone shows a varying rock spectrum concerning grain size, the proportion of the components lime, marl and sand as well as colour. The boundaries of the beds are smooth indicating slowly changing sedimentation conditions. In most drillings only a few of the rock types described below are met.

The uppermost type A is a calcareous dense to fine-grained siltstone with a very low glauconite content and a massive fabric. It is followed by transition type B1 leading to the greygreen type B2, a marly and silty fine sandstone with a schlieric fabric. B3 is similar to B2 but mostly dominated by nodular bedding caused by siliceous and glauconite-free concretions in greenish silty fine sandstone. Alternate bedding between B2 and B3 is common. The rock type B4 in the lowest layer composed of slightly sandy limestone shows a flaser structure and very low glauconite content.

The Lower Green Sandstone generally consists of two types partially very porous medium-grained sandstones, here named as C1 and C2. The greyish-green C1 is mostly overlaying C2, but alternate bedding with prevailing blurring bounds is sometimes occurring. Both types are characterized by a massive fabric. C2 contains fragments of white shells and shows compared to C1 an intensive green because of the higher glauconite content.

ANALYSES

In the laboratory of the Bavarian Environment Agency the following parameters were determined to obtain information about the characteristics of the different types of Regensburg Green Sandstone:

- water absorption at atmospheric pressure and at 3 kPa (≈ vacuum)
- bulk and mineral density, porosity, saturation coefficient
- water absorption coefficient “w” (= A-value) and B-value
- water vapour absorption (45 % r.h., 75 % r.h., 100 % r.h.)
- hygric dilatation (24 h – value and max-value)
- ultrasonic velocity (incl. dynamic Young's modulus)
- uniaxial compressive strength and biaxial bending strength (incl. static Young's modulus)
- frost resistance
- X-ray fluorescence and X-ray diffraction
- thin sections

RESULTS AND CONCLUSIONS

Table 1 shows a selection of the analysed parameters. Regardless of the rock type most of them scatter distinctly induced by the obviously varying degree of composition and weathering of all types of the Regensburg Green Sandstone.

Table 1 – Minimum and maximum values of some geophysical parameters of the Regensburg Green Sandstone types B2, B4, C1 and C2. POR = porosity; BD = bulk density; MD = mineral density; A-Value = water absorption coefficient “w”; YM-UV = dynamic Young’s modulus from ultrasonic velocity; UCS = uniaxial compressive strength; BBS = biaxial bending strength.

	B2	B4	C1	C2
POR [Vol.-%]	3 – 22	1 – 11	3 – 14	5 – 28
BD [g/cm^3]	2,05 – 2,57	2,14 – 2,66	2,33 – 2,63	1,92 – 2,52
MD [g/cm^3]	2,48 – 2,76	2,60 – 2,82	2,53 – 2,75	2,59 – 2,79
A-value kg/(m^{2}h^{0,5})]	0,12 – 2,55	0,01 – 0,91	0,11 – 0,73	0,25 – 7,91
YM-UV [GPa]	7 – 75	14 – 65	12 – 61	7 – 31
UCS [MPa]	22 – 168	42 – 160	37 – 124	13 – 46
BBS [MPa]	2,0 – 30,4	5,1 – 23,5	4,2 – 25,0	0,3 – 15,5

Type C1 has the best properties indicated especially by the uniaxial comprehensive strength, biaxial bending strength, porosity and water absorption coefficient “w”. Type C2 shows a deep green colour; however, due to friability the physical requirements aren’t partly met. As C1 and C2 are sometimes interbedded on a small scale the mining of both types is proposed. In some cases the use of type B2 might be possible with the sometimes occurring frost-susceptibility in mind. Despite the appropriate physical properties owing to the bright beige colour Type B4 seems to be less suitable for the substitution of green sandstone.

Based on the results of drill programs, field work and analyses five new prospective areas and one abandoned quarry for mining Regensburg Green sandstone are recommended.

Analyses of cores of a recent drill program near the above mentioned quarry are going on.

ACKNOLEDGEMENTS

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SHALLOW GEOTHERMAL TECHNOLOGIES AND PRACTICAL EXAMPLES

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KEY WORDS: heat pump, heat exchanger, geothermal energy, groundwater, Coefficient of Performance, Seasonal Performance Factor, under floor heating

HEAT PUMP TECHNOLOGY

Shallow geothermal systems use the ground or groundwater below the earth's surface as heat source.
The heat pump allows to use the low temperature of the shallow underground. A heat pump is an electrically-powered device that extracts available heat from one area (heat source) and transfers it to another (the heat sink).
The main types of Ground Source Heat Pumps (GSHP) are closed-loop geothermal pumps and open-loop geothermal pumps. Both systems can be used for heating and cooling of buildings. Cooling (free cooling and active cooling with the heat pump) is normally used in larger commercial installations.
A differentiation can be made into following groups:

- The heat of the underground is used by a closed circuit pipe system, which is installed horizontally one or two meters below the surface.
- A second possibility is the so-called Borehole Heat Exchanger (BHE). These closed circuit pipe systems are installed vertically up to 400 m of depth in the ground. The double-U-tube heat exchanger is most commonly used.
- The groundwater heat pump is an open circuit system. The groundwater is being pumped from a well to the heat exchanger in the heat pump and afterwards returned to the aquifer through a re-injection well.

For all systems it is important to take into account the regulations of the water management act.

EFFICIENCY OF HEAT PUMPS

The efficiency of a heat pump is directly related to the temperature ranges in which it operates. It is characterized by the seasonal performance factor (SPF). It contains all kinds of energy fluxes of a geothermal plant. Different factors can influence the efficiency of a geothermal plant. A small temperature difference between the heat source and the heat sink make a heat pump more efficient.
Underfloor heating, panel heating or conventional radiators can be used as heat sink. Underfloor heating and panel heating maximise the efficiency of a heat pump installation but it is not essential.
Another value is the coefficient of performance (COP). It is a device-independent factor but does not consider the whole plant. Therefore it is important to keep both factors apart.

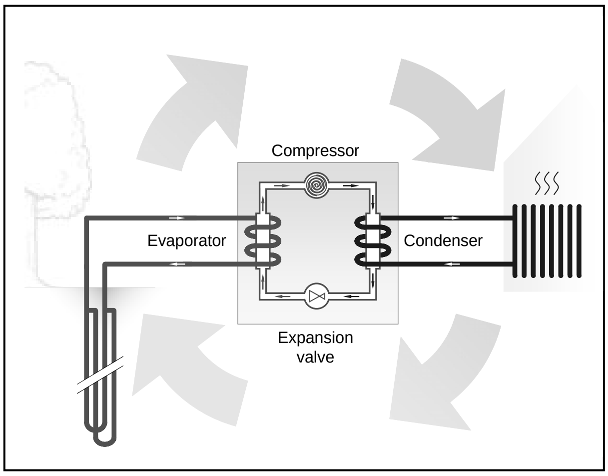

Figure 1 – Scheme of functionality of a heat pump.

Year	water	ground	air
2003	1152	6197	2396
2004	1403	8190	3043
2005	2276	11155	5056
2006	4419	24239	15297
2007	3245	23640	17748
2008	4457	29993	28002

Figure 2 – number of installed heat pumps in Germany.

GEOTHERMAL PLANTS IN BAVARIA

Most geothermal plants in Bavaria use borehole heat exchangers. Typically they are installed in two boreholes with a typical depth of around 75 m. A double-U-tube of polyethylene (PE100 or PE-X) heat exchanger is installed inside each borehole. The heat carrier fluid (antifreeze) circulates in the double-U-tube and transports the thermal energy up to the heat pump. Most common heat output is around 10 kW for heating and hot sanitary water preparation. Approximately 17,000 geothermal plants were installed in Bavaria in the year 2008.

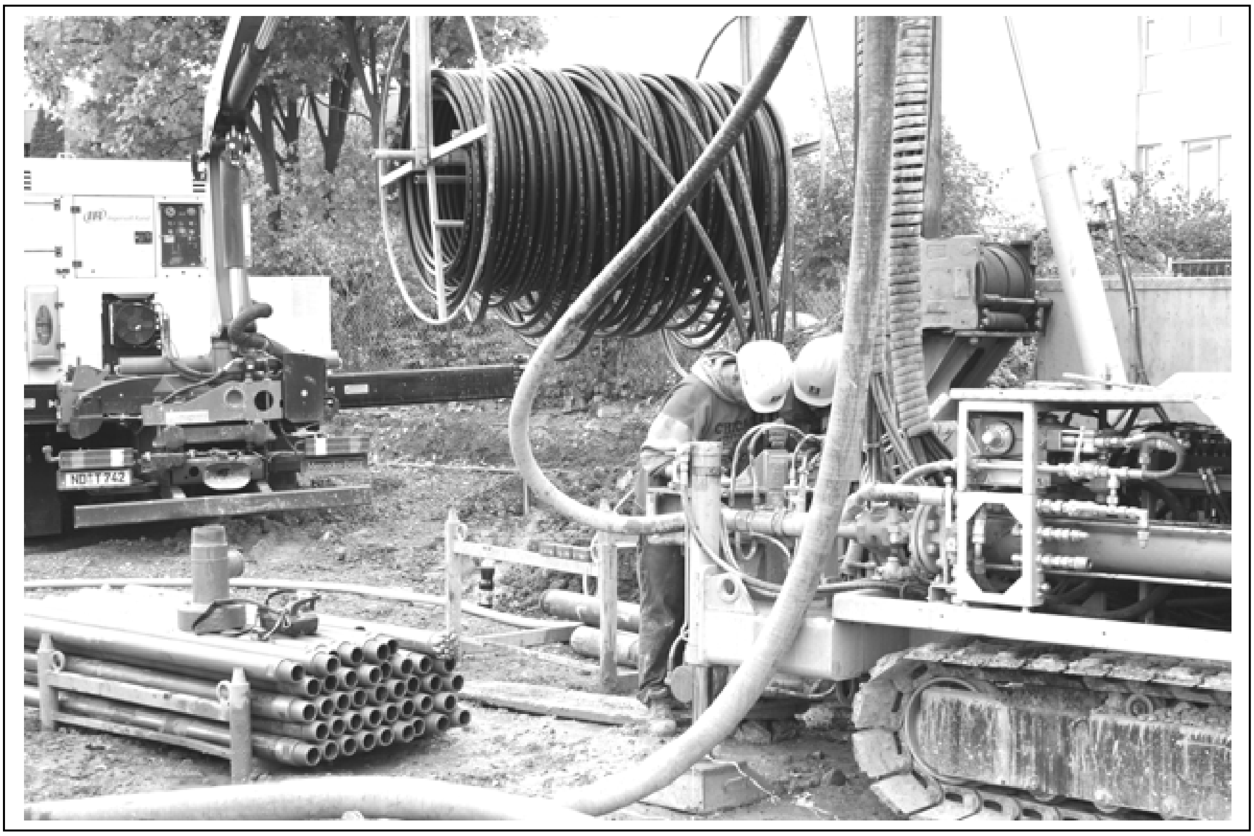

Figure 3 – Installation of a Borehole Heat Exchanger

REFERENCE PLANTS

The project “Information Offensive Shallow Geothermal Energy” carried out at the Bavarian Environment Agency shall point out the general conditions of a ground source heat pump under typical Bavarian conditions. In order to determine the necessary parameters, measurement devices will be mounted in selected plants and longterm data will be collected. Also existing plants which already have measuring instruments will be considered.
Flow meters, heat meters, temperature sensors and data loggers will be used to record measured value such as

- temperature outside and inside the building
- inlet temperature and return temperature in refrigerant circuit
- flow rate
- heating and cooling energy flows
- electrical energy consumption

The effiziency of a ground source heat pump can be characterized with these data. Furthermore the coefficent of performance and the seasonal performance factor will be calculated. The seasonal temperature variance of the subsurface can be evaluated.

ACKNOWLEDGMENTS

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GENETIC OF KONDOR COPPER AND GOLD MINERALIZATION IN ALIGUDARZ AREA, LORESTAN, IRAN

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Abstract:

The Kondor area is located in 20 Km southwest of Aligudarz city and in northwest of Lorestan province. The most important rock units in this area are slate and schist, mica schist, cordierite and silimanite mica schist and hornfelse. Lithologically, the pluton is composed mainly of granite and granodiorite of S-type with upper cretaceous-paleocene time. The Masterun granitoid pluton is respect for copper, gold and their economic elements.

In this area is observed Cu-Au mineralization. On the based of fluid inclusion studies, this mineralization is epithermal. On the based of this study, needful metals for mineralization are provided in schist. Study of S stable isotope showed that sulfur in schist.

KEY WORDS: copper, gold, Kondor, Aligudarz, Lorestan, S stable isotope, mineralization, schist, ore fluids.

1-Introduction

The studied area is located in 20 Km away from northeastern of Aligurarz and northeastern of Lorestan province. According to the tectonic divisions of Iran(Sokoutis, 2000), this area is a part of the Sanandaj-Sirjan zone has been one of the most active zones during the history of Iran geology.

The studied area lies between latitude 33°30′ 0″ , 33° 34 ′ 2 ″ northern and longitude 49° 36′ 51″ , 49° 45′ 0 ″ eastern. The studied area lies between latitude 33°30′ 0″ , 33° 34 ′ 2 ″ northern and longitude 49° 36′ 51″ , 49° 45′ 0 ″ eastern.

2-Geology of the studied area

Stone projection of Kondor area 1:20,000 Geological map sheet is limited to the upper Triass-Jurassic sediments and also quaternary-sediment and current period (fig.1). Most rocky outcrops of area belong to Shemshak formation at the age of upper Triass-Jurassic period that sustained metamorphosis up to now including slits and oriented shales some semischists, semimica schists with siliceous veins and veinlets and mica schists with cordite and sillimanite .Black hornfelses, which are the results of intersection metamorphosis of sandstone units, can be seen easily. The granitoid mass and the rest of sandstone units have been influenced by tectonic strains and became milonitized.

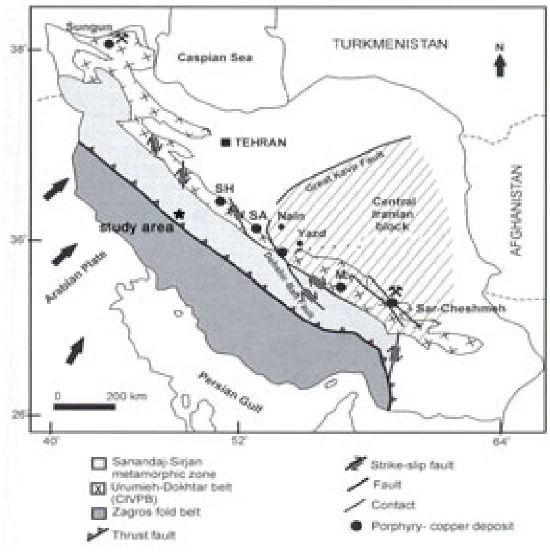

*Fig1 : Tectonic division map of Iran (Sokoutis,2000) and location of Kondor area * quartz veins , injected into the Jurassic metamorphosed schist.*

On the basis of some researches, the granitoids which exist in this area, are a type of S and they are barren of Cu-Au ore-mineralization (Bagheriyan, et al , 2006). The plutons of type S, based on (Beus,1968),(Tauson,1961) and (Taylor, 1979)'s studies , are able to have a potential economic for W, Sn and U. But this pluton is also barren of the above elements (Bagheriyan, et al, 2005). The barren pluton is related to its performance and the volatile amount of substances such as H_2O, F, Cl and CO_2 which plays an important role in transferring metal elements to ionized complex (Maning & Henderson, 1984). Therefore, one the reasons of infertility in pluton is to have a little amount of Cl ion as a result of little fugacity during the magma formation and crystallization (Bagheriyan et al, 2005). Infertility of pluton was confirmed by using C.I parameter (chromatin coefficient) versus Rb/Sr (karimpour & Bows, 1983). With regard to the above studies, it seems that the area shouldn't have any mineralization related to the pluton , but what attracts us to this area is the existence of several Cu-Au indices which consist of another elements such as silver, molybdenum and tungsten (Shahrokhi, 2003c). The existence and formation of mineralized indices in this area are supposed to be related to the granitoid mass of Masterun (shahrokhi, 2003; Shahrokhi & Lotfi, 2004; Shahrokhi et al, 2008c). One of these indices is located in 3.5 Km away from the north of Kondor village and in the east of the granitoid mass of Masterun situated in the northeastern of Aligudarz city. Its type is poly metal with quartz veins which are injected into the metamorphosed Jurassic shale (photo.1).

***Photo 1** : A view of Kondor index in east of the granitoid mass of Masterun which is a poly metal type , along with*

3- Mineralization and geochemistry

Sampling of the research area has been done systematically. Based on these studies, average assay of Cu was .5% to .7% and average assay of Au was about 1.2g in a tone.

Ore- graph study of Kondor index shows that there are different ores (minerals) which can be classified into four groups as follow:

1- Sulfides : pyrite, chalcopyrite, marcasite , chalcosite , chovolite, braunite and titanite
2- Hydroxides : goethite, lepidocrocite, and hematite
3- Natural elements: including copper and gold
4- Carbonates :including malachite and azurite

In the research area, ore sulfides specially chalcopyrites were the most frequent ore (photo.2). Sometimesgoethite, chalcosite and covellite covered the initial crystal of chalcopyrite (photo.3). This confirmed the replacement under the oxidation- regeneration which was done by meteoric water in supergenic environment. Because of the existence of limy units in the region and concerning the available $(CO_3)^2$ ion, so malachite can also be created (photo.4). The blades of titanite occasionally be seen as well (photo.4). Pyrite has been influenced by weathering process and changed into goethite from its borders (photo.5).

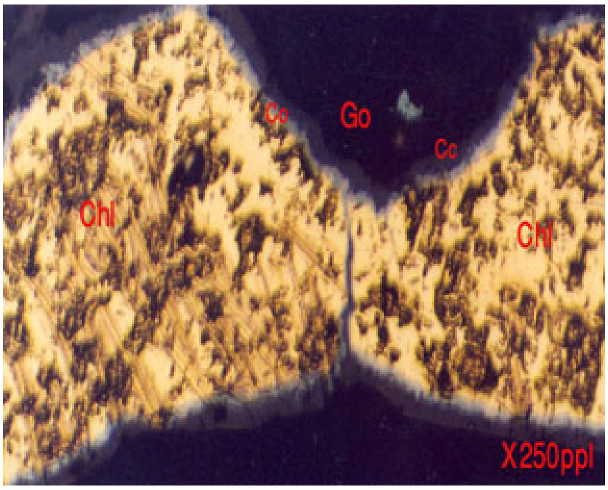

***Photo 2**: A view of remained texture in which the remnants of initial crystal of chalcopyrite were covered by outer borders of chalcosite and inner borders of chalcosite covellite. This shows that replacement under the oxidation-regeneration condition was occurred by meteoric water in supergene environment.*

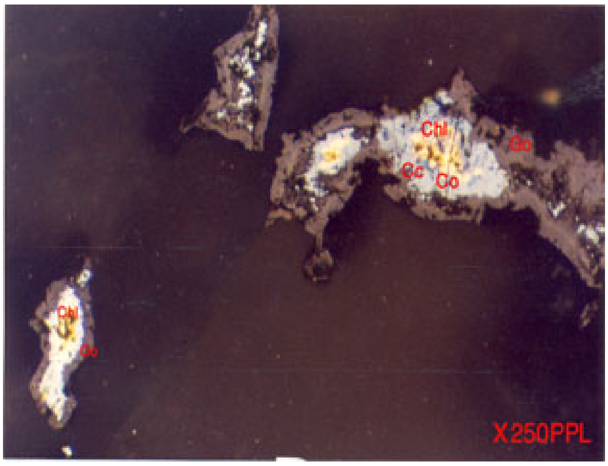

***Photo 3**: A view of the remained texture in which remnants of initial chalcopyrite crystal were covered by chalcosite and covellite.*

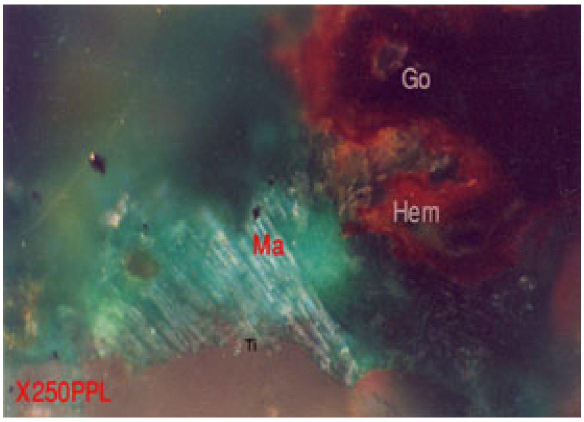

***Photo 4**: A formation view of malachite , goethite and hematite. Titanite blades can also be seen.*

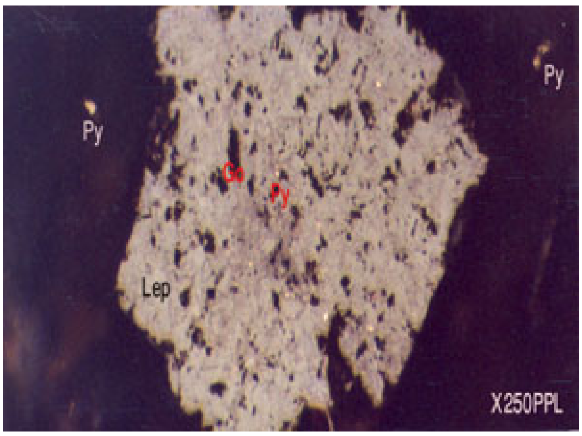

***Photo 5**: A view of remained microcrystal of pyrite inside semi shaped crystal of goethite and lepidocrocite.*

4- Study of fluid inclusions

Experimental results of heating and frigidity of some fluid inclusions indicate a nearly wide thermal range of homogenization temperature between 230 to 400 $^{\circ}$c , salinity range of 11.5 to 26.5 equals to weight percentage of sodium chloride, the effective depth is between 200 and 2780m , 52 to 706 bar of pressure, and 7.79 to 8.8 density. The temperature range of frigidity is different from 10 to 20.8 $^{\circ}$c. Loss of big bubbles in fluid inclusions shows a kind of boiling among fluid ions (Muller,1996). The absence of daughter crystals among fluid inclusions of this area indicates little amount of Cl around the research area (Hezarkhani, 1998).

5- Study of the element origins in the research area.

As we know the pluton' is S-type , it is barren for Au-Cu mineralization and other concomitant elements, considering the results of fluid inclusions confirmed the mineralization of epithermal type, so we collected 20 samples Jurassic shale linearly between the distance of granitoid pluton and Kondor index in order to study origin of elements particularly to analyze Cu and Au. The results of 13 samples are seen in table 1. The studies showed that amount of Cu and Au in shale was more than the threshold, and it indicated an increase in Cu-Au amount from the pluton to the Kondor (table 1).So we come to this conclusion that meteoric fluids and magma were able to pass through cracks and gaps made by mountain formation of laramine and moved through shale and carry the mentioned elements. When they reached the location of Kondor, they involved in retrograde boiling through the regional fault and finally caused mineralization.

6- Study of sulfur isotopes

The amount of measured sulfur in chalcopyrite of the research area is within the range of 29.5 to 32 with a average of 31.25. From figure 5 it can be inferred that the origin of sulfur in the research area must be sedimentary. On the other hand, with regard to available data, we can say that the sulfur required to form pyrite had an organic origin or prepared by sea water. Therefore, sulfur in form of sulfide hydrogen could participate in related reactions to create Au sulfides.

7- Conclusion

The granitoid mass of this area is an S-type. Although the mass is barren for Cu and Au-mineralization, presence of regions with Cu and Au around the mass is considerable. Study of fluid inclusions shows that the Kondor index is an epithermal type. Study of sulfur isotopes indicates sulfur of ores has a sedimentary origin. From these findings it is inferred that the granitoid pluton only had a function of preparing heat and sulfur and required metals for mineralization extracted from Jurassic shale.

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MINERALOGICAL AND GEOCHEMICAL CHARACTERISTICS OF TAFRESH (CENTRAL IRAN)

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ABSTRACT
The area under study that located in central and 221 kilometers of SW of Tehran is a part of Qom quadrangle.

From the lithological point of view, the most rocks are volcanic and plutonic rocks. Volcanic rocks are andesibasalt, andesite, dacite and rhyolite that is emplaced during Eocene. Plutonic rocks are included of diorite, tonalite and granodiorite that is emplaced during Oligo _ Miocene. Magmatic rocks have plagioclase, alcalifeldspar quartz, clinopyroxne and biotite. The amphibole crystals has rim burnt. The most texture is porphyry, microlite for volcanic rocks and granular, pertite for plutonic rocks.

From the geochemical and petrological point of view , variation of major elements , index differentiation and trace element show crystallization on the basis of petrological diagrams magmatic rocks of area under study are calc – alkaline and tholeiitic and they are belong to subduction (CAG) . Similarity between volcanic and plutonic rocks and belonging them to the same place and the same time show that volcanic and plutonic rocks maybe have the same origin.

Keywords: volcanic, plutonic, andesite, continental margin, calc-alkaline

INTRODUCTION

Magmatic rocks under study are included of intrusive and extrusive rocks is situated in around of Tafresh, 221 kilometers of SW of Tehran, with $50°01'$ eastern longitude and $34°51'$ northern latitude (Fig. 1).

The area is a part of Qom quadrangle (central Iran). From the geologically point of view, this area is a portion of central Iran zone that is situated along the Urumieh-Dokhtar Volcanic zone. The main fault of area have NW-SE and N-S trend with a very important role in the geological variation, formation of sedimentary basins and volcanic activities.

Outcrops of rocks in area under study related to Mesozoic and Cenozoic ages and the oldest rocks is carbonate rocks of Middle Triassic (Hadjian, 1970). The oldest Tertiary sedimentary of Eocene in the area under study belong to early Eocene (Emami, 1991). Eocene deposits are included of sedimentary rocks, pyroclastics and lava flows that show more than 3000 meters thick. After Eocene Magmatic activities were limited so as in the Quaternary, there is not any volcanic activity in the Tafresh area.

Tectonically, general trend of volcanic rocks of Tafresh area is NW-SW. Faults, especially Indus fault caused that volcanic rocks have overlained carbonate deposits of Qom formation or Pliocene conglomerate.

DISCUSSION

In order to undertake, mineralogical petrographical, geochemical and petrological studies, dense sampling and field work, considerations were made and 20 samples of magmatic rocks of Tafresh were selected for major and trace elements analyses by XRF. In addition 200 thin sections were provided for microscopic studies. All of the rocks are classified based on modal analysis and geochemical-mineralogical methods (fig.2 & Fig 3 and Fig 4).

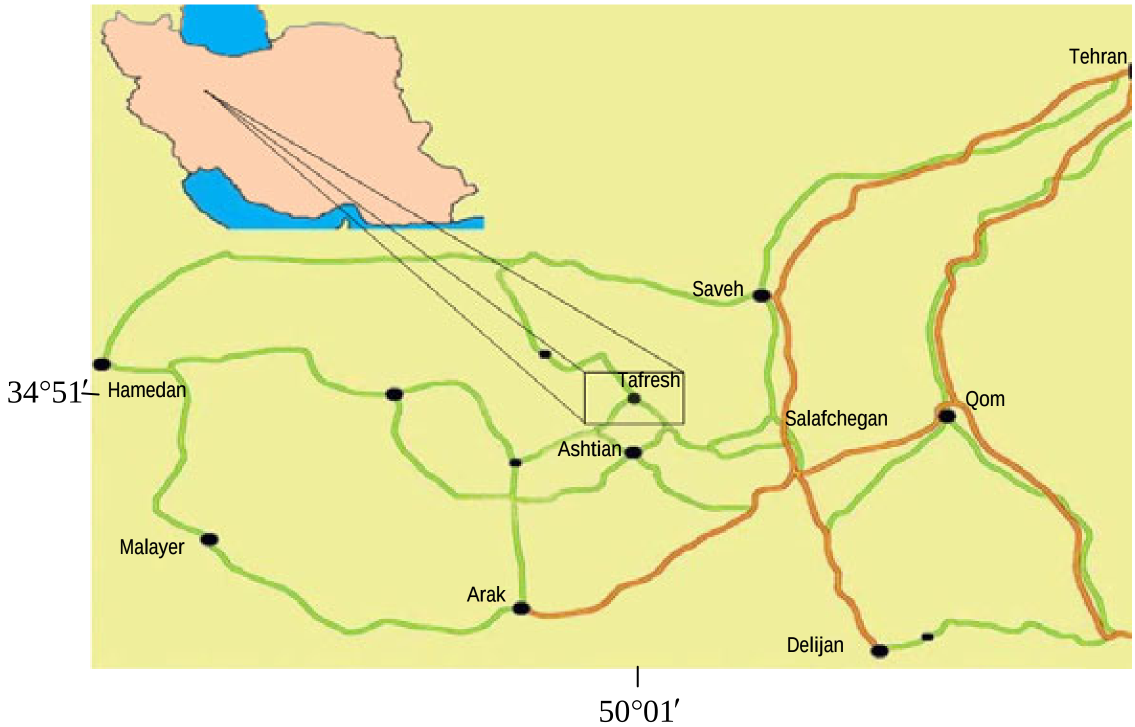


Figure.1: Geographical position of Magmatic rocks of Tafresh

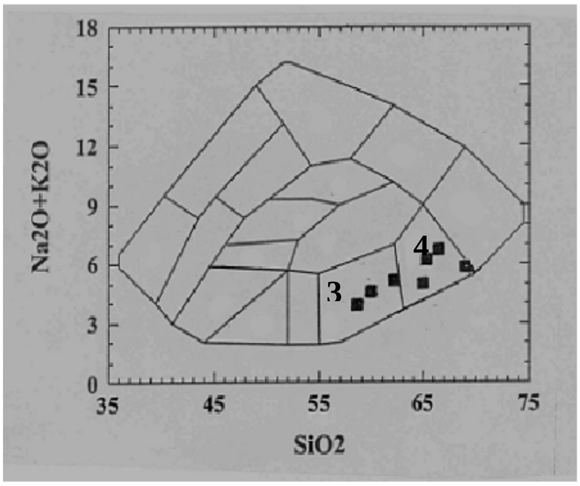


Figure 2: Plutonic rocks of Tafresh area based on Cox et al. diagram, 1979
3: Diorite 4: Tonalite and Granodiorite

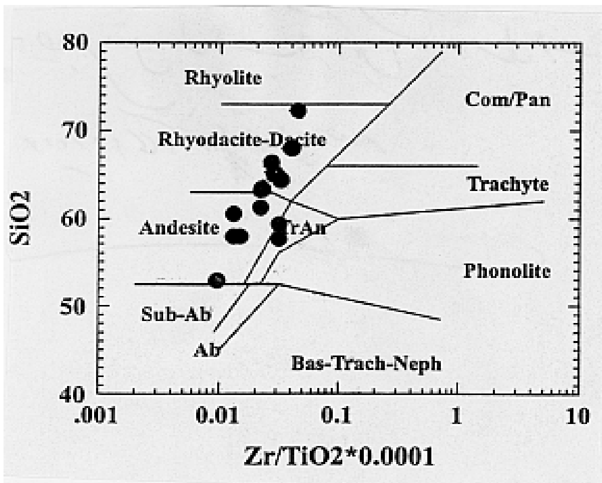


Figure 3: Volcanic rocks of Tafresh area based on Middlemost, 1985.
12:Trachyite 18: Andesibasalt 19: Andesite
20: Andesite, Dacite 21: Dacite 22: Riodacite

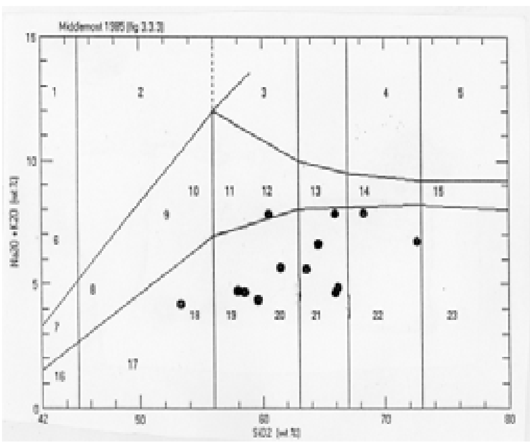
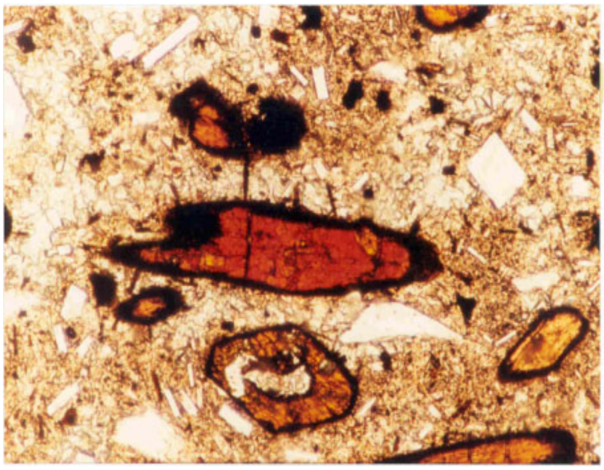


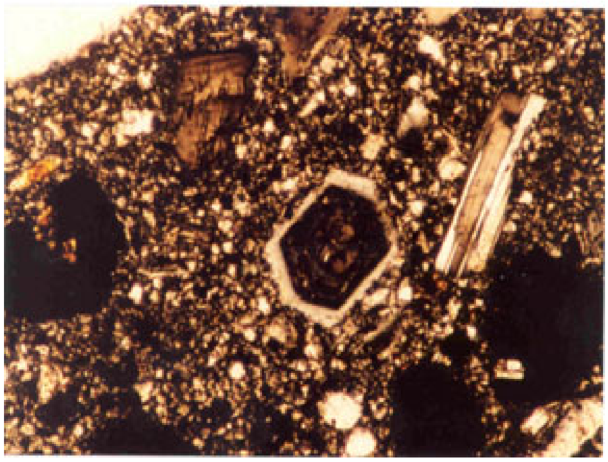
Figure 4: Volcanic rocks (andesite, trachyandesite, rhyodacite and dacite) of Tafresh area based on Winchester, J. A. and Floyd, P. A. diagram, 1977.

According to mineralogical, geochemical and modal analysis volcanic rocks under study in Tafresh area are, andesibasalt, andesite, dacite and rhyolite that is emplaced during Eocene and plutonic rocks are included of diorite, tonalite and granodiorites that is emplaced during Oligo-Miocene. Magmatic rocks have cut by daykes. Moreover could be find ignimbrite and tuff. Textures of Magmatic rocks are of perthite, granular, granophyric in plutonic rocks and porphyritic, microlitic porphyritic, microlitic and sieve textures in volcanic rocks.

Magmatic rocks have plagioclase, alkalifeldespar, quartz and a lesser amount of clinopyroxene and amphiboles. Plagioclases are automorph to sub-automorph with zoning structure and amphibole crystals have opacite rimmed (Pics. 1, 2).



Picture 1: Amphibole crystals with opacite rims 5×10 XPL



Picture 2: Zoned and twinned, plagioclase phenocrysts 5×10 PL

This phenomenon shows that magma responsible for rocks have a high temperature.

The secondary minerals are apatite, sphene, zircon, iron oxides, calcite and chlorite.

Using discriminates diagrams of Irvine and Bargar (1971), Manior and Piccoli (1989) and Pearce & Can (1984) Magmatic rocks of area under study are calc-alkaline and they are belong to subduction (CAG).

Plot of results on spider diagrams show this matter (Fig 5) (Wilson, 1989).

Similarity between volcanic and plutonic rocks and belonging them to the same place and the same time show that volcanic and plutonic rocks may be has the same origin.

Conclusion

Most of area under study has been covered by volcanic, pyroclastics and intrusive rocks.

Outcrops of Magmatic rocks show that in the area under study there is not rocks older than Triassic. Lithological and investigation of fossils show that volcanic rocks belong to Eocene and plutonic rocks related to Oligo-Miocene.

The most volumetric abundances of Magmatic rocks are diorite, tonalite, granodiorite, andesite, dacite, rhyodacite and rhyolite, and in a lesser amount syenite and andesibasalt.

The sequences of Magmatic rocks have cut by dykes.

On the basis of evidence of mineralogical, petrographical, geochemical and petrological show differentiation and crystallization for Magmatic rocks and Magmatic rocks of area under study are calc-alkaline and they are belong to subduction (CAG**)**.

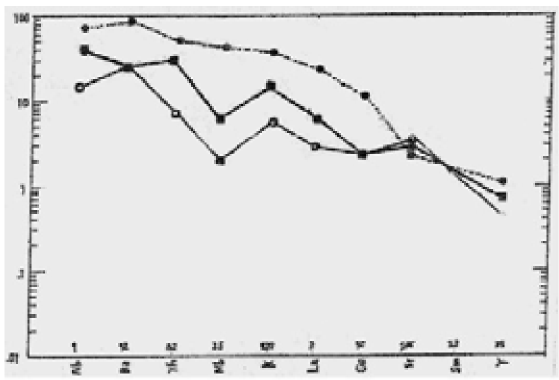


Fig 5: Spiderdiagram for volcanic rocks of Tafresh area, Wilson, 1996.

○ CAG ● ORG ■ Tafresh

And finally volcanic and plutonic rocks maybe has the same origin.

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GENESIS OF PYRITE AND MONTMORILLONITE MINERALIZATION IN OLD SEDIMENTS OF URMIA LAKE (NW IRAN) BY SEM

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Mineralization event of pyrite and montmorillonite in old sediments of Urmia Lake was caused in Azarshahr area. The formation of pyrite and montmorillonite usually was happened into ostracoda, gastropoda, lamellibranchiata microfossils and microbioturbations. SEM and XRD studies indicate that the pyrite and montmorillonite minerals have formed in mono-polycrystalline and framboidal forms, montmorillonite minerals have formed in edge of pyrites, adhere to pyrites and syngenetic with them.

INTRODUCTION

Existence of pyritization in all of geologic time length was discussed by Fisher (1986), Sweeney et al. (1973), Berner (1969, 1970, 1983) happened in saturation of H_2S and presence of Fe into environment. Urmia lake with its exclusive geographic and and lithologic characteristics was located at NW of Iran (Fig. 1) The pyretic depositions of this lake was discussed in this paper.

Existence of pyritization and montmorillonitization event into old sediment deposits of Urmia lake, were happened into Ostracoda, gastropoda, lamellibranchiate microfossils and microbioturbations that have organic matter and Fe ions, in same age with diagenesis. The aim of this study is investigation of pyrite and montmorillonite minerali-zation conditions into mentioned sediments.

GEOLOGICAL SETTING

Structural and sedimentary anisotropy in different epochs in Iran geology is caused to existence of many episodic theses about it. The first structural zoning of Iran offered by Stocklin (1968) and later ideas founded on it. Urmia lake basin was located at Alborz-Azerbaijan (Nabavi, 1976) and at central Iran zone (Stocklin, 1968). From view of sedimentary characteristics, this region is a restite part of NW Sanandaj-Sirjan zone (Fig1). According to Furon (1941) Urmia lake in Plio-Pleistocene was spreading until to Tabriz (in east) and Maragheh (in SE). Based on Mckenzi (1972) this lake is located in a part of crushing zone between Arab-Iran plates and Turkey microplate, that surrounded by highlands. The old sediments of this basin are alternations of fossiliferous carbonate nodules rich clay bed, gypsy-siliciferous clays (Fig. 2A, C), diatomite layers, bone beds, sand and siltstones, Fe-oxide, pyrite rich laminates (Fig. 2B) with gastropoda, ostracoda, lamellibran-chiate and montmorillonite beds. Upsurfaces of these sandy alternations covered with oblique lamination, regular ripple marks and hematite rich sands. Iron oxide deposited into joints of clay crust and it formed space filling form (Fig. 3D). Alternation of evaporates consists of old carboniferous-gypsiferous clay beds and contemporary color evaporate depositions. Mentioned sediments deposited on Qom formation with Oligomiocene age at east part and on cretaceous sediments and river sediments at west region of basin. These characteristics indicated the direction of water movement that activation of Urmia and Tabriz faults from Miocene to contemporary times have important role about it. Calcic green ostracoda rich sediments and coal beds in a 50m depth core confirmed this idea. In this study, an interaction of clay layer with pyritization, montmorillonization, gastropoda, ostracoda, lamellibran chiate and microbioturbation events, investigated by XRD & SEM-EDX. Mentioned montmorillonites have used as shampoo for wasing applications from ancient ages to present time.

MATERIALS AND METHODS

Geological setting is consists a stratigraphic expedition and sampling. according to noncompatibility of sediments thin section preparation was impossible and their mineralogical setting done by XRD. SEM samples separated and cleaned with H_2O_2 , coated with Au coating and studied with LIO 440I SEM at Tabriz university microanalysis center.

SUMMARY

The southern part of Urmia lake was covered with altered products of Sahand volcanic mountains. The old sediment of lake, are alternation of white, pink microbivalves rich clay, silt and channel sands. Red Fe rich layers with 2-5cm thickness formed as intercalations into clay beds. There are some vertical and inclined joints on surface of clay layers with 5cm width and 10-50cm height that formed from pressing processes in dry seasons. This joints filled by Fe rich sediments. The pyritized shell content layers are member of intercalation of clay layers. Morphology and energy of environment, biogeochemistry of lake water and geochemistry of intergranular waters have main role in formation of autogenic sedimentary pyrite and montmorillonites. Mineralogical features of pyritization zone from XRD (Fig. 3), morphological and textural evidence by SEM-EDX suggest that these montmorillonite rich zones resulted from the alteration if volcanic ash in organic-rich microenvironments (Pollastro, 1980). Pyritization usually is observable into microbivalves, gastropoda and microbioturbation micro-environments (Fig. 4). Montmorillonite minerals are surround-ing around of pyrite masses (Fig. 5 & 6c), and probably formed in initial diagenesis, same age with pyritization or after of it, under environmental chemical characteristics, and they prevent for lateral growth of pyrites. The growth of pyrite crystals happened from the edge of shells to center of them, montmorillonite are between crystals and they are look like as intergranular cement for pyrites. In addition to pyrite-montmorillonite, microparticles of amorphous carbonates are observable on the pyrite masses. Main compostions in shells are from aragonite needles, in gastropoda and ostracoda from calcite (Fig. 6d) and in lamellibranchiate are from siderite (Fig. 6a).

CONCLUSIONS

Pyritization-montmorillonization as an autogenic processes have formed in initial diagenesis stage into microbivalves, gastropoda and microbioturbation microenvironments. The microbivalves are aquatic, but, the gastropodas transported from outside environ-ment to lake environment. The organic matters in bivalves were disintegrated by no aerobic bacteria's, and yield H_2S with Fe content of siderite caused to pyrite formation. Iron and other elements probably produced from volcanic rocks alteration and transported with rivers to lake.

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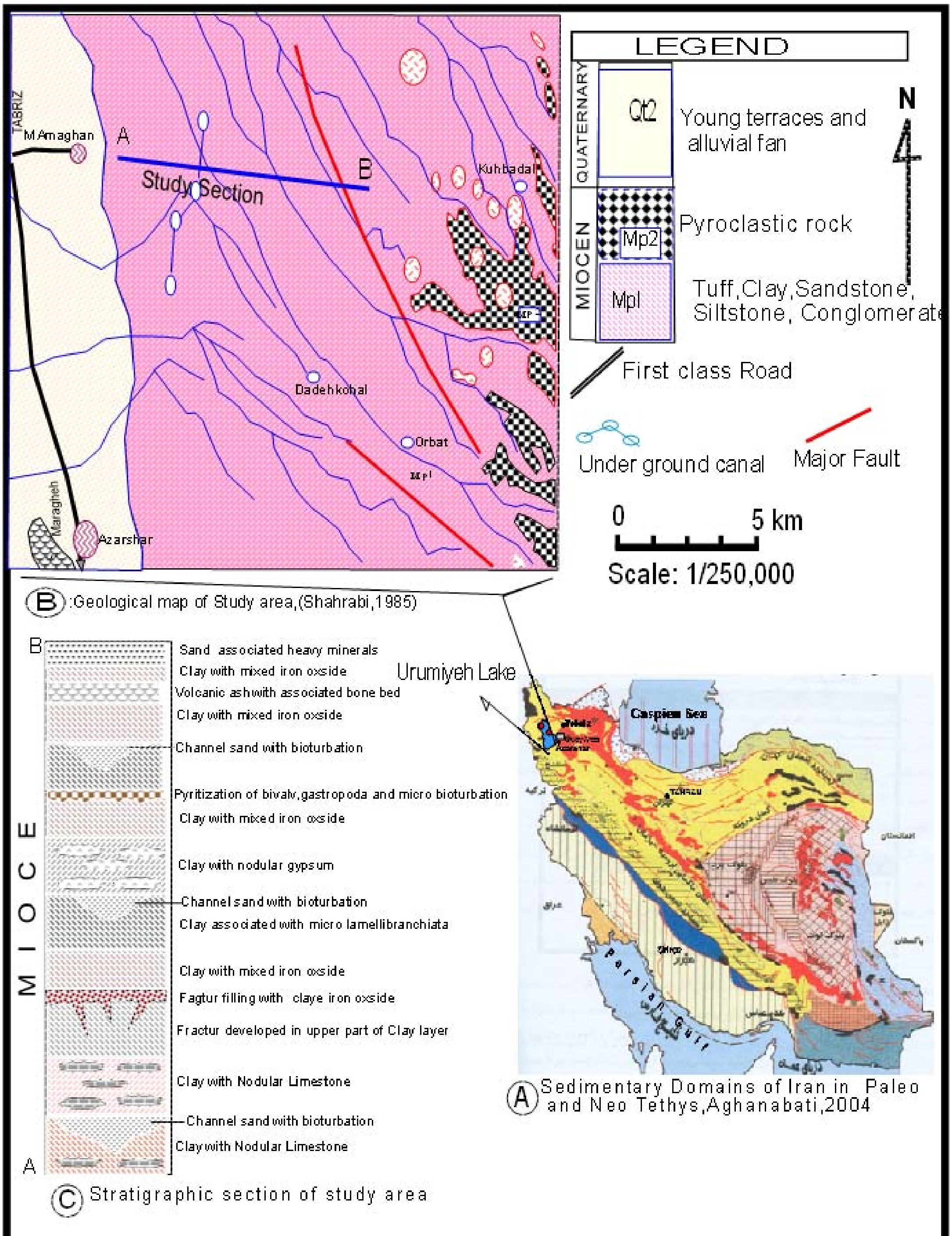

Fig-1:Geological map of Study area.

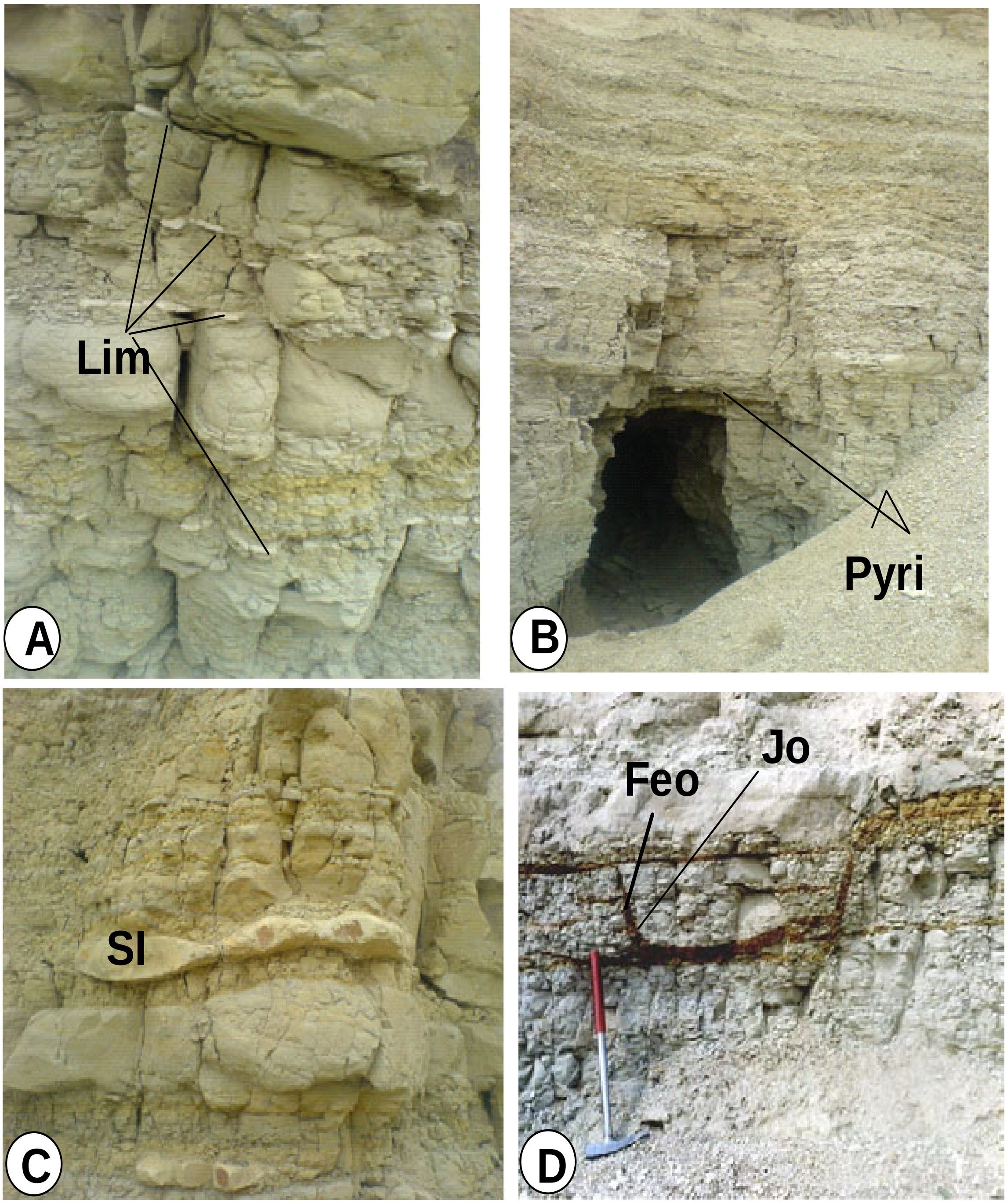

Fig. 2: Alternation of Urmia lake clay sediments (A) calciferous clays and limestone lenses(Lim.), (B) Alternation of clay and pyritization zone (Pyri), (C) silicifeours clays and silicic lenses(Si), (D) space filling of clay joints(JO) with Fe Oxides(FeO) .

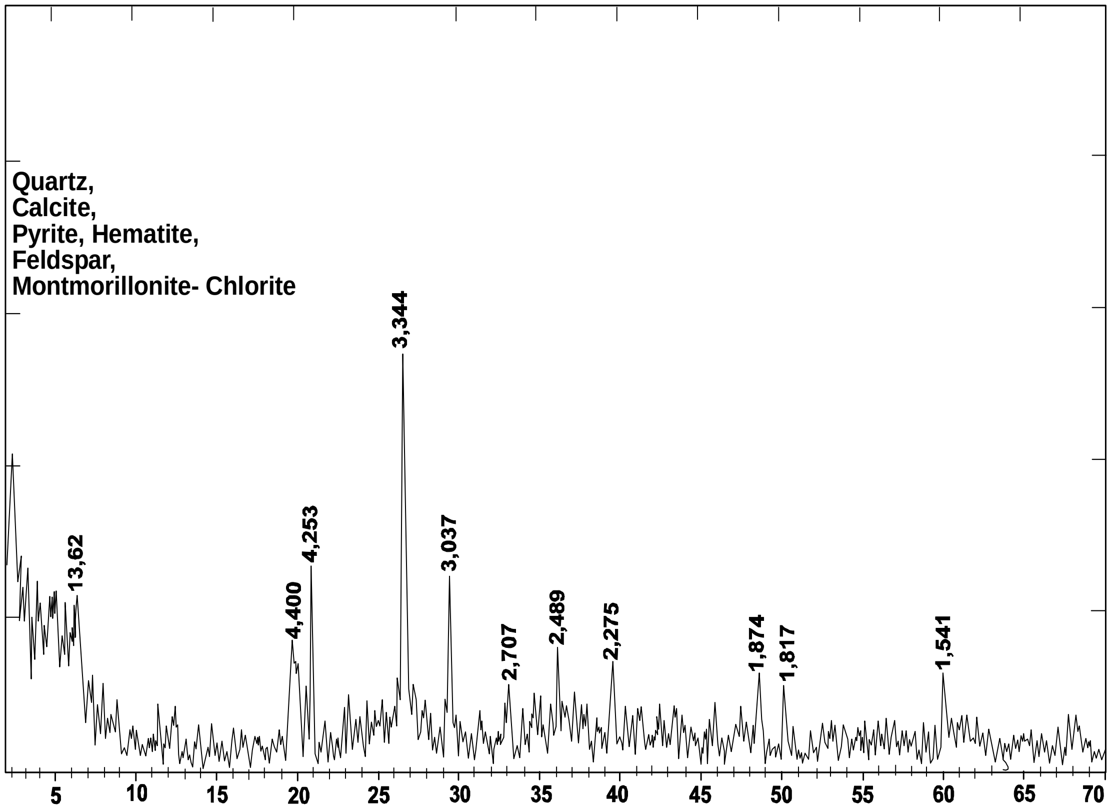

Fig. 3: Mineralogical features of pyritization zone by XRD

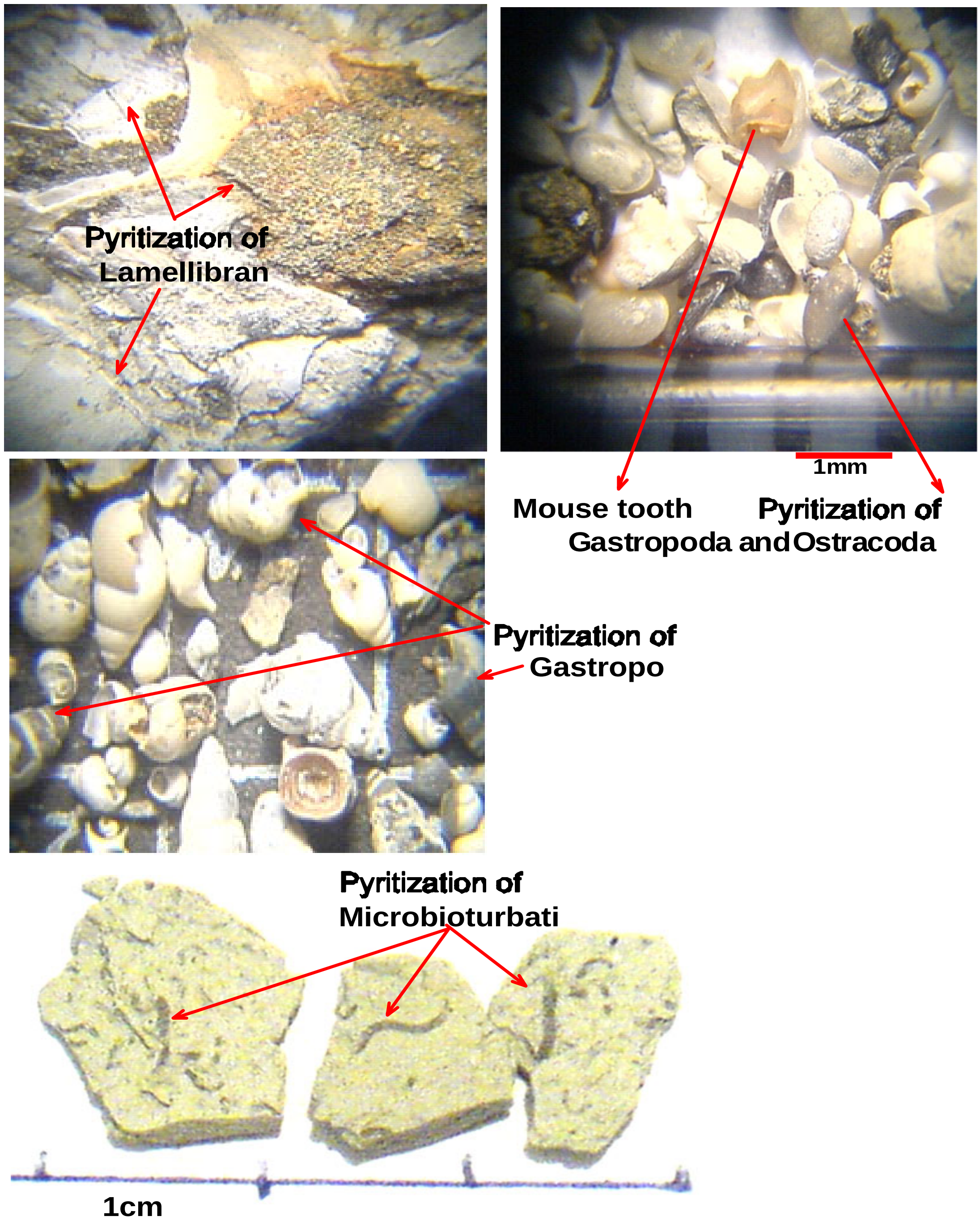

Fig-4:Pyritization of mirofossil as Ostracoda,Gastropoda, Lamellibranchia and Microbioturbation

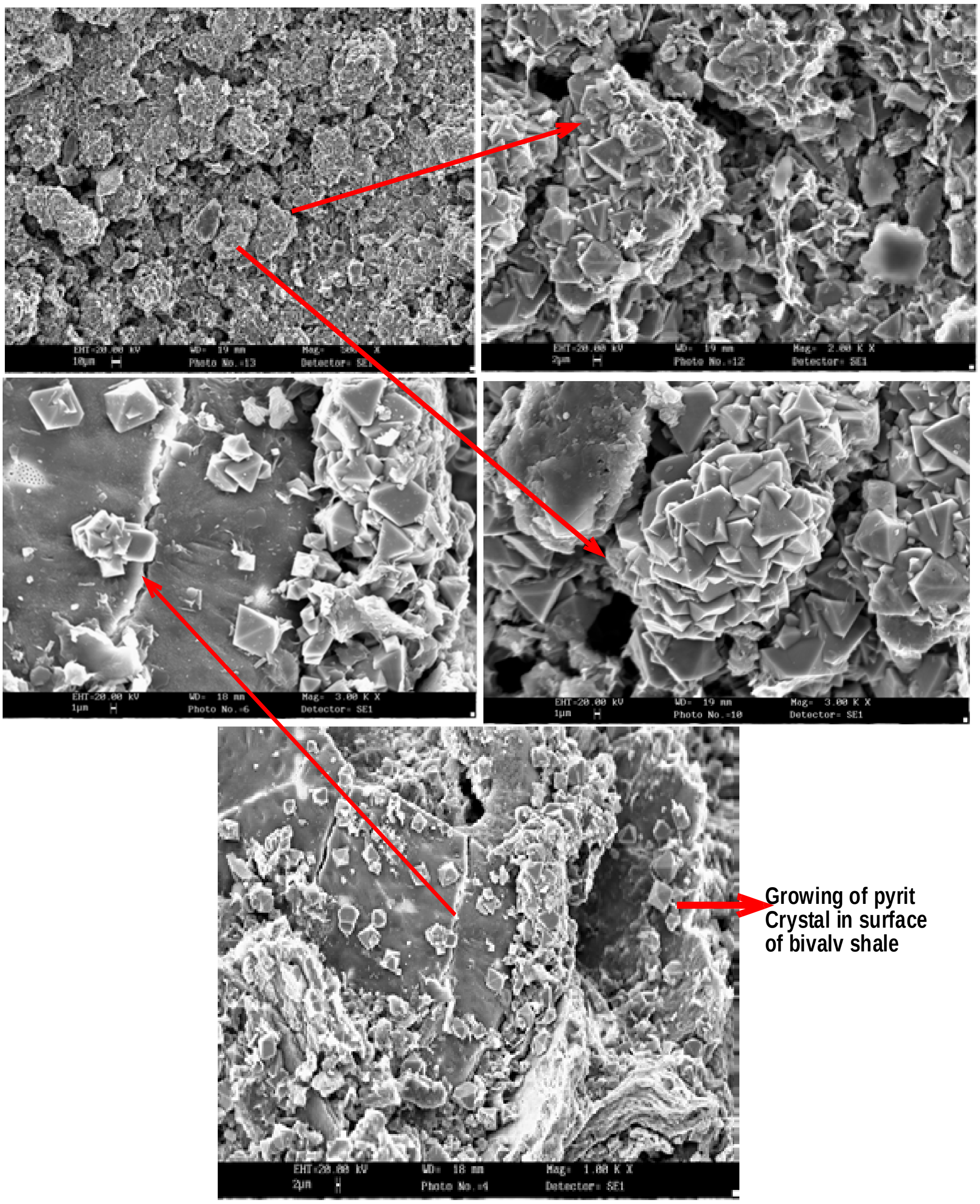

Fig. 5: Pyrite field formed in cell of microbivalve, growing clay minerals around pyrite mass

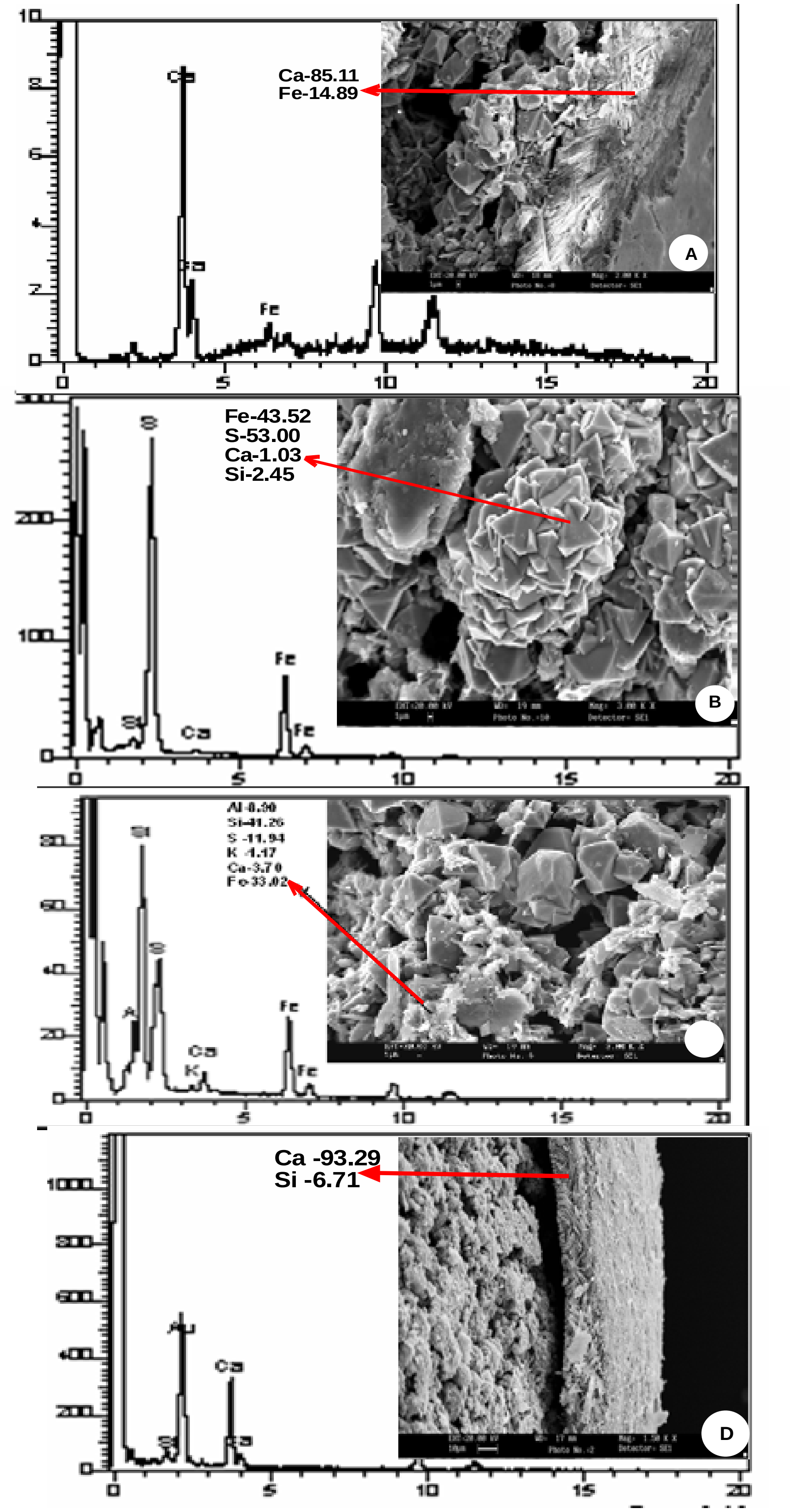

Fig. 6: Chamical analysis of Lamellibranchiata Shell(A), Pyrite Crystal(B) and Montmorillonite clay minerals(C) and Gastropoda by SEM-EDX.

ROLE OF MINERALOGICAL MAPPING IN PROSPECTING FOR KIMBERLITE WITHIN AREAS WITH COVERING GLACIAL DEPOSITS

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KEY WORDS: mineralogical method, mineralogical database, kimberlite indicator minerals, diamond deposit prospecting, Paleozoic terrigenous deposits, Quaternary glacial deposits, dispersion haloes

INTRODUCTION

The mineralogical method remains one of the main instrument of diamond deposit prospecting for territories where covering glacial deposits are widely developed. It allows to determine the direction of debris transport and assess the remoteness of kimberlite indicator minerals (KIM) found in sampling.

The regularities of KIM dispersion haloes formation within plates were studied in Zimniyberezhny diamondiferous area.

To study the mechanism of dispersion halo formation in deposits overlying kimberlite bodies, panning was performed for core take from > 500 holes to identity the most informative horizons containing KIM.

FEATURES OF ZIMNIY BEREG AREA PROSPECTING ENVIRONMENT

Diamondiferous kimberlite pipes of Zimneberezhny area were buried under Paleozoic terrigenous-carbonate and Quaternary glacial deposits (Figure 1).

The basement of the Paleozoic sequence comprises Carboniferous motley colored and red bed sand and sandstone 50-80 m thick. There are the two members within the sand and sandstone. The lower comprises continental coarse grained sandstone, siltstone with gritstone partings (alluvial, lacustrine facies). The upperone – sands, aleurosandstones of marine shallow water (basin facies).

Quaternary deposits (20 to 180 meters) are poligenous complex of glacial, fluvioglacial and interglacial lacustrine and marine strata.

Non-unidirectional movements of glaciers resulted in total areal contamination of deposits by indicator minerals of alkalic-ultramafic (and kimberlite) magmatism (olivine, Cr -spinelides, Cr-diopside, pyrope, picroilmenite and magnesian ilmenite).

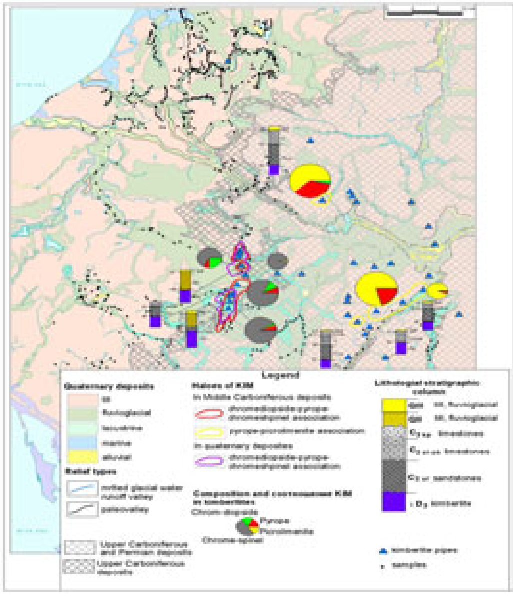

Figure 1 - Dispersion haloes of kimberlite indicator minerals in covering deposits

KIMBERLITE INDICATOR MINERALS

Diamondiferous pipes of Zimneberezhny area contain two mantle KIM associations: Cr-diopside-pyrope-Cr-spinel and pyrope-picroilmenite.

KIM of Cr-diopside-pyrope-Cr-spinel association. Cr-spinelides are represented by smooth-face octahedrons complicated by vicinal surface, combination and myrioedric crystals characterized by corrosion-hydrothermal type of surface microrelief. Their features are etching channels and protomagmatic partings on surface, fractured rims chemically different from central grain parts, internal nonuniformities expressed by block structure of some crystals, traces of plastic deformation and inclusions of other phases (Afanasyev, 2008). They are characterized by high Mg value (8-14 wt.%);Ti value (up to 4 wt.%) and wide isomorphism in Cr^{3+}- Al^{3+} series. Features of Cr-spinelide composition suggest significant depth of kimberlite - forming magma focus. Predominant rocks are Cr-spinelides of coesite depth subfacies which belong by chemical composition, to magnesial subferrichromites, more rarelysubferrialumochromites (Sablukov et al., 2000; Kudryavtseva et al., 2005).

Pyropes are represented by fritted rounded-oval grains and their violet and purple fragments that have pitted-combed, of coesite, grospyditedepth subfacies, lherzolite paragenesis. Pyropes of diamond association account for no more than 1-3 %.

Cr-diopside is represented by oval grains and their emerald-green fragments, they have thinly matted or cavernous splintery and are rich Cr (up to 2,4 wt.%) and poor in Fe (up to 1,7 wt.%).

KIM of pyrope-picroilmenite (including Cr-diopside) association. Picroilmenite represented by fine grains (cavernous pitted surface) from kimberlite cement and nodules of aggregate (mosaic) and monocrystalline structure. Diamondiferous kimberlites are dominated by monocrystalline picroilmenite, non-diamondiferous by polycrystalline (aggregate) picroilmenite. Picroilmenite in diamondiferous kimberlites is high-magnesian and high-chromous, with a narrow chemical composition range. MgO content there varies 12,0-17,5 wt.%, Cr_2O_3 – 1,0-5,5 wt.%; non – diamondiferous kimberlites composition is low- magnesian (MgO – 4,6 wt.%), almost chrome-free, Mn content is elevated (MnO – 0,6–1,0 wt.%).

Pyropes are characterized by abundance of orange-red grains having thinly matted, corrosion-hydrothermal surface, Ti content is elevated (up to 1,6 wt.%). Predominance of dunite-harzburgite paragenesis low-chrome differences is typical.

In chromdiopside, Cr content low (up to 1,0 wt.%) and Fe content is elevated (up to 3,5 wt.%).

Thus in Zimnebereszny area typomorphic properties of KIMs (morphology and chemical composition) are unlike those of other alkaline-ultramafic magmatites.

KIM FROM COVERING DEPOSITS

KIM from Paleozoic deposits. They are represented by three groups of different exogen history:

1. KIM which preserved typomorphic features they had in kimberlite and are most informative in terms of prospecting. Are present in carboniferous terrigenous deposits above kimberlite bodies and close to contours. The chemical composition of KIM from these haloes is identical to that of indicator minerals from kimberlites (Figure 2);

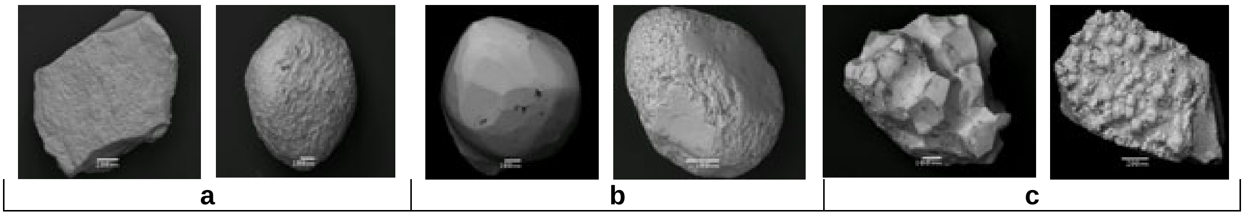

Figure 2 – KIM from proximate removal dispersion haloes: pyrope (a); Cr-spinelide (b); picroilmenite (c)

2. KIM covering traces of hypergene corrosion and undergone low mechanical wear observed in carboniferous deposits continental facies;

3. KIM undergone strong mechanical wear, confined to upper horizons of carboniferous terrigenous deposits (Figure 3).

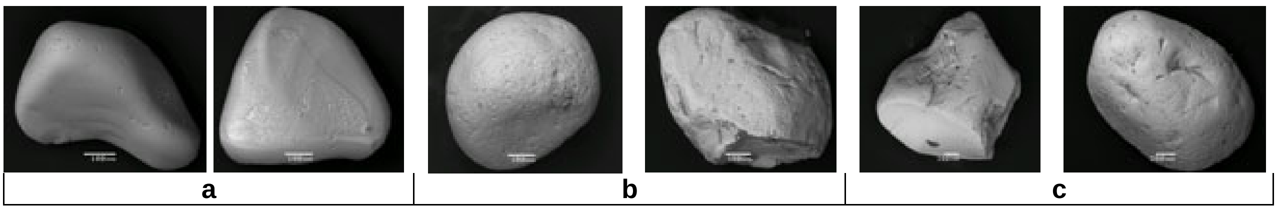

Figure 3 – KIM from remote removal dispersion haloes: pyrope (a); Cr-spinelide (b); picroilmenite (c)

KIM dispersion haloes of proximate (up to 1,5 km). The former are confined to basal horizons of continental-type carboniferous deposits and traced, in cross-section, for up to 10 m from their base.

KIM from glacial deposits. They are represented by two groups:

1. KIM which directly captured by a glacier in kimberlite exaration;

2 KIM which assimilated from underlying carboniferous deposits and preserved typomorphic features they had in kimberlite.

Dispersion haloes of proximate removal traced for up to 50 m vertically and up to 2 km laterally are defined in moraine loams and fluvioglacial sands of the middle glacial complex above kimberlite bodies and beyond contours.

KIM from recent channel alluvium. KIM dispersion haloes of proximate removal in recent channel alluvium of Zimny Bereg rivers are limited in distribution and found at areas: a) not overlain by carboniferous deposits, with Quaternary deposits – up to 50 m thick; b) overlain by Carboniferous deposits (10 m thick max.) and Quaternary deposits up to 50 m thick. KIM from proximate removal dispersion haloes in recent alluvium are traced for no further than 3 km from sources which is related to weak dynamics of postglacial rivers.

STRUCTURE OF MINERALOGICAL DATABASE

Cumulative array of the mineralogical facts allow creating computer-based database for work is underway on cartographical and factual information.

Two main blocks are included in this database: "Mantle minerals of diamondiferous and non-diamondiferous kimberlites of Zimny Bereg diamondiferous field" and "The results of mineralogical sampling in all ages cover deposits". The database consist of aggregate of maps, plans, standard geological sections and tables (Figure 4).

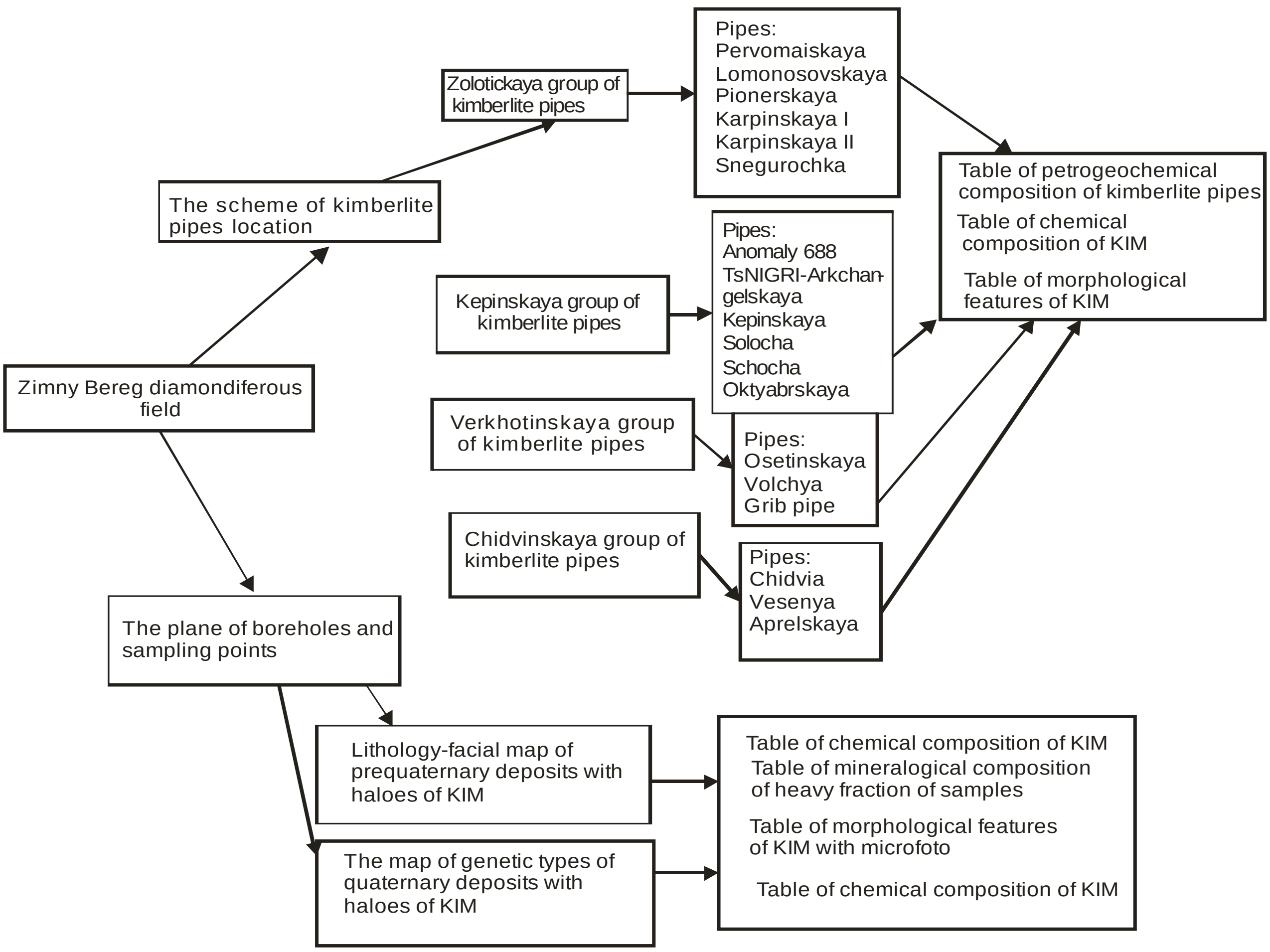

Figure 4 - Structure of mineralogical database

The first block contains information about material composition of kimberlitic bodies combine into the separate groups. The first block accompanied by tables of chemical composition, morphological features and photomicrography of mantle mineral's grains.

The second block contains information about all ages deposits accommodating haloes of KIM of various genetic types, set of maps (for example, "Lithologic-facial maps of basal layers of pre-quaternary deposits", "Map of genetic types of quaternary deposits" et all). The second block also accompanied by tables of chemical composition, morphological features of KIM. It contains lithologic description of samples, data of mineral composition of heavy fraction of samples and photomicrography of KIM's grains showed peculiarities of it's micro-surfaces.

CONCLUSIONS

The mineralogical prospecting method for Zimneberezhny area is most effective when Carboniferous terrigenous deposits are as thick as 10 m, glacial Quaternary deposits – up to 50 m thick. In this case, KIM haloes of proximal transport are traced throughout their strata and displayed in composition of recent alluvium (Shcherbakova T.Y., 2005).

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GROUNDWATER RESOURCES SANITARY PROTECTION ZONES: TWO CASE STUDIES FROM THE CROATIAN KARST

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KEY WORDS: karst spring, water supply, GIS, water protection.

KARST GROUNDWATER PROTECTION IN CROATIA AND TWO CASE STUDIES

A very important land-use mode in Croatian karst areas is the formation of sanitary protection zones for potable water resources. According to Croatian legislation, karst groundwater should be protected in four zones (Table 1), and a possible fifth zone—groundwater reservation, in some cases. These rules are the consequences of the experiences of numerous researchers, mostly in the last few decades (Bahun, 1989; Milanović, 1996; Fritz & Ramljak, 1999; Biondić et al., 1999). In karst terrains, there are four zones with different restrictions and levels of land use; as a part of spatial planning, these zones have to be classified using the geographic information system (GIS) technique.

Sanitary protection zone	Hydrogeological description	Criteria	
		Time for groundwater flow (day)	Apparent groundwater velocity (cm/s)
I	Fence around the extraction site.	-	-
II	The closest part of catchment, preferential flow zones and ponors; highly karstified zones.	< 1	> 3
III	Terrain close to preferential flow zones; permeable rocks connected with main drainage directions etc.	1 – 10	1 – 3
IV	Peripheral zones in catchment, rocks of lower permeability etc.	10 – 50	< 1

Table 1 – Sanitary protection zones (Narodne Novine 55/02), with brief hydrogeological descriptions.

The case studies considered are Lička Jesenica karst springs in Lika (middle Croatia) and the Miljacka spring in Dalmatia (south Croatia) (Figure 1). The areas studied are part of the well-known Dinaric karst region, which is extremely heterogeneous and is characterized by deep and irregular karstification. During the last few years, there has been an extensive hydrogeological research program carried out on both locations. Every extraction site in Croatia, used for water-supply purpose, has to have sanitary protection zones. The most important data required for the determination of the sanitary protection zones are the apparent velocities determined by the tracer tests. The second sanitary protection zone is part of a catchment with groundwater velocities above 3 cm/s and encompasses the preferential flow directions, usually connected with fault or fracture zones, in addition to the area closer to the pumping site. The main swallow holes directly connected with the pumping site are also considered as a part of the 2nd sanitary protection zone. The third sanitary protection zone includes the area with water velocities between 1 and 3 cm/s. The fourth zone extends over the distant parts of the catchment. After the legal implementation of the sanitary zones as suggested by hydrogeologists, all existing pollutants should be eliminated or remediated. No further activities can be carried out in these areas without detailed hydrogeological research, which is also described in legislation and is called the “micro zoning” procedure (Pavičić et al., 2007).

Figure 1 – Location map of the two areas researched in Croatia.

CASE STUDY 1 – LIČKA JESENICA

Lička Jesenica is a karst river flowing from its two main springs to swallow holes at the other side of its karst polje. One of these springs (Malo Vrelo) is currently an extraction site for the local community, and the other one, Veliko Vrelo, is an even more important spring that is planned to be applied in future plans for the water supply spanning much wider areas. To provide sanitary protection zones, many different techniques, such as geological and hydrogeological mapping, geophysical researches, hydrogeochemical and isotopic data, monitoring of water level and discharge, and tracer tests, have been assembled into one general report. This catchment has been widely studied in the past (Bahun, 1989). Although this catchment is considered as two separate catchments, by detailed hydrogeological mapping, it has been decided by the authors to connect it into one catchment in the distant part, which separates into two karst aquifers in the closer hinterland. Between these two aquifers, there is one dolomitic barrier clearly distinguished. Nevertheless, the responses of the two springs to rain, in addition to the chemical compositions of the groundwater, are very similar and indicate the same recharge area. Spring water level (discharge) and EC value were measured continually for one hydrological year using Eijkelkamp Diver CTD loggers (Stroj et al., 2008).

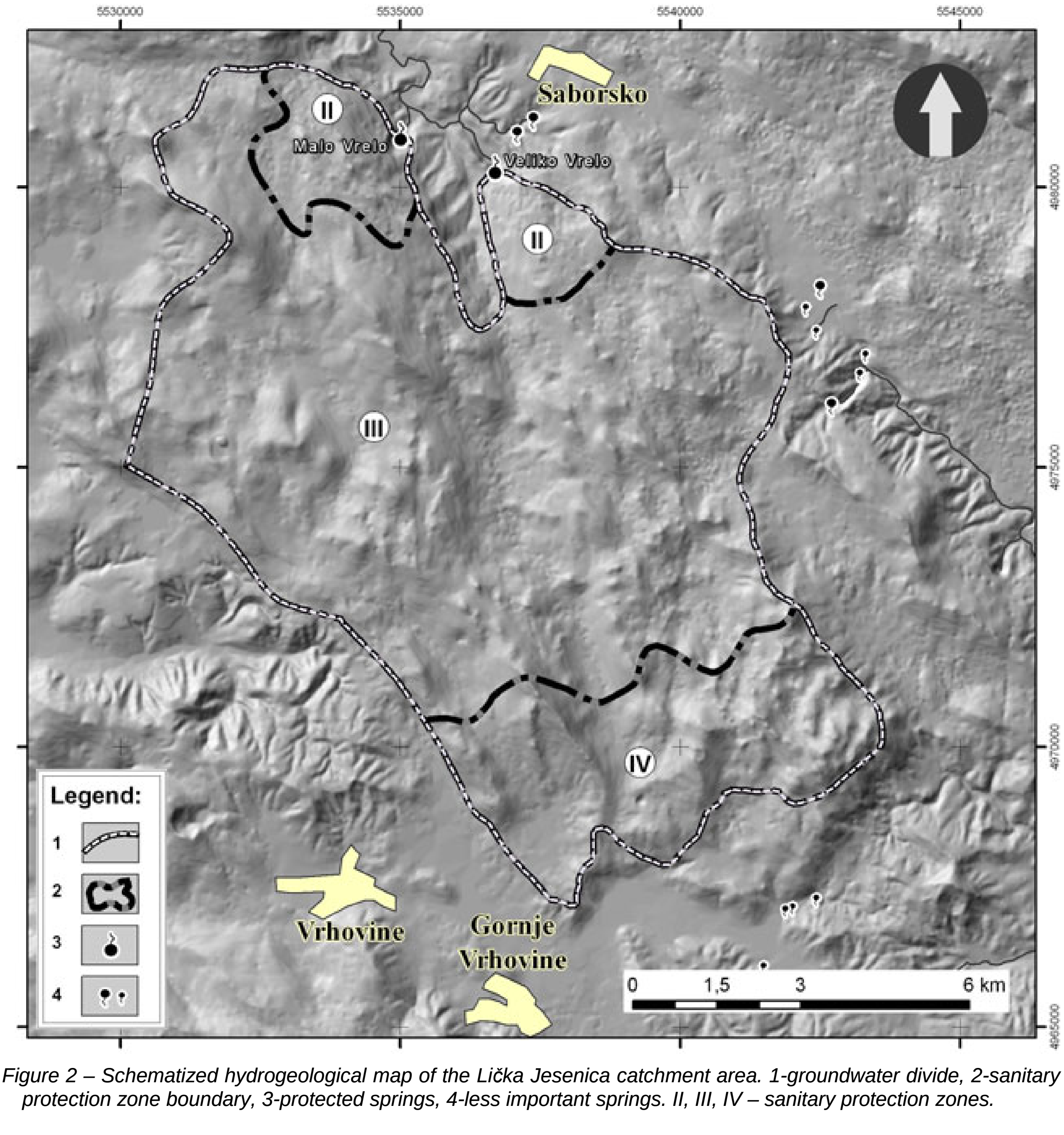

Figure 2 – Schematized hydrogeological map of the Lička Jesenica catchment area. 1-groundwater divide, 2-sanitary protection zone boundary, 3-protected springs, 4-less important springs. II, III, IV – sanitary protection zones.

CASE STUDY 2 – MILJACKA

The Miljacka spring is currently an extraction site for the public water supply of nearby settlements. The total amount extracted is 130 L/s; however, there are plans for further extension and to supply water to a larger area (using some 400 L/s).

Miljacka is a typical karst spring situated in the canyon of the Krka River, only a few meters away from the river itself. The canyon is 150 m deep and very steep-cut in a relatively undisturbed plateau built of Eocene-Oligocene "Promina" rock mass. The rock mass can be considered relatively permeable because it is fractured and karstified. In the hinterland, the aquifer is mostly built of limestones and dolomites of the Cretaceous, Jurassic, and Triassic periods. The hydrogeological relations of this karst system are very complex. Although the Miljacka spring is in the Krka River's canyon, it gets the major portion of its water from another river, Zrmanja. This has been proven with a tracing test (Fritz et al., 1986). The catchment area of the Miljacka spring has been researched many times in the past, and the results are very different (Komatina, 1967; Fritz & Pavičić, 1982, 1987).

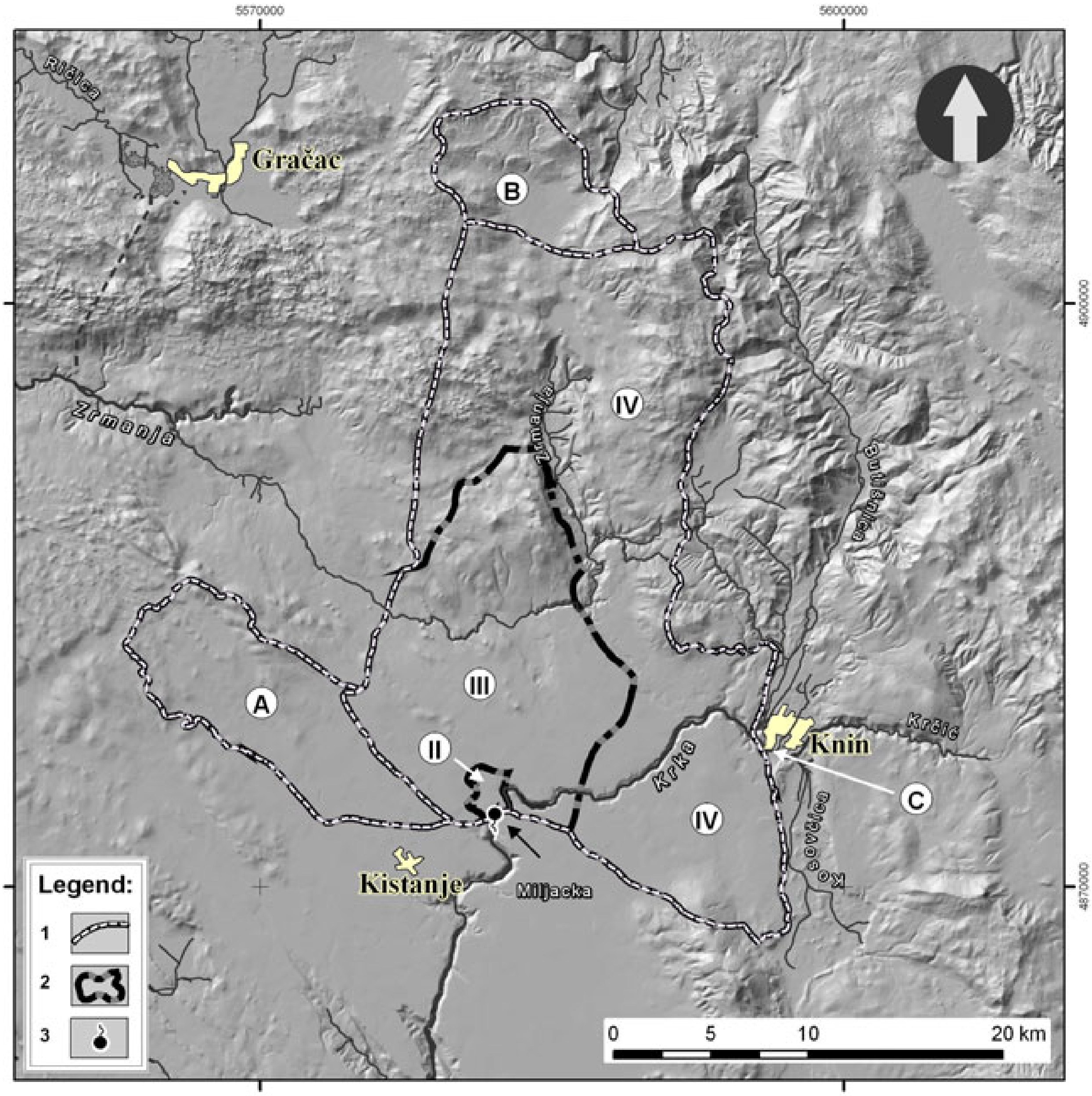

Figure 3 – Schematized hydrogeological map of the Miljacka spring catchment area. 1-groundwater divide, 2-sanitary protection zone boundary, 3-protected spring. II, III, IV – sanitary protection zones. A, B – questionable areas, possible part of the Miljacka catchment; C – direction of the Krka River surface flow impact.

After detailed hydrogeological mapping and hydrogeochemical research in the last few years (Terzić et al., 2008), this catchment has been determined to have an area of 516 km^2, with the observation that there is a significant influence from the Krka River, which cannot be omitted. In the subsequent research phases, the entire catchment of the Krka River, upstream from the Brljan retention, should be added, together with Krka's confluents Butišnica, Krčić, and Kosovčica.

In accordance with all the available data, groundwater sanitary protection zones are proposed. Open questions are emphasized, and these should be researched in the near future, enabling their addition into sanitary protection.

CONCLUDING DISCUSSION

The protected area of the Jesenica springs includes the entire catchment area (110.27 km^2). Nevertheless, protection of the Miljacka spring is limited only to a part of the catchment, and a significant part of the catchment in the east remains to be added after the next phase of investigation. The part of the catchment containing a portion of the inflow area is mostly built of carbonate rocks and is very permeable; it was determined to extend up to an area of 516.46 km^2. Only a part of the water collected on this huge surface actually discharges into the Miljacka. In contrast, in the west and north, there are small parts of the terrain whose credentials as belonging to the Miljacka catchment are questionable and have to be additionally researched. From the eastern part of the terrain (an arrow in the Figure 3), there is inflow of the Krka River into the karst terrain close to the Miljacka spring. In the riverbed, there are a few swallow holes noted, but these have never been traced. Although the majority of the groundwater flows from the north and the Zrmanja River, there is still the possibility that a certain percentage of the spring water originates from Krka. Therefore, the entire catchment region of the Krka River and its confluents Butišnica, Krčić, and Kosovčica, will have to be added to these proposed groundwater protection zones.

All the data collected during the bulk research in the two presented case studies have been deposited in the database and processed with the ArcGIS software package, which resulted in GIS-based cartography. The main goal is to create an interface, with ArcGIS as an interactive modeling environment. Regarding the areas of Lička Jesenica and Miljacka karst springs, establishment of groundwater sanitary protection zones has been the first step toward the significant improvement in land use of these wide karst catchments.

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Topic – Geological heritage and popularisation of geosciences

LANDSCAPES AND WINE

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KEY WORDS: Geology Wine International Year of Planet Earth

LANDSCAPE AND WINE AREAS

Geology and wine is one of the thematic projects within the International Year of Planet Earth
This project aims at explaining the deep and complex link between Earth Sciences and cultural heritage. Vineyard cultivation and wine production are strictly connected with the local geological context. This co*ncept is well known and shared:*
farmers and wine producers agree with geologists about the need of a complete and scientific *knowledge* of territory.
The study of a wine production area, starts usually from geological and geomorphological data as those that we can find in a detailed area map.
Geochemical and pedological analysis as well as *climatic* and *microclimatic* informations are indispensable to give an exhaustive description of a wine land.

- each wine has his own landscape: natural and cultural landscape.
- what is landscape? It's the image of the spatial organization of elements and structures.
- Landscape is the result of the interaction among physical, biotic and anthropic phenomena acting in a different spatial-temporal scales (Foreman & Godron)
- It's the image of the spatial organization of elements and structures

CARTA DELLA NATURA PROJECT

Mankind has his first approach with the environment, *viewing* and feeling the landscape. Shape is the synthesis of the endogenous and exogenous processes that mould earth surfaces.
Studying landscape is a complex thing. Maps are the most complete tools in order to have a deep knowledge and a clear image of the studied areas
The Carta della Natura project (a national project under the law 394/91) aims at assessing the state of the environment in the whole *Italian* territory,
The methodology follows an holistic approach, considering all the components of a landscape and integrating the information.

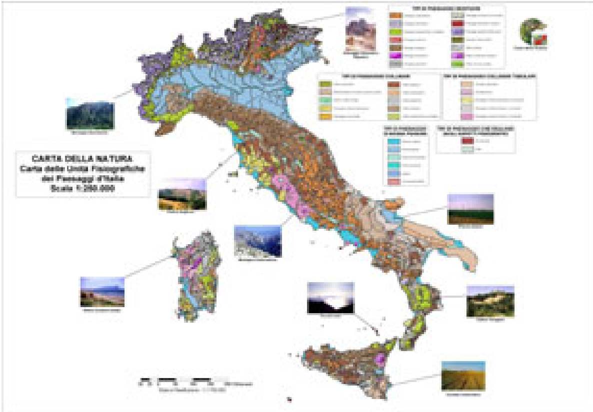

Figure 1 Physiographic Units Map of Italy and Landscapes.

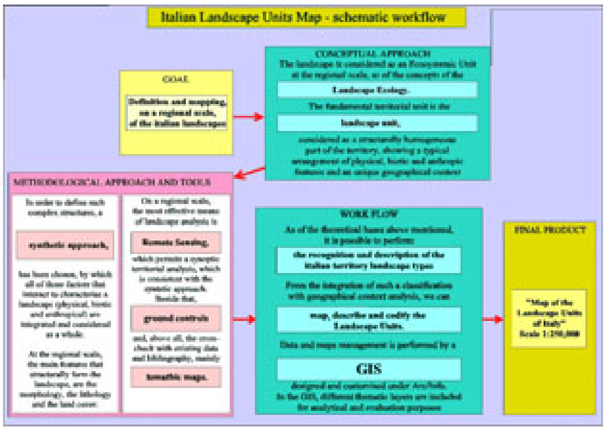

Figure 2 – Schematic workflow

Remote Sensing methods play a primary role in Landscape studies
Essential tools are: DEM, Hydrologic *modeling*, Thematic Maps, Lithology, Hydrography, Land Cover.
Geology, shape, roughness, hydrology, climate and land cover are studied using remote sensing;
Data and informations are organized in a Geographic Information System.
GIS are flexible, dynamic, updatable tools.
*D*ifferent scales of analysis allow to consider the object of study from different points of view.

In the “Carta della Natura” project, were chosen two main work scales, according to a *multiscalare* approach
1:250.000 for a regional level
1:50.000 for a more detailed analysis
The parameters considered are mainly related to the morphologic settings and to geologic and *land cover* settings: Elevation; Energy of Relief; Physiographic components; Drainage pattern.
At the 1:250.000 scale, Physiography is the feature that best approximates the results of a landscape classification performed following an holistic approach

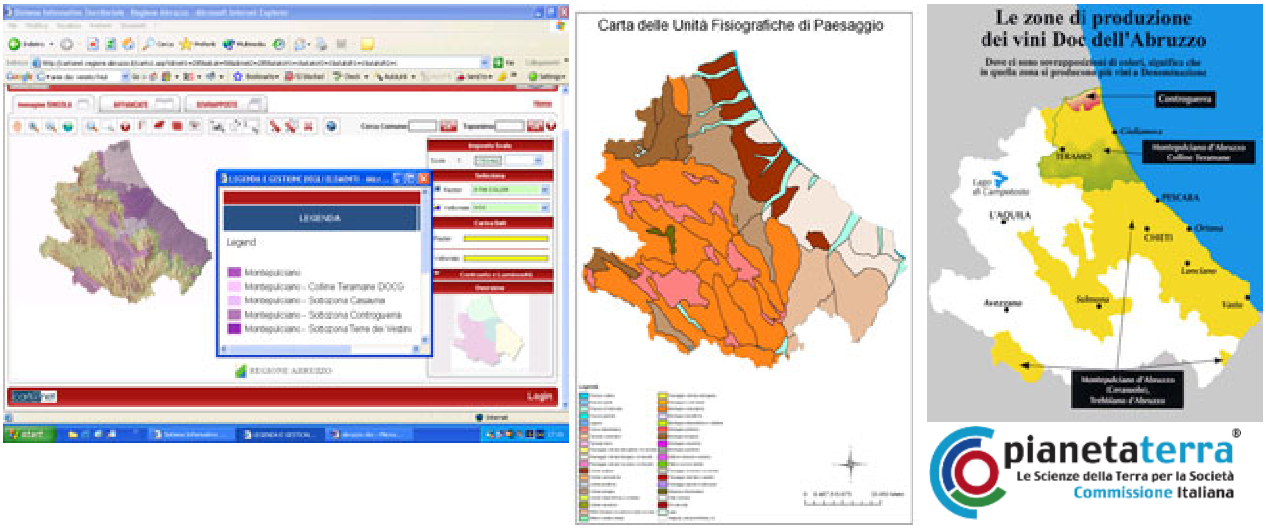

Figure 3 Physiographic Units Map of Abruzzo and D.O.C. wine areas

NATURE AND CULTURE

Landscape units are identified, described and and mapped on the entire *Italian* territory at 1:250.000 scale.
They are codified according to a special code of Landscape Types.
A “Landscape Type” is a typical association of land features *recognizable* at a regional scale
Integrating different maps and related data base we can find new information.
For *example*, considering the pattern of the “landscape units” we can make *hypothesis* on territorial planning, sustainable *development*; vineyard cultivation and wine producti*on referring to climate change,* in order to safeguard the landscape, increase and emphasize its quality level.
The Landscape is a resource. Quality of Landscape is an individual and social well-being chance.
The Landscape is everywhere an essential element of quality of life and cooperate in the development of local cultures (European Landscape Convention)

The link between Earth, *Landscape* and Wine is a link between Nature and Culture.
*I*t can be essential to try a new kind of popularization of scientific heritage, in order to involve the whole of society in a common action for a sustainable *development.*

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THE GEOTHEMATIC ATLAS OF SWITZERLAND: AN OVERVIEW OF GEOLOGICALLY RELEVANT MAPS FOR EVERYONE

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KEY WORDS: geological themes, interactive, atlas, datasets, overview.

MOTIVATION AND CHALLENGES

Geological information is made available for the purposes of recognizing and reacting to environmental problems, evaluating construction projects and natural resources, planning excursions and simply enjoying nature. Many users of this information are also producers and include various federal and state agencies, the energy industry, universities and private consulting offices. In Switzerland the production of this information is highly decentralised, so the vast number of different data sources signifies a wide variety of formats, qualities, accessibilities and visualisations. Coordinated and harmonised data sources can boost the efficiency and thoroughness of a geological investigation or inquiry (Spinatsch, 2004). For reasons of health, economy and general well-being, it is desirable that correctly selected geological information arrives punctually and exactly where it is required.

PROJECT DESCRIPTION

To help coordinate and harmonise geological information, the Swiss Geological Survey and its collaborators began last year to produce an atlas with a broad palette of themes relevant to geology (Beres et al. 2008). This atlas is aimed at a diverse audience and has the following goals:

- To maximise the availability, the accessibility and the number of customers of geology-related datasets.
- To raise the awareness of the availability and the use of these datasets in political and public domains.
- To sensitise the public to the importance of earth science by showing its relevance in everyday life.

Recent publications (Jackson, 2004; Hofmann & Schönlaub, 2007) show that particularly the last goal is best achieved by creating an atlas in the form of a book.

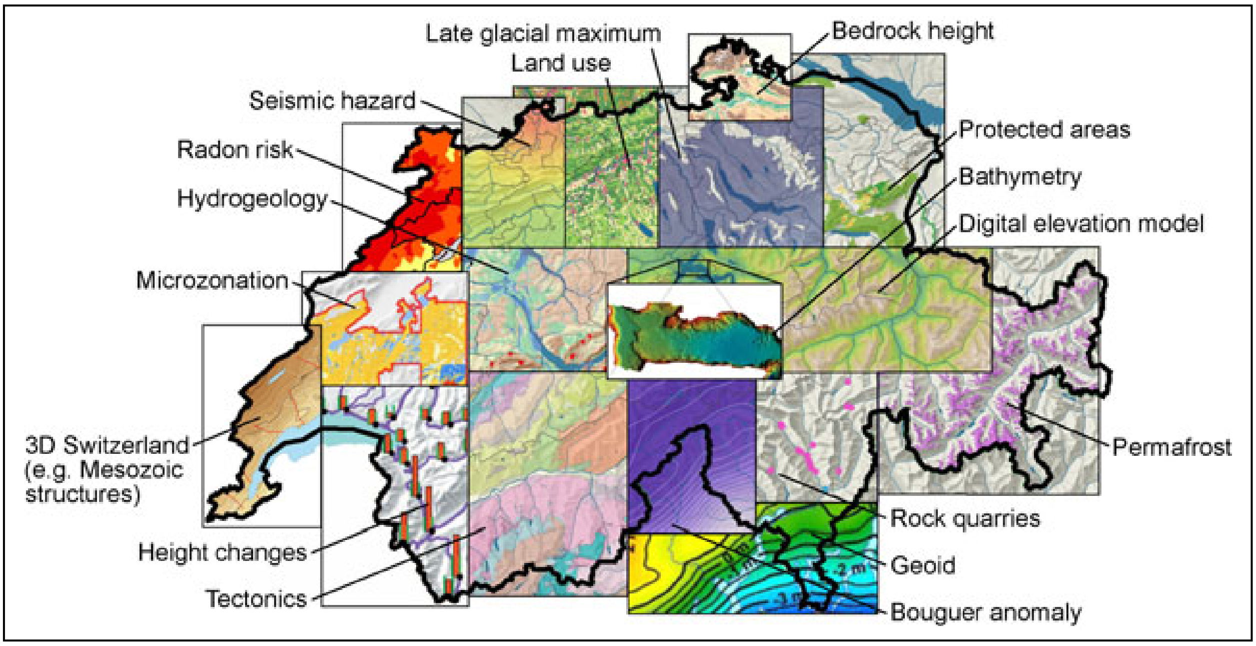

Figure 1 – Symbolic representation of the geothematic atlas. Data sources: www.bafu.admin.ch, www.bag.admin.ch, www.swisstopo.admin.ch, www.sgtk.ch, www.sgpk.ch, www.eawag.ch, www.boe-ag.ch, www.atlasderschweiz.ch.

The production of the geothematic atlas began with a feasibility study to evaluate possible themes (examples in Fig. 1), examine appropriate data bases and measure client needs. Acquiring, editing, visualising, harmonising and updating datasets belong to some of the major tasks (Fig. 2). It is also important to coordinate various institutions (e.g. federal and cantonal offices, commissions, private companies and universities) and to strengthen national and international collaboration. As one of the ongoing projects of the Geological Information System of Switzerland (Oesterling et al., 2009), this atlas is expected to give an outline of current knowledge and to help clarify where there is a need to produce more data and information.

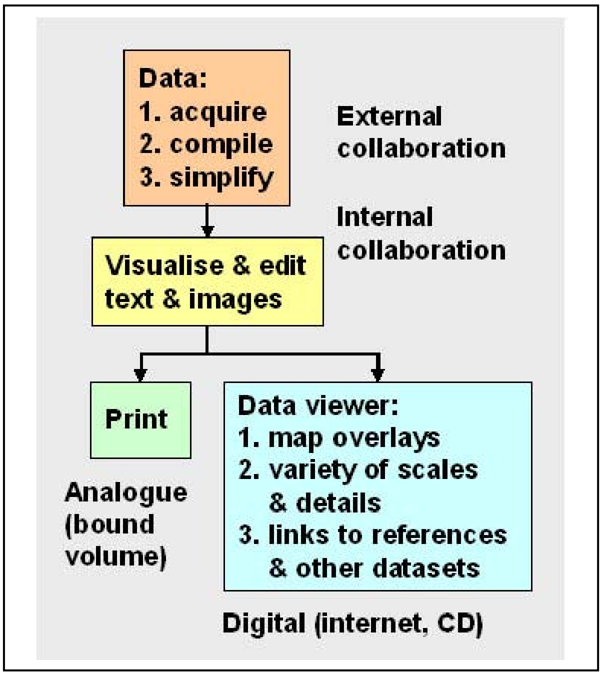

Figure 2 – General work flow for the atlas production.

For providing supplementary details and visualisation, interactive internet applications such as the Geological Data Viewer are an important component of the project (Fig. 2). This viewer embodies the visual access to numerous datasets of the Swiss Geological Survey and other institutions in the field of earth sciences. It also allows a limited spatial analysis and the possibility to examine data at various scales, and it gives direct links to further information, such as references, publications and other metadata. The revolutionary development of GIS technology in recent years has opened many possibilities for publishing an attractive, interactive and wide-ranging geothematic atlas.

CURRENT RESULTS

Presently, the atlas has about 60 themes, which are categorised into the following four basic groups:

- Earth fundamentals (e.g. tectonics, stratigraphy, bathymetry, soil types, magnetic field, gravity anomalies and topography).
- Construction and resources (e.g. hydrogeology, land use, geothermal energy and various types of rock quarries).
- Natural hazards (e.g. earthquake risk, permafrost, mass movements, radon risk and other geochemical threats).
- Geotourism (e.g. show caves, glacial features, geotopes, hiking trails, geoparks and other protected areas).

A symbolic representation of the atlas (Fig. 1) illustrates some of these themes. Surface phenomena and features (e.g. topography, land use and precipitation) are also linked with geological processes and are therefore taken into account.

Following the approach of Sieber & Huber (2007) for creating a general atlas, each theme includes systematic map displays, clear but brief descriptions, an instructive map index and relevant images (Fig. 3). According to the preliminary layout, two pages are reserved for each theme. The left page shows the dataset on a map of Switzerland. Topography and, in the case of point-data, a simplified geology may serve as the background. This page also includes the legend, logos, references and internet addresses. The right page presents the title, the theme's category, explanatory text and carefully selected diagrams and photographs. Explanations are kept in simple, understandable terms and include the definition and theoretical background of the theme, the purpose of using the map and the methods of producing the map.

Since Switzerland is a multilingual country, a column of text in German and a second column of the same text in French are necessary. A summary of the text in English would be particularly helpful for international readers. Alternatively, the English summary may be omitted in order to gain more space. In this case, an electronic version of the entire atlas would be made available in English and Italian on a CD attached to the inside cover.

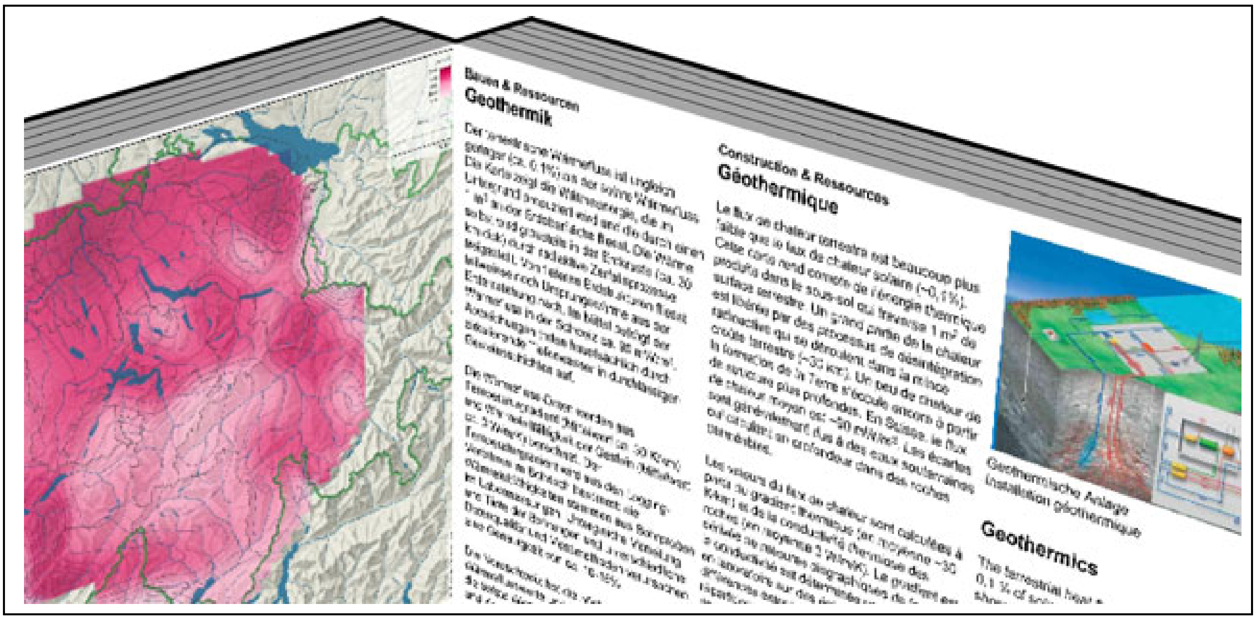

Figure 3 – Preliminary layout of the atlas showing geothermics as the selected theme.

CONCLUSION AND OUTLOOK

In summary, Switzerland's geothematic atlas is intended as an attractive and informative overview of datasets with geological relevance and is expected to highlight the country's unique natural features. It should sensitise a broad audience as well as symbolise and strengthen national and international coordination. When considering today's increasing mobility and pace of durable development, the production of such an atlas may be an important topic in other countries. Eventually, these atlases could also serve as a tool to harmonise the production of maps on an international level.

ACKNOWLEDGEMENTS

The authors are grateful to Dr. Nils Oesterling for contributing helpful ideas, comments and guidance.

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LANDSCAPE AND GEOHERITAGE: A STARTING POINT FOR POPULARISING GEOSCIENCE

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KEY WORDS:
geological heritage, landscape, website, webgis, geosites, regional law,thematic maps geo-environmental trails, geotourism, environmental protection

Geological heritage and popularisation of geoscience

Introduction

In order to meet society's increasing need for information on geo-environmental matters, the Emilia-Romagna Geological Survey (Servizio Geologico, Sismico e dei Suoli - SGSS) has launched a comprehensive outreach programme to share the knowledge base it has built up in the field of Earth Sciences.
The SGSS is a regional technical-scientific body which coordinates and promotes activities in the field of earth sciences, natural resources and geo-natural hazards. The SGSS collect and elaborate the necessary quality-controlled data, turning it into information and knowledge and making the latter available to support policy makers and the needs of society.

Outreach programme

This programme is addressed to both public administration, technicians and professionals, focusing on the use of geological and soil maps, thematic maps derived from these and their applications. Maps designed for sector operators are freely accessible for consultation on the cartographic website which, for several years now, has been publishing maps produced by the SGSS:http://www/wcm/geologia/canali/cartografia/sito_cartografia/sito_cartografia.htm
Furthermore, the SGSS strives to educate the public at large through its website http://www.regione.emilia-romagna.it/geologia
and several other media, including: maps of geological-environmental itineraries, documentaries, educational CDs, travelling exhibitions and the publication of books and information leaflets on key geo-environmental themes.
With these initiatives, the priority is to understand how to explain the basic concepts of geoscience to the general public. We know that generally Geoscience *seems* to deal with matters that are far removed from everyday life. Therefore we believe that a multidisciplinary approach has to be used to bridge the gap between geoscience and society. Firstly, the SGSS worked to make geo-information available to the public through an attractive format and language that is easy to understand. To achieve this goal, the SGSS created a working group (comprising geologists, graphic artists, social science experts , educators) to find the best communication strategy for each kind of end-user (school children, citizens, young people, tourists, politicians, etc.). Secondly, it was important to consider how ordinary people can experience the basic concepts of geoscience in their own lives. Our experience has demonstrated that landscape is a powerful tool for the dissemination of geoscientific information to the general public.

Figure 1 – .Geological heritage of Emilia-Romagna

Geological heritage (fig.1) is the basic element of the landscape and it often has strong links with other elements of the territory like history, agriculture, environmental aspects, gastronomy and so on. An important link is undoubtedly with the environmental protection metter because the most part of the protected areas of the Emilia-Romagna Region, as well as the sites of natura 2000 network (with their habitats*)*, are principally founded above peculiar geological features. Consequently, a lot of geological heritage elements are included into these important naturalistic sites;
For these reasons, SGSS decided to strengthen the territorial dimension of the outreach programme, linking the aspects mentioned above,

to the census of the Emilia-Romagna geological heritage.
The census is a scientific project that has been carried out starting from data collected over more than 25 years of regional geological mapping (1:10.000 to 1:25.000 scale). A digital database stores all the information about the "regional sites of geological interest" (more than 700 to date) facilitating the production of innovative geological maps and other products.

Figure 2 – Exemple of geosite: Triassic gypsum and Bismantova stone.

In 2006 Emilia-Romagna regional authority introduced a legislation (Regional Law n°9/2006**)** intended to safeguard and valorize regional geodiversity identified through the above census. This legislation acknowledges that it is in the public interest to safeguard, manage and valorize Emilia-Romagna's geodiversity as well as the geological heritage associated with the latter, since these are of inherent scientific, environmental, cultural and touristic-recreational value. The objective is therefore to promote awareness, sustainable public access and use of sites, educational use of places of geological interest, caves and geological landscapes and to support those groups and individuals (associations, voluntary groups, regional professionals, universities, etc.) who, together with the general public, help achieve these objectives.
The SGSS fournished all the data collected in the census to the province administrations, who can use them for town-and-country planning.
In addition to the census, and with a view to ultimately producing simplified geological maps for non-geologist users, the SGSS compiled The "Emilia-Romagna Geological Landscape Map", 1:250.000 scale (Fig. 3 and 4).
This map emphasizes the strong relationship between geology and landscape, showing how different rocks produce different features and different behaviour of the territory. The map shows the basic concepts of geoscience by looking closely at the landscape we see in front of us every day.
From the coast to the Appenine watershed, the map identifies thirteen geological landscape units characterized by the presence of specific geological units and particular geomorphological characteristics.

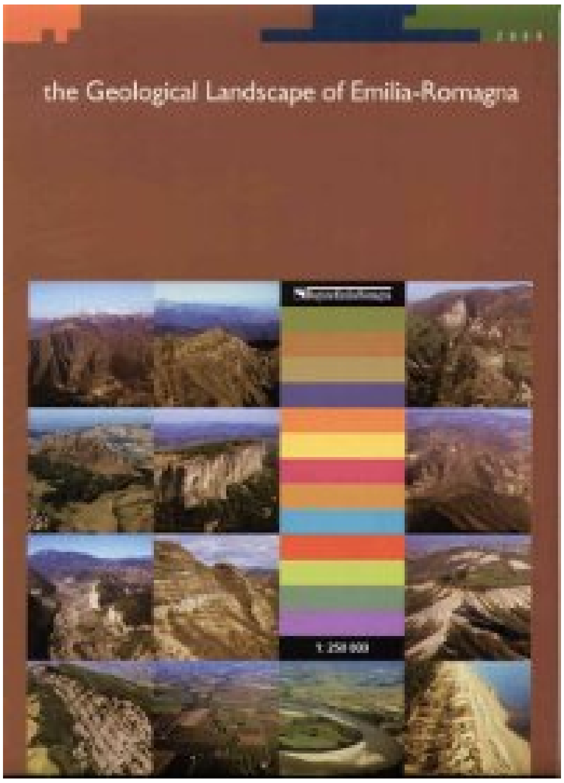

Figure 3 – The Emilia-Romagna geological landscape map; 1:250.000 scale. Map cover

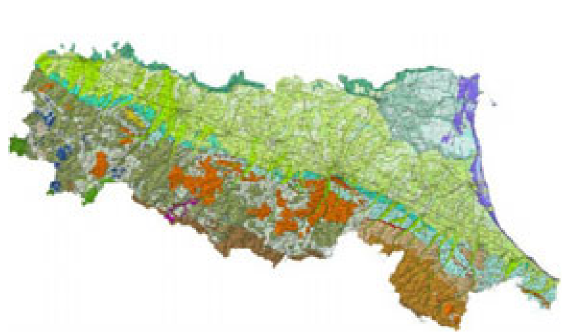

Figure 4 – The Emilia-Romagna geological landscape map; 1:250.000 scale

In order to make information derived from the census of geosites user-friendly and easily available to the general public, a webGIS website of the region's "geological heritage" was created. In the background, the website features the geological landscape map, pinpointing the various geosites located throughout the region. For each geosite identified, an explanatory chart contains a description of its characteristics, the reference geological map (1:10.000 scale), one or more photos and further in-depth documents. The project aims to make the portal the most popular website for geological-touristic consultation in our region. To this end, the website will be enriched with information on places of historical interest (castles, fortifications, archaeological sites), museums, geo-environmental itineraries, eno-gastronomic trails, whose locations are inextricably linked to the geological nature of the territory.

This project, which sees us work in tandem with a number of categories (e.g. agritourisms, parks, provincial authorities, universities….) and links geological information to other fields and disciplines (public administration, tourism and agritourism, schools), has enabled us to educate an ever large public about our work.

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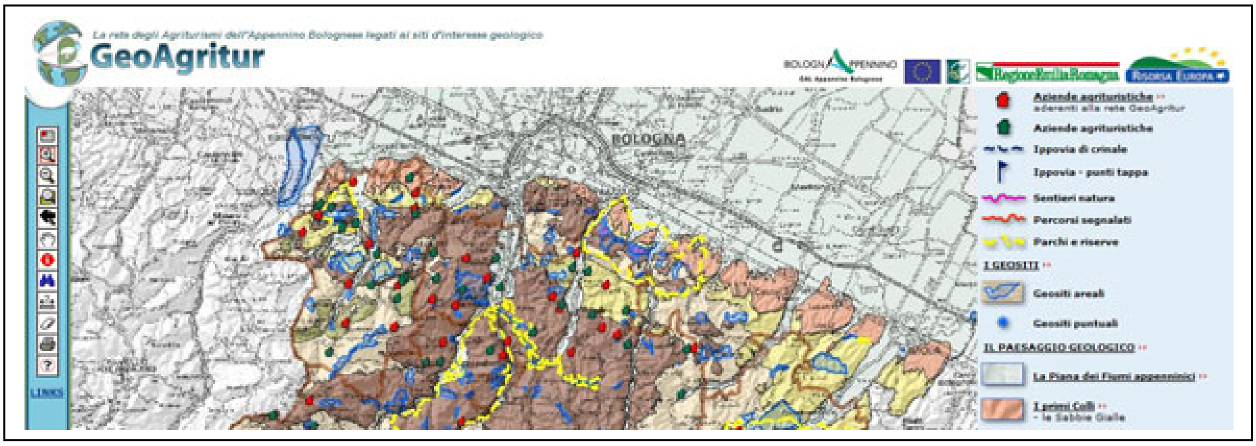

Figure 5 –"GeoAgritur" website: Home page .

One example of this integration is the GeoAgriTur project which, since its launch in 2008, has used the Internet in order to bring the general public information on geosites of the Bolognese Appenines and agritourism companies involved in the project.

Browsing the cartographic website **http://geo.regione.emiliaromagna.it/gal/viewer.htm,** (fig.5) users can access scientific information on places of intrinsic geological interest, get suggestions on trails that can be tackled on foot or on horseback and learn about the educational services offered by agritourism companies which are members of the GeoAgritur network.

Lastly, as part of the geological popularization project, we will continue to establish an increasing number of geological-environmental trails in the region in order to allow the general public to gain direct knowledge of our geological heritage through personal experience of the land. These trails, some of which are located in natural parks, will feature information panels along the way explaining the local geology; the panels will be designed with eye-catching graphics and language that is easy to understand in order to appeal to as wide a public as possible. The project mission is to establish trails across the whole territory which focus on the geological aspects of our region, as yet another way of popularizing geoscience.

Conclusion

The landscape is a powerful tool for bringing geological knowledge within the grasp of non-geologist users. The strong relationship between geology and landscape, when linked to other territorial elements, has the potential to stimulate citizens to re-appropriate the values of the territory's heritage, encouraging their participation in the territory's cultural revitalization and environmental protection.

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GeoAgritur website: http://geo.regione.emilia-romagna.it/gal/viewer.htm

Geological, seismic and soil Survey website: http://www.regione.emilia-romagna.it/geologia

THE GEOSITE "I SALTI DEL DIAVOLO" AND THE HIKING TRAIL "LA VIA DEGLI SCALPELLINI" (VAL BAGANZA – ITALIA)

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KEY WORDS: Geosites; Geology and Tourism; Cretaceous; Stonemasons; Devil's Jumps; Hiking Trail; Via Francigena

I SALTI DEL DIAVOLO

I Salti del Diavolo (The Devil's Jumps) are the emerging in the Baganza Valley (IT) of a Sedimentary Formation of the Cretaceous Age, which is irregularly visible, along the northern Apennine Ridge, at the base of the Monte Cassio Flysch Unit. Here the Formation appears as an alignment, about 5 km long, of narrow spikes and rocky faces (*The Devil's Jumps*) emerging sharply and abruptly from the surrounding fields and woods. From the sedimentary point of view I Salti del Diavolo are constituted by a decreasing granulometry succession of conglomerates and sandstones that derive from the crumbling of petrographically heterogeneous rocks.

LA VIA DEGLI SCALPELLINI

The compact sandstone of the top was exploited starting from the Middle Age by the stonemasons of the area to realize sculptures and architectural constructions that still embellish the villages of Baganza Valley and the romanesque parishes situated along *Via Francigena* (a pilgrim road to Rome coming from England and France), while the conglomerate at the base was used to make grindstones for the water mills once working along the Baganza stream.

Aiming to promote the peculiar landscape and the natural and local history of the Geosite, the Province of Parma, in 2007, realized an hiking trail, with touristic facilities and informational notice boards, named "La Via degli Scalpellini" (Stonemason's road). The hiking trail runs close to the emerging of the Devil's Jumps and it links the two opposite hillsides of Val Baganza retracing the path used, until the 50s of the last century, by local stonemasons to gain the rock extraction sites spread all along the ridge. The Baganza stream crossing is guaranteed by an hanging footbridge from where it is possible to enjoy an amazing panorama of the Salti's outcrop that emerges like a barrier from the creek bed. The path offers two departure points, with facilities for tourists, and it's linked with the Via Francigena, an excursion axis of European relevance that traces the homonym road used during the Middle Age by the pilgrims coming from England and France to reach Rome.

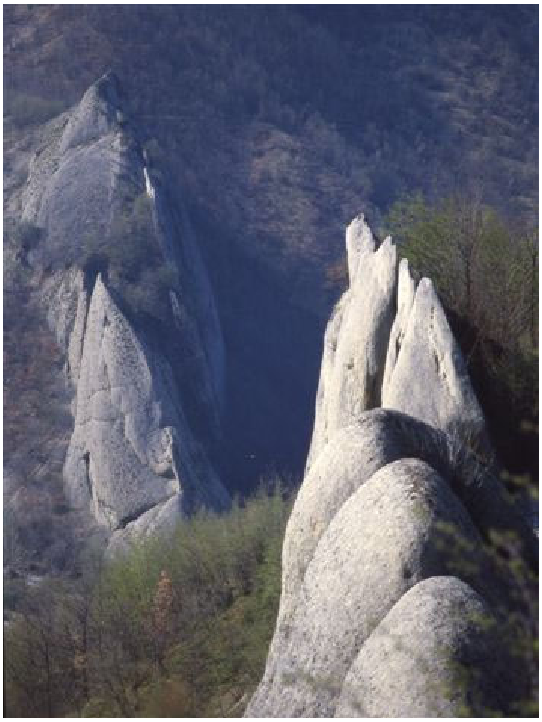

Figure 1 – I Salti del Diavolo.

Along the way, some informational notice boards illustrate with texts, graphics and pictures, the geological emerging and the ancient modalities used by local stonemasons to mine and work the stones. While walking in the stonemason footprints, it's now possible to discover the traces that centuries of hand-mining left in the rocks of the Devil's Jumps and read in the rocks themselves the much deeper history that caused their formation and their subsequent shaping in the present form.

Figure 2 –An Informational board along the hiking trail

Figure 3 –An Informational board near a conglomerate pit for grindstones extraction

Figure 4 –The footbridge over the River Baganza and a "Devil's Jump"

ACKNOWLEDGEMENTS

Many thanks to prof Giorgio Zanzucchi and Edvige Masini of University of Parma.

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GEOPARKS – A NEW TOOL FOR THE PROMOTION OF EARTH SCIENCES

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KEY WORDS: Conservation, Education, Sustainable Development, Geoheritage, Landscapes, Geotourism

SUMMARY

After recently being asked to define a *Geopark* by several geoscientists, it was clear that this concept may require some more information as an introduction to this new geo-initiative.

A Geopark is a geographical area where *geological and geomorphological heritage* sites are part of a holistic concept involving conservation, education and sustainable development. As well, non-geological themes are an integral part of a Geopark, especially when their significance to landscape and geology can be demonstrated to visitors. For this reason, sites of ecological, archaeological, historical and/or cultural value are included. In many societies, natural, cultural and social (industrial) history is inextricably linked, and thus, cannot be separated.

Geoparks that are part of the UNESCO-assisted "Global Network of National Geoparks" were launched in 2004 and based on the successful model established by the European Geoparks Network in 2000. The Global Geoparks Network aims to:

- preserve their geoheritage for present and future generations;
- educate the general public about issues in geological sciences and their relation to environmental matters;
- ensure sustainable socio-economic and cultural development;
- foster multi-cultural cooperation for heritage and conservation and the maintenance of geological and cultural diversity, using participatory schemes and co-partnerships;
- stimulate research when appropriate;
- contribute actively to the life of the Network through joint initiatives (e.g. communication, publications, exchange of information, twinning, participation in meetings)

Since Geoparks are set up under various management authorities in order to conserve significant geological and geomorphological features, this of course, can lead to collaborating, if and when appropriate, with universities, geological surveys and the relevant statutory bodies. Thr Network provides a platform of cooperation between experts and practioners in geological heritage.

Public outreach activities and programs are created to communicate geoscientific knowledge and environmental concepts at the geological site. This is achieved by establishing museums, information centres, walking trails, guided tours, school excursions, and seminars, as well as producing informative literature, maps, educational materials and displays for a broad public audience.

Many sites comprise rare or aesthetically appealing features. The local natural heritage in each Geopark attracts an increasing number of visitors, and logically this triggers the creation of local enterprises and cottage industries involved in geotourism. The Geoparks concept goes a step further to foster scientific research and to cooperate with universities, as well as with governmental geo- or environmental-oriented research institutes. As a result, a Geopark stimulates economic activity and sustainable development through geotourism to the site.

Under the umbrella of UNESCO important national geological sites are gaining worldwide recognition. Since 2000, 57 Geoparks from 17 countries have been set up in Australia, Austria, Brazil, China, Croatia, Czech Republic, France, Germany, Greece, Ireland, Italy, Iran, Malaysia, Norway, Portugal, Romania, Spain, and the United Kingdom.

Further information can be obtained through UNESCO's Geopark Secretariat, Division of Ecological and Earth Sciences, Margarete Patzak, 1 rue Miollis, 75015 Paris, France, or the following websites:

- www.unesco.org/science/earth/geoparks
- www.europeangeoparksnetwork.org

Global UNESCO Network of Geoparks

According to national and international initiatives, like the "International Declaration of the Rights of the Memories of the Earth" (Digne, France 1991), the IGCP, IUGS, ProGeo, Malvern Group, UNESCO's Division of Earth Sciences and the Council of Europe, an international group of experts on Geoparks recommended the establishment of a "Global Network of National Geological Parks (Geoparks) seeking UNESCO's assistance" in order to promote the three goals of conserving a healthy environment, educating in Earth Sciences at large, and fostering sustainable economical local development.

In February 2004 the UNESCO international group of experts assembled in Paris where the following items were discussed and decided:

a) the establishment of a Global UNESCO Network of Geoparks
b) the acceptance of the Operational Guidelines for application on the global Network.

It was also decided that the existing 17 European Geoparks and 8 new Chinese Geoparks be included in the Global UNESCO Network of Geoparks.

As a result the "First International Conference on Geoparks" was held in Beijing, China from 27 to 29 June 2004, in order to promote the establishment of a worldwide network of national Geoparks with the contributions from the international governmental and non-governmental community.

In October 2004 during the 5th European Geoparks Meeting held in Petralia Sottana, Madonie Geopark, a new agreement between the Division of Earth Sciences of UNESCO and the European Geoparks Network was officially signed.

According to this agreement:"A European territory wishing to become a member of the UNESCO Global Network of Geoparks must submit a full application dossier to the European Geoparks Network, which acts as the integration organisation into the UNESCO Network for the European continent.

The Division of Earth Sciences of UNESCO recognises that the European Geoparks Network is the reference to follow for the creation of other continental networks of geoparks."

The foundation of the Unesco Network of Geoparks

On Friday 13 February 2004 a meeting on geoparks was held in UNESCO Headquarters in Paris. In the meeting participated members of the Scientific Board of the IGCP, representatives of the International Geographical Union (IGU) and the International Union of Geological Sciences (IUGS), and international experts on geological heritage conservation and promotion. The following items have been discussed and decided:

Presentation and establishment of the "Operational Guidelines for National Geoparks seeking UNESCO's assistance" (Global UNESCO Network of Geoparks)
The establishment of a Global UNESCO Network of Geoparks.
The foundation of a Coordination Office for the Global UNESCO Network of Geoparks at the Ministry of Land and Resources in Beijing China.
New geoparks are invited to send their application respecting guidelines and criteria upon to UNESCO's Division of Earth Sciences, that will forward it to the International Advisory Group.
If there is a Geopark network on a national level existing, the applicant geopark has to be first member of this network.
For Europe the already established cooperation agreement between UNESCO's Division of Earth Sciences and the European Geoparks Network, shall serve as the mechanism for integration national Geoparks through the label of European Geoparks into the global UNESCO Network.
The Division of Earth Sciences is encouraged to confirm or initiate agreements at a regional (continental) level using the cooperation agreement with the EGN as an example.
During a closed meeting of the International Advisory Group of Experts the evaluation of the existing geoparks took place. It was decided to include 17 European Geoparks and 8 Chinese Geoparks in the Global UNESCO Network of Geoparks .

Members of the Global Network of Geoparks (November 2008)

57 National Geoparks (33 European, 20 Chinese, 1 Brazil, 1 Iran, 1 Malaysia, 1 Australia) are

currently members of the Global Network of Geoparks assisted by UNESCO.

Network Members:

1. Mount Lushan Geopark - PR China
2. Geopark Wudalianchi - PR China
3. Songshan Geopark - PR China
4. Yuntaishan Geopark - PR China
5. Danxiashan Geopark - PR China
6. Stone Forest Geopark – Shilin Geopark - PR China
7. Zhangjiajie Sandstone Peak Forest Geopark - PR China
8. Huangshan Geopark - PR China
9. Reserve Géologique de Haute Provence – France http://www.resgeol04.org/
10. Petrified Forest of Lesvos – Greece http://www.petrifiedforest.gr/
11. Vulkaneifel European Geopark – Germany http://www.geopark-vulkaneifel.de/
12. Maestrazgo Cultural Park – Spain
13. Psiloritis Natural Park – Greece http://www.psiloritis.net.gr/
14. Nature park Terra Vita European Geopark – Germany
15. Coper Coast – Ireland
16. Marble Arch Caves European Geopark– Northern Ireland, United Kingdom
17. Madonie Natural Park – Italy http://www.parcodellemadonie.it
18. Kamptal Geopark – Austria www.krahuletzmuseum.at
19. Nature Park Eisenwurzen – Austria http://www.geoline.at/
20. European Geopark Bergstrasse–Odenwald - Germany www.geo-naturpark.de
21. North Pennines AONB – United Kingdom http://www.northpennines.org.uk/
22. Abberley and Malvern Hills Geopark – United Kingdom www.worc.ac.uk
23. Park Naturel Régional du Luberon – France
24. North West Highlands – Scotland, UK
25. Geopark Swabian Albs – Germany
26. Geopark Harz Braunschweiger Land Ostfalen – Germany
27. Mecklenburg Ice age Park - Germany
28. Xingwen National geopark– P.R. China
29. Hexigten National geopark– P.R. China
30. Yandangshan National geopark– P.R. China
31. Taining National geopark– P.R. China
32. Hateg Country Dinosaur Geopark - Rumania
33. Parco del Beigua - Italy
34. Fforest Fawr Geopark - Wales UK
35. Bohemian Paradise Geopark - Czech Republic
36. Qeshm Island - Iran
37. Subeticas Geopark - Spain (July 2006)
38. Sobrarbe Geopark - Spain (July 2006)
39. Cabo de Gata - Spain (July 2006)
40. Naturtejo Geopark - Portugal (July 2006)
41. Gea-Norvegica - Norway (July 2006)
42. Araripe Geopark – Brazil (September 2006)
43. Fangshan Geopark - Hebei Province, P.R. China (September 2006)
44. Leiqiong Geopark (Heinan Province, P.R. China (September 2006)
45. Funiushan Geopark (Henan Province, P.R. China (September 2006)
46. Wangwushan-Daimeishan Geopark an Province, P.R. China (September 2006)
47. Jingpohu Geopark - Heilongjiang province, P.R. China (September 2006)
48. Taishan Geopark - Shandong province, North east, P.R. China (September 2006)
49. Geological, Mining Park of Sardinia – ITALY (April 2007) http://www.parcogeominerario.eu
50. Papuk Geopark – CROATIA (April 2007)
51. Lochaber Geopark – Scotland UK (April 2007)
52. Langkawi Geopark – Malaysia (June 2007)
53. English Riviera Geopark - England UK (September 2007)
54. Longhushan Geopark - P.R. China (November 2007)
55. Zizong Geopark – P.R.China (January 2008)
56. Adamello Brenda Geopark – Italy (April 2008)
57. Kanawinka Geopark – Australia (June 2008)

A LITHOLOGICAL DIVERSITY INDEX FOR MAPPING THE SPATIAL DISTRIBUTION OF GEODIVERSITY

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KEY WORDS: geodiversity index, lithotypes, central Italy.

INTRODUCTION

The aim of this work was to assess and describe the spatial distribution of lithological geodiversity across the Lazio region (Central Italy). Covering approximately 17,200 km^2, and encompassing the Country's capital Rome, the Lazio region is one of Italy's first level administrative units. Located along the Tyrrhenian coast, it is characterised by coastal plains in the western part, by some large lakes of volcanic origin in the northern and central parts, and by a portion of the Apennines chain as well as by other smaller mountain groups. A GIS-based modeling approach was applied to perform a multiparametric analysis of those variables assumed to be the most significant in describing the lithological diversity of the study area. A geodiversity index can be defined as a measure of the variability of geological features and abiotic processes in a given area. We considered the lithological geodiversity, that is the component of geodiversity *latu sensu* explained by the variability of lithotypes found within the Region. In particular, we devised an index to combine into a single numerical value three main parameters directly related to three important facets of the spatial patterns of lithologies, i.e. rarity, diversity and fragmentation. Relative weigths, correlated to the presumed importance of these parameters in obtaining a comparative evaluation of the spatial patterns of the lithological component of geodiversity, were used to combine them into a single numerical index, which was then calculated at two different resolution levels for the entire study area. The analysis provided useful insights into the patterns and features of geodiversity within the area under investigation, which will feed into spatial planning activities aimed also at preserving the geodiversity heritage of the region. The model can be easily applied to other geographic contexts, provided that baseline data on the lithology of the target area are homogeneously and consistently available.

METHODOLOGY

All analyses were performed at two different resolution levels, i.e. 1-km and 5-km, using two reference grids based on the UTM coordinate system. Once the two grids were defined, the first step in the analysis was to select the parameters useful to evaluate the lithological geodiversity of the Lazio region, taking into account the quality and accuracy of the available baseline layers. In fact, all parameters were derived from the 1:25.000 Geological map of the Lazio region (UNIVERSITÀ' ROMA TRE, 2003), which currently represent the most updated and accurate layer available for the entire region. The entire region's territory was considered, even though we did not take into account areas covered by sea or permanent water bodies, areas covered by debris resulting from human activities (as they were not representative any more of geological processes) and areas pertaining to the territory of the Vatican State.Lithological geodiversity was considered as the weigthed combination of the three following parameters:

- Rarity of lithotypes.
- Diversity of lithotypes.
- Fragmentation of lithotypes.

Each cell of the two reference grids was assigned numerical values quantifying the above-mentioned parameters within the cell itself (see details below on how such values were calculated for each parameter). Absolute values for each parameter were then converted into 1 to 5 scores using classes defined based on different criteria: for the lithological rarity, classes were defined on a logaritmic scale, in order to highlight less common lithotypes, as rarity of a lithotype was inversely proportional to the surface area. For the other two parameters classes were defined as natural intervals (JENKS, 1963). In this case, as classes were defined based on the absolute range of values observed across all cells, different classes had to be used when performing the analysis at different resolution levels. Scores calculated for each parameter were then scaled using a weigth factor, assumed to describe the relative importance that each parameter has on the regional scale. They were then combined to obtain a normalised index of lithological geodiversity. It is obvious that the model is based on an empirical approach, and not on the application of a pre-defined algorithm. The model was however carefully refined and calibrated, with the general aim of devising a tool that could generate output values as objectively as possible, and that could provide reliable when applied at different scales or to different geographic contexts.

LITHOLOGICAL RARITY

The lithological rarity (LR) score was based on the rarest lithotype found, among the 38 different lithotypes recorded for the region, within each cell as follows: each lithotype was first given a rarity score, based on the percentage of the whole region covered by the type itself. Such scores were assigned according to intervals defined on a logarithmic scale, with higher values assigned to the rarest classes and lower values given to the most commnon lithotypes (see table 1). Each cell of the reference grids was then assigned the highest score among those assigned to all lithotypes found within the cell itself. Using the highest score allowed to obtain values emphasizing the occurrence of rare lithotypes, whose presence would have been masked by more common types should the score had been based on the average of scores.

% of Region covered by Lithotypes	LR score	Description
0,001 – 0,01	5	Very rare
0,01 – 0,1	4	Rare
0,1 – 1	3	Fairly rare
1 – 10	2	Common
10 – 100	1	Very common

Table 1 – Classes used to assign rarity scores to lithotypes.

LITHOLOGICAL DIVERSITY

The lithological diversity (LD) value was assigned to each cell by using the Shannon's Diversity Index (SDI) applied to the surface of each cell occupied by the different lithotypes (MCGARIGAL & MARKS, 1994). For each cell the index, with values ranging between 0 and ∞, was therefore calculated as follows:

- SDI = - ∑ (Ai / A) Lg2 (Ai / A)

Where "A_i" is the total area covered by all patches of lithotype "i" found within the cell and "A" is total area of the cell. For cells along the region boundary, or for those cells partially covered by water bodies, the area of the cell was given by the sum of the patches covered by lithotypes, therefore excluding the surface not covered by any class or without data. SDI values were then converted into Lithological Diversity scores, ranging between 1 and 5, according to classes defined by a natural interval subdivision (JENKS, 1963) of the overall range of values (see table 2 for classes used to assign scores on the 1-km grid).

SDI values	LD score	Description
1,66 – 2,92	5	Extremely diverse
1,19 – 1,65	4	Highly diverse
0,75 – 1,18	3	Diverse
0,29 – 0,74	2	Moderately diverse
0,00 – 0,28	1	Low diversity

Figure 3 – Classes used to assign diversity scores to cells based on the SDI.

LITHOLOGICAL FRAGMENTATION

Lithological fragmentation (LF) values were assigned to each cell according to the number of patches in which lithotypes were subdivided. For each cell, the overall number of patches was taken as a simple but effective measure of the fragmentation of lithotypes, as often done for example in landscape fragmentation analyses (ELKIE et alii, 1999). Values describing the number of patches were then converted into Lithological Fragmentation scores, ranging between 1 and 5, according to classes defined by a natural interval subdivision (JENKS, 1963) of the overall range of values (see table 3 for classes used to assign scores on the 1-km grid).

N° of Patches	LF score	Description
13-22	5	Extremely fragmented
9-12	4	Highly fragmented
6-8	3	Fragmented
3-5	2	Moderately fragmented
1-2	1	Scarcely fragmented

Figure 3 – Classes used to assign fragmentation scores to cells based on the Number of Patches

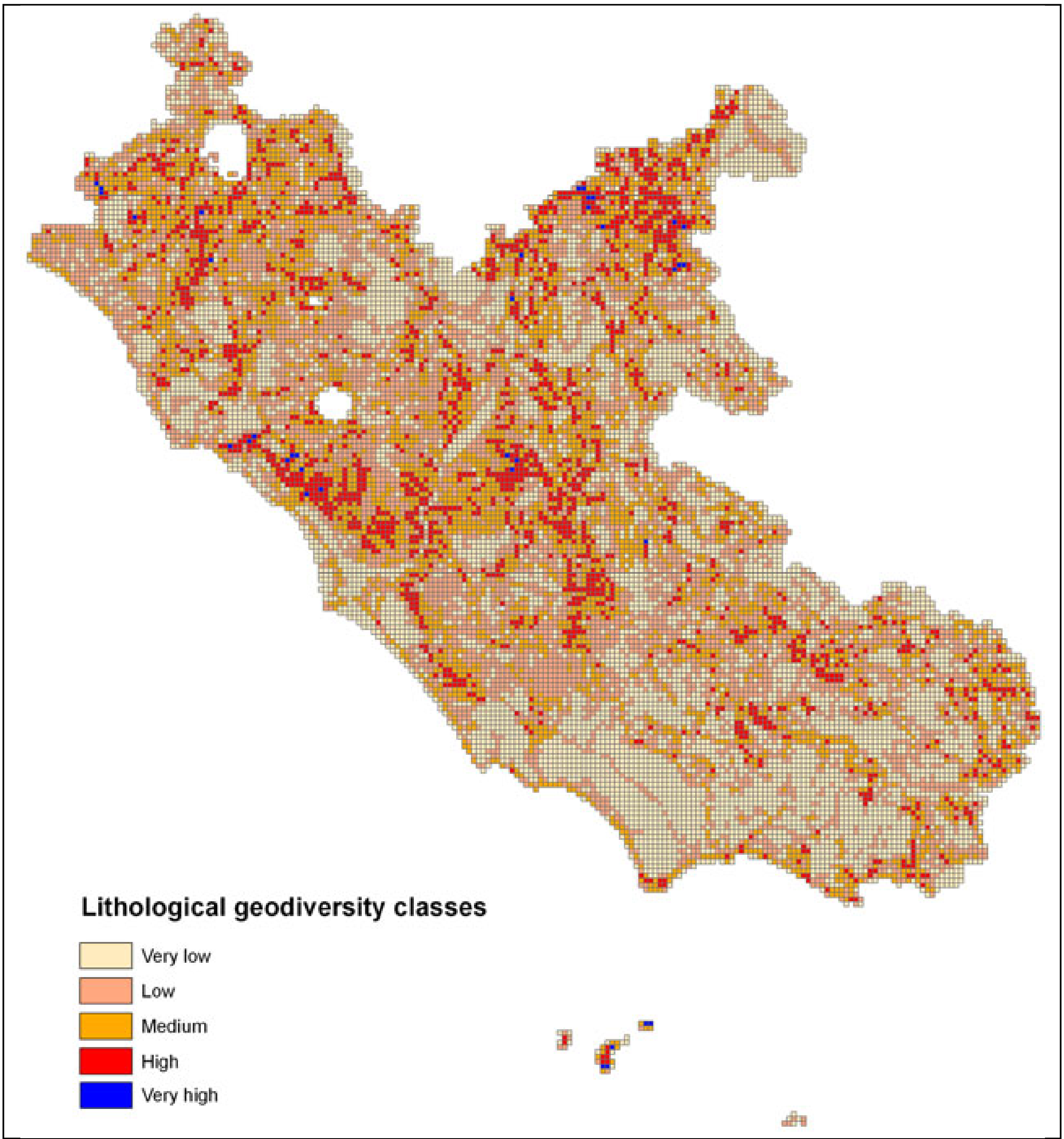

Figure 1 – Lithological Geodiversity Map (1 km grid)

LITHOLOGICAL GEODIVERSITY INDEX

The Lithological Geodiversity Index (LGI) is obtained from the weigthed combination of the Lithological Rarity, Lithological Fragmentation and Lithological Diversity parameters, as follows:

- LGI = 3LD + 2LR + LF

We chose to assign a relatively higher weigth to the Lithological Diversity and the Lithological Rarity parameters as they were considered more appropriate to, and representative of the geological context of the region. The Lithological Fragmentation score, although not to be overlooked, was assumed to be more influenced by the level of resolution of the layers and especially by the accuracy and precision of the polygon delineation, and it therefore entered into the index calculation with a lower relative weigth. To facilitate its visual interpretation, LGI values resulting from this weigthed combination were then used to define 5 classes of Lithological Geodiversity, by subdiving the overall range of values obtained into 5 equal intervals, as per table 4. The final output map at 1-km cell resolution is shown in fig. 1.

LGI values	LG score	LG class
25 – 30	5	Very high
21 - 25	4	High
19 - 20	3	Medium
11 - 15	2	Low
6 - 10	1	Very low

Table 4 – Classes of LGI (1 km and 5 km grids)

DISCUSSION AND CONCLUDING REMARKS

Our Lithological Geodiversity Index represent a useful tool to describe and synthetize, within each cell of the reference grid used for the analysis, some important components of geodiversity, and in particular those describing the lithological features of the area under investigation. LGI values result from the weigthed combination of three parameters related to the lithological diversity within a given area: the relative frequency of the different outcropping types (described by the Lithological Rarity parameter), their spatial distribution patterns (described by the Lithological Fragmentation parameter), their eterogeneity (described by the Lithological Diversity parameter in terms of relative extension of the surface covered by the different lithotypes). Even though we still have not undertaken a more detailed evaluation, we predict that the reliability of the final outputs would be affected mainly by the following factors:

- Cell size of grid used for the analysis.
- Currency and resolution of the baseline data layers
- Spatial accuracy in the definition of polygons.
- Method used to assign scores for the various parameters taken into account in the analysis

The two maps produced as output of this study show that the 1-km grid allows for a better representation of the geodiversity patterns within the study area. This is probably due to a better performance of the Lithological Rarity parameter at this resolution, as well as to the higher resolution maintained using this grid. This latter trait is of particular concern when using the index in the context of spatial planning activities undertaken at the scale of sub-national administrative units like the Lazio Region. In such cases a higher resolution grid allows for a better demarcation of areas of high value in terms of geodiversity. The complexity of the LGI, as well as the weigths used to modulate the relative importance of the various parameters entering into its calculation, do not allow for an easy and direct interpretation of the values obtained with respect to the factors shaping the observed geodiversity patterns, or to formulate any hypothesis in terms of their determinants.

LGI values, even though directly and strongly related to the local context of each cell and to the spatial distribution of geodiversity components, are the result of a relatively complex blend of different parameters, so that in the end it is quite difficult to establish clear links with commonly recognized patterns of distribution of specific geological features. This characteristic of the LGI is in our opinion an advantage rather than a drawback, as it makes easier to avoid evaluations based solely on experience or common perception of single geodiversity patterns. Apart from the subjectivity component introduced by the definition of the weighting factors that enter into its formula, the LGI values allowed in fact for a more objective representation of the lithological geodiversity at the level of the Lazio region. In addition to the planning purposes that initially prompted us to undertake the analysis, the index was in fact formulated with the broader aim of stimulating a more objective approach, in qualitative as well as in quantitative terms, within the scientific debate on geodiversity, which is currently dominated by rather subjective approaches and point of views. In qualitative terms, the increased objectivity introduced by the LGI is a result of the disconnect between the values of the index itself and the common perception of the local patterns of geodiversity held among experts and practitioners. In addition to that, the LGI represents a useful tool to combine and synthetize, with a consistent approach across the entire study area, the different components of lithological diversity into a single numerical value that is then easier to handle for applied purposes.

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APPLICATION OF INNOVATIVE TECHNOLOGY QR-CODE FOR POPULARISATION OF EARTH HERITAGE TOPCIS AT THE WORLD HERITAGE SITE MESSEL PIT, GERMANY

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K*EY WORDS: popularising earth heritage, geoparks, geo-sites, outdoor-landscape communication technology*

1. POPULARISING EARTH HERITAGE BY THE WORLD HERITAGE CONVENTION and BY THE GEOPARKS PHILOSOPHY

In the early 1970's the World Heritage Convention was signed by first states to safeguard the cultural and natural heritage on planet earth. Only about 10 years later the first activities have been launched to promote specially earth heritage topics. In those days the general public was focussed on biological topics and the abiotic part of planet earth had nearly disappeared from the consciousness of people's life. In the context of growing quality of life circumstances and decreasing ressource exploitation towards the end of the 19th century, nobody felt touched by geological or earth heritage. The time of gold digging, diamond, coal and petrol exploitation as well as topics like steal production as basic industry for technical development were no longer a main aspect for survival.
The human society turned towards a more holiday orientated one. The population became more open to pick up the fascination of volcanoes, natural disasters, fossil sites and pits and other geological, mineralogical and palaeontological landscape phenomena. In brief geological and earth heritage, their importance and the necessity of their protection became more obvious: geotopes or geo-sites and their use in tourism destinations to be developed as trails to walk along were born. This was the start off for a new type of tourism, a new type of landscape and earth heritage interpretation for the general public and a new type of education. Discovery of rocks, landscapes and processes of their formation by using innovative tools and media to make interested people aware of their fascination and understand was first priority. Up to today, a wide range of tools and media has been developed especially from the year 2000 onwards, when the European Geoparks Network and in 2004, when the Global Geoparks Network was founded. In the following table the chronology of one of the first and most successful developments of geo trails in the region called "Vulkaneifel" the later Vulkaneifel European Geopark is given, Fig. 1.

Year	Implemen-tation action	No. of panels in landscape	Manager	Material /book/ leaflet
1989	Geo-Trail Hillesheim	32	LC	Book
1993	Geo-Route Manderscheid	30	LC	Leaflet
1994	Geopark-Gerolstein	84	LC	Books
1997	Earth History Routes Hillesheim		LC	Leaflets
2000	Volcanogarden Steffeln	3	WGF-Daun	Material edu-cation
2003	Vulcano park East Eifel	40	District	Leaflet
2005	German Volcano-Road	See existing panels	Districts, Regions	Book
2006	Vulkaneifel Geopark	See existing	WFG-Daun	Leaflet
Total	Vulkaneifel	ca. 189	Region	existing

Figure 1 – Key initiatives for outdoor earht heritage presentation as development of landscape interpretation trails in volcaneifel 1989-2006 (LC-local community, WFG-Economy forwarding company)

With the first panels being destroyed a new discussion about costs of maintenance for the local communities started. This is only in a few number of regions well solved. Also because of the enourmous amount of panels which have been put into the landscape, a certain refuse to go on with "paneling the landscape" meanwhile exists.

2. EARTH SCIENCE MEETS TOURISM MARKETING: a challenge for communication media

Directly connected with the implementation of geo trail panels the regional economy focussed on their use for tourism. Especially walkers staying in attractive holiday regions with walking trails and being interested in earth heritage sites used this new offer with very positive resonance. So the general public could now choose stops on the trails they were interested in. Some panels had a scientific poster style. Others were in a way that visitors were still more able to understand them and liked them especially because they were non-scientific in style. The obvious result for the tourism managers was that some of the panels were too scientific and not very communicative for visitors. However those who walked across a landscape were happy to find some information on site about things and parts of the landscape they never would have given attention to.

By this situation the important question started: Will it be possible to transfer earth heritage topics to the population in a way that a closer relationship is being reconstructed between human beings and the geological formation and phenomena of the landscape? It was interesting to see that the additional point of the geoparks, to extend the “highlighting” of geo-phenomena towards the socio-economic, sustainable development of the region as well as to take this earth heritage as foundation for the future development, led to a high acceptance of the “geoparks” by the residents of the regions which is shown by the fast growing number of geoparks. All of the use panels! This indicates that the way to start communication with panels is a worldwide accepted way of transferring information. The question arises: What is the reason to put a panel onto a certain site? Another one is: Can there be a general design or what is the “red lines” to make them? The type of a panel is not closely related to cultural heritage as many of the panels show. An important point has been found in the question: What is the aim of the panel? What does communication mean: information, activity, enjoyment of artistic design or what? From the point of tourism this is very important as it leads to the effect that visitors come to a place they get to know as being interesting that they should have visited them. Too it leads to a longer stay when they like what they find on site and then they “leave money” in the place the visit. This has a positive input and benefit for the region.

In Fig. 2 a new type of panel is shown which was created for the UNESCO World Heritage Site Messel Pit in the year 2005. Here especially the intention of the panels was to make visitors to communicate with other visitors because of the “surprise” of what the panel shows. Important here too is the aspect that at a UNESCO-World Heritage Site the visitors of many different countries should come into contact! However is this enough by observing that more and more human beings avoid to discover nature because they fear to get lost? Within this the challenge arose: how can visitors get a sort of “red line” that creates confidence to enter an unknown territory without feeling lost?

Now, after nearly 30 years of technical progress the QR-Code technology appeared for city guides first. It seems to be a new transfer medium that fulfills a looked for spectrum of the today’s society needs, wishes and also to discover nature again by them e.g. in Scotland (Lochaber Geopark) and at the Messel Pit nearly at the same time.

Figure 2 - Panel at the UNESCO-Messel Pit Fossil Site, Window into premeval life

3. MESSEL FOSSIL PIT – A WORLD HERITAGE SITE: THE CHALLENGE OF A HIDDEN UNIQUENESS

In the year 1995 the Messel Pit and especially its oil shale material which contains fossils from eocene times (ca. 47 millions years ago), was honoured by the UNESCO inscription as World Heritage Site (WHS). It is among the 33 UNESCO-WHS in Germany the only natural heritage site.

Beside the sensational mammalian fossils, paleontologists have also confirmed at least 109 plant families, as well as rich fish, amphibian, bird, reptile and invertebrate species. These numbers are constantly being updated since many recent finds have yet been fully examined. The Messel Pit site is still regulated by Federal Mining Law and therefore not free accessible to visitors. The visitor is fascinated by the details, completeness, colours and aesthetics preserved in the numerous and spectabcular Messel Pit fossils. The exhibits can be adminred in the museums in Messel, the Hesse State Museum, Darmstadt and the Senckenberg Natural Museum, Frankfurt/M.. These findings were made in the open air quarry when the Messel Pit oil shale material was exploited as energy ressource and reach up to today. A rich industrial history is combined with the Messel Pit. Today visitors can hardly understand this as more or less nothing is left at the site, except the former form: a hole – a pit. This industry was the foundation for the discovery of the fossils, for an economic development for the region and for the social and political history before it became certificated by UNESCO. All fossils are burried within the oil shale material which derived from green algae which settled down at the bottom of the volcanic lake that existed about 47 Million years ago. The bodies of the animals and plants fossilised and were conserved as skeletons. The excavations bring them into daylight as unique findings today.

4. WHY LINKING THE MESSEL FOSSIL PIT WITH THE TOWN OF MESSEL

One important phase of the pit was its post industrial time when the planning and realisation of a waste disposal site was decided. In this context the local community of Messel safeguarded finally its existence as Pit. Together with earth scientists and the state of Hesse, they applied for WHS status. The town of Messel lies only 4 km north of the town part called "Grube Messel" were the miners lived who worked in the Messel Pit. To revive the importance of the ressource in the last centuries from the economic point of view and for future sustainable development a connection from the Messel Pit to the town of Messel was proposed. The idea was to take a new technology to transfer photographs, impressions of the time of industry and the atmosphere of "fighting against the waste disposal site". By linking both: town and the Messel Pit the population of the town of Messel shall benefit from the increasing number of visitors coming to visit the Messel Pit today and in 2010 after the launch of the visitor centre.

5. WHY THE INNOVATIVE TECHNOLOGY QR-CODE APPLICATED ON EARTH AND INDUSTRIAL HERITAGE OF THE MESSEL PIT

The UNESCO WHS Messel Pit is within the Rhine Main area beside unique fossil findings also well known because of its use as energy ressource and too from the population's fight against the waste disposal site. On top of the earth heritage with disciplines like geology, structural geology, paleontology, volcanology, sedimentology, paleobotany etc. other fields with an adequate spectrum of sub-disciplines are concerned in the other areas. The UNESCO-World Heritage Site Messel Pit has a very high complexity on topics and information. Can the wide population given access to these "worlds"? How can this be done?
Scientists can imagine that there exists a large pool of work, results and data on them. Panels are a limiting transfer media in this context. However the new technical media connected with the world wide web together with GPS-technique etc. have enourmous saving capacity and possibilities of simple integration of moving pictures and or animations making topics alive and to orientate in an unknown landscape. After same research on this it was clear that "Mobile Tagg, use of readers and QR-codes" answer the preconditions listed above. The most suitable to be used at the Messel Pit was the QR-codes technology.

6. WHAT IS QR? HOW TO USE IT AND OUTFIT OF THE IMPLEMENTED MOBILE TAGG TRAIL

The new QR-code technique is to most members of the modern society well known. When they go to buy their daily milk, butter and more in a shopping centre the packages they buy have certain line patterns on them which are scanned at the caisse, identified and give as information the price of the e.g. package butter. This shows that modern technique is necessary: a computer with a programme to identify and returning information.
The QR-code is similar. It is a pattern looking like "hieroglyphes", Fig. 3, that has been prepared as software on a computer.

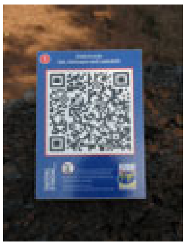

Figure 3 QR-code "hieroglyphes", fixed on a rock pieces

The scanner necessary is a mobile phone camera with a decoder that can enter the internet and read the information saved onto this platform. The information put there ranges from texts, photographs, video clips up to films and animations or interviews. The amount of information that can put there is enormous and contains too voice and moving pictures which is new to have them in the middle of nowhere – when a walker uses QR-code in walking across a landscape, finds a QR-code stop and makes a photograph to get to the information pool. After this identification, the user starts and is guided through the system. Interesting in the context of population, society and tourism is that a very new type of the population is approached: those mainly sitting in front of the computer! And not only walkers and nature lovers. However a limitation exists: a very modern mobile phone is necessary and in the moment few people know this technology. The result of the mobile tagg implementation at the WHS Messel Pit is a trail that starts from the entrance of the Messel Pit to 10 locations which are shown on Figure 4.

Fig. 4 - Map with the 10 locations of the QR-code trail on time, time witnesses and landscape around the WHS Messel Pit

At the info points the following topics a highlighted, shown or explained:

- discovering fossils by mining,
- products from oil shale
- area with industry in the year 1937
- waste disposal site Messel Pit
- fossil hunting by private collectors
- industrial use of "kiln relict material" from oil shale heating processes
- fight of the population of Messel against the waste disposal site
- production site Ytong
- scientific excavation
- visitor centre at the UNESCO-WHS site

The trail covers the following areas around the pit:

- Eastern region around Messel Pit in direction station of Messel with train tresspass to the north with integration of a disidues tree forest,
- kiln material relict deposit hill in the northeast of the Messel Pit within the forest aread north of the pit in west direction-Messel towards the fossil and history museum, direction "Grube Messel" part of Messel
- Messel Pit with viewing point at entrance of Ytong/Xella company and returning the parallel road back to the Messel Pit.

At the start off panel, an explanation introduces the user to the mobile tagg trail with the new technology.

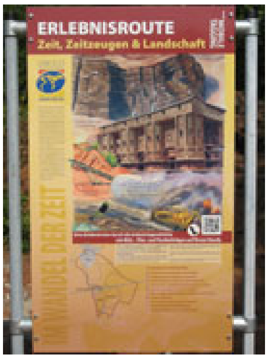

Figure 4 Start off panel with introduction to use with overview map

The information about the topics can be loaded down. The data pool delivers texts, interviews of time witnesses and a documentary film clip. Interesting insights into the emotional atmosphere of the time when the waste disposal site was planned and built are given by this. Some interviews are given by those who have fought against the waste disposal site. Historical material about the company using the oil shale to produce petrol and tar was used to develop an animated flight through the reconstructed company area of 1937. Finally access is given to scientific information on fossil topics like findings as well as to co-evolution between mushrooms and their fertilizer plants in the context with kiln relict material.

7. RESULTS OF MOBILE TAGG IMPLEMENTATION FOR VISITORS TO DISCOVER LANDSCAPE & INDUSTRIAL HISTORY

A new experience of time, historical work, production plants and witnesses revives a former time and social history of a community by QR-code. An emotional link is being created by this and results in a new discovery excitement for visitors who walk around a landscape which is a former industrial area and too a cultural landscape. The innovative technology has been presented on the CEBIT in 2008 and risen high interest in another part of the society afters its launch in 2008. The positive resonance there as well as from first visitors of this trails proof that visitor use it and too use new technologies to have access to history, knowledge and science in a different way.
Too the user of this technology train a "moving in" an unknown area. Their relationship to the natural environment is being reactivated by this. The natural curiosity of human beings is supported as basis for discovery of topics, of experience in his environment and receiving knowledge and information across highlighted and or not highlighted but interesting and important time documents.

SECTION

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ENHANCING THE KNOWLEDGE AND THE EXPLOITATION OF SITES WITH A GEO-TOURISTIC VALUE: A WEB-GIS APPLICATION FOR THE MIDDLE TANARO VALLEY (CUNEO PROVINCE, ITALY)

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KEY WORDS: cartography, geotourism, Web-GIS

INTRODUCTION

In the last years the advancement of digital technologies and the large diffusion of internet facilities have favoured, also in the field of cartography, the increasing use of electronic devices and the development of dedicated software. Examples of these progresses are offered by Web-GIS applications: GIS applications whose functionality is combined with Internet technology, allowing the publication of cartographical data integrated with other information, including hyperlink to images and virtual bird's-eye views. They can be valuable and comprehensive instruments to present results of Geosciences researches to the general public.
This paper describes a research project carried out by academic institutions in agreement with the Torino Natural Science Museum; aiming to develop a Web-GIS application in order to promote the knowledge and the exploitation of sites with a geo-touristic value located in Middle Tanaro Valley (Cuneo Province, Italy).

GEOGRAPHICAL AND GEOMORPHOLOGICAL OUTLINE OF THE STUDY AREA

The study area is shown on fig. 1: it covers a portion of the Cuneo province administrative area. To the south, the area extends as far as the town of Bene Vagienna; to the west it encloses the Stura of Demonte river, while to the east the Tanaro river; to the north the area extends as far as the Bra and Pocapaglia towns.
From the geomorphological point of view, the area can be divided into two sectors.
1) The first one is characterized by river terraces standing out as islands from the plain. The morphogenesis of these landforms is due both to Pleistocene climate changes and to the NNE diversion of the drainage system, triggered by neo-tectonic activity. The terraces consist of Pleistocene deposits; they gradually join to the west with the main plain surface, otherwise suddenly connected to the present valley bottoms of Tanaro and Stura of Demonte rivers. To the east the Pleistocene plateaus are grading to Olocene terraces suspended above the Tanaro river bed. As a consequence of the capture of the Tanaro river, the whole terraces are cut by streams that dug deep gorges in their distal sector, where marine deposits of the Piemonte Tertiary Basin outcrop.
2) The second one is located in the northeast sector of the study area; it is characterized by a complex set of narrow and deep valleys due to the retrogressive river erosion, consequence of Tanaro NNE deviation. This kind of processes, actually no more active, created badlands and dramatic landforms, locally well known with the name of "Rocche di Pocapaglia".
In the whole area eight geomorphosites of different contents and interests have been selected. They all show a high educational value, allowing the understanding of the geomorphological evolutionary stages and the morphodynamics processes affecting the territory.

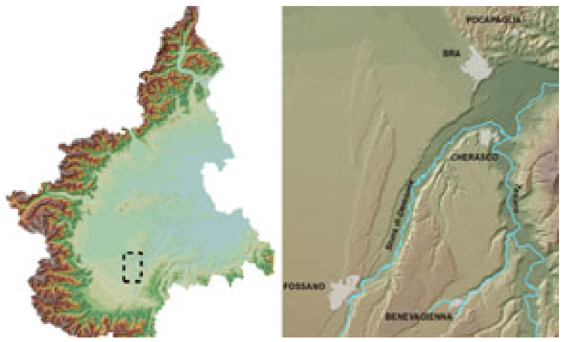

Figure 1 – Left: Piemonte Region. Right: Study area.

WebGIS ARCHITECTURE

In order to promote the knowledge and the exploitation of the geomorphosites selected in the study area, a Web-GIS application has been developed by which it is possible to reach a large number of people. Moreover this solution is economical and easy for users: whatever hardware or software configuration they are using

for internet connection, and with only elementary computer knowledge, they can access the data shared by the Web-GIS. Using an Internet based geographical data service, the management of spatial and non-spatial data is allow. Geographic Information Systems (GIS) are indispensable tools for analyzing and managing spatial data, giving back a real-time updatable, interactive and extremely flexible data. The non-spatial data linked to spatial elements, can be efficiently managed using Relational Database Management System (RDBMS).
The development of a Web-based system by integrating GIS and RDBMS allows sharing information among a wide range of users.
Geographical data has been implemented in a Web-GIS based on MapServer and P.Mapper.
Mapserver is an open source platform developed by University of Minnesota. For this project we installed the MS4W package, designed to perform a full installation of Apache, PHP, MapServer CGI, MapScript.
P.Mapper is a framework, developed by DM Solutions, intended to offer broad functionality and multiple configurations in order to facilitate the setup of a MapServer application based on PHP/MapScript. The purpose of this package is to allow all levels of MapServer users to quickly install a working environment for MapServer development on Windows.
Non-spatial data has been stored using the relational database MySQL Community Edition released under GNU General Public licence. It consists of related tables that hold all the information requested by the Italian National Geological Survey (managed by ISPRA). Furthermore we added several additional information useful to characterize the sites under different aspect: aesthetic, accessibility, ecological, cultural, historical, religious and potential risk.
The table also includes fields that can be used to store binary data (images and multi-media contents) in order to encourage a first approach by the general public.
In relation to Connection between Mapserver and MySQL data use PHP scripting language (Fig. 2).

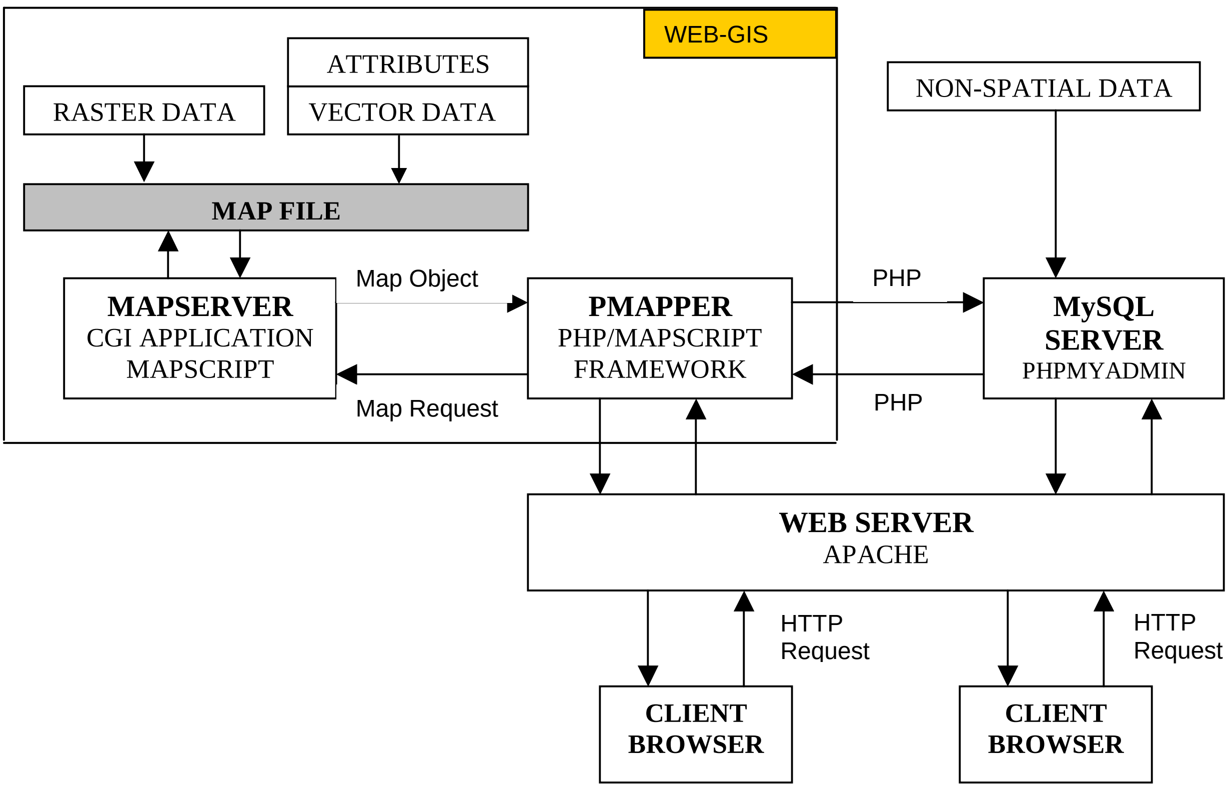

Fig. 2 – Architectural layout of Web-GIS application.

LAYER INFORMATION AND WEBGIS FUNCTIO-NALITIES

The Web-GIS follows the aim of the project to develop an useful information tool, easy to access and suitable both for people interested in the geo-touristic assets of the area for educational or tourist purposes, and experts interested in scientific contents. For this reason was important to create an application usable by the general public: layers to display and attributes associated could represent a difficulty for users (this should not be underestimated), but at the same time it is necessary to keep a scientific rigours.

We organised the information in two different groups, in order to provide a complete and exhaustive frame where basic information and geological entities are located.

The first group include: shaded relief background derived from Digital Elevation Model, lithology, hydrography, natural parks, utility services and network infrastructures, touristic, historical and cultural features.

The second group include several layers, representing the main geological and geomorphological features. Thanks to the functionalities of the application, any users may navigate inside the cartography with user friendly panning and zooming procedures. The users may also highlight different layers according to the scale of view and query the feature, simply clicking on it. They may choose what to load on the map and thanks to transparency function how to display it.

Each geosite in the map has an attribute table containing hyperlink to the MySQL database, where it is possible to recover all the information stored in the inventory and evaluation forms. Furthermore, another link allows to open a descriptive card, added to facilitate general public to the comprehension of the forming processes of the present-day landscape.

The cards associated with each geosites have three main sections:

- In the first one, there is a general outline of the geosite, with a description of the geomorphological features in relation to their forming processes.
- In the second one, there is a set of pictures, stratigraphic sections, 3D views and texts useful to understand the geomorphological evolution of the geosite.
- In the last section are reported curiosities, legends, cultural or ecological notes concerning the geosite.

CONCLUSION

Undoubtedly, the use of a Web-GIS application should provide users with a complete instrument for a free on-line fruition, allowing a knowledgeable approach not only for people involved in the field of geosciences, but also for people interested in touristic field excursion or for professionals involved in educational activities.

Thanks to the possibility of navigating interactively throughout the map, and of quering the features to obtain information from data stored in MySQL server, a Web-GIS application presents a lot of advantages if compared with a traditional map:

- It is a complete and easy to use system to manage, analyze and present features and data;
- It can easily deliver up-to-date information;
- It allows further personalizations;
- It supports hyperlinks setting to connect other information on the web;
- if it is produced with Open Source software, is possible to get a tool without spending money on computer program royalties.

On the other hand, there are some disadvantage too:

- it requires stability and maintenance of the server;
- it needs internet connection with high bandwidth;
- it necessitates a little familiarity with GIS applications;
- it is an immature informatic tool if compared to the development of standalone GIS applications.

The Web-GIS application and the database described in this paper are part of a Ph'D program on "Earth System Science for Environment, Natural Resource and Cultural Heritage" (University Modena and Reggio Emilia). Activities have been carried out at the Geodiversity Documentation Office established in the Torino Natural Science Museum in cooperation with the GeoSITLab (Earth Science Department, University of Torino).

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OLD MINES OF COTICULE AND SLATES: A UNIQUE GEOLOGICAL HERITAGE IN THE PAYS DE SALM, BELGIUM

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KEY WORDS: coticule, slate, mining exploitation, Vielsalm, Belgium, Stavelot-Venn Massif, GIS, patrimony, popularization book.

INTRODUCTION

Since the end of the Middle Ages, the Country of Salm (Vielsalm, Lierneux…) is famous for its purplish slates imported in a part of Europe but also for the famous razor hone stone called coticule which was worldwide exported for its unique properties. Slate veins and coticule were initially exploited in open pits and later, starting from the middle of the 19th century, in underground workings. Around 30 concessions of slate veins and coticule were active in the commune of Vielsalm. Nowadays, the industrial activity is limited only in 2 quarries extracting, the coticule for the first one and a purple slate called «ottrélite impériale» for the second one.

Figure 1 – Folded thin vein of a typical pale yellow coticule, underground gallery, Lierneux (Photo X. Devleeschouwer).

Coticule is a very fine-grained highly manganiferous metamorphic rock mainly composed of spessartine garnet (micrometric size), mica and quartz (grain size below 1 µm). They are typically very rich in manganese (up to 24 wt% MnO), poor in iron (less than 1 wt% FeO or Fe_2O_3) and are generally very rich in garnet (> 40 wt%) and rather poor in quartz (< 30 wt%) (Lamens, 1986). Coticule is a natural abrasive stone used to sharpen and hone razor, all types of blades and numerous cutting tools.

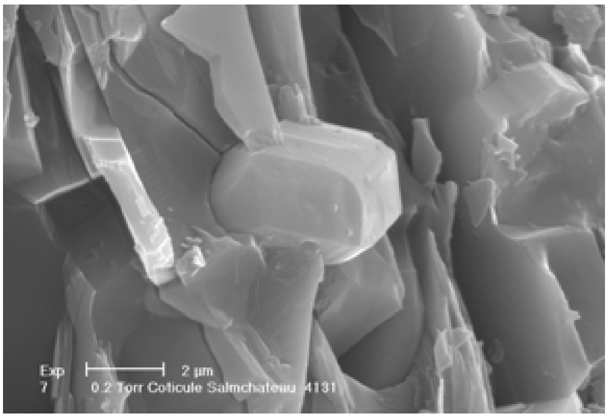

Figure 2 – SEM image of a garnet spessartine crystal embedded in micas flakes from a coticule vein, Salmchâteau, Vielsalm (Photo E. Goemaere).

GEOLOGICAL SETTING

The Pays de Salm area is located in the Caledonian Stavelot-Venn Massif that is the best-exposed Lower Paleozoic (Early Cambrian up to the Middle Ordovician) inlier in the allochthonous Variscan Ardennes Nappe in Belgium. It is a complex structure composed of sedimentary (slates, siltstones, sandstones, black shales) and rare magmatic rocks, which belongs to the Ordovician. They correspond to the Salm Group (Verniers et al., 2001) subdivided into three stratigraphical formations (respectively, from base to top, Jalhay, Ottré and Bihain Formations). Slate veins and coticule deposits have been mined in the Formation of Ottré (Salm Group, Ordovician). The Ottré Formation (230 m thick) is composed of red siltstones, slates, red slates alternating with 1-15 cm thick yellowish coticule beds and violet chloritoid-rich slates. These sedimentary rocks are enriched in iron and manganese (mined in the Lienne valley during around 200 years since the 18th century). This formation is sliced by several thrust faults and bordered to the east by the Lower Devonian sedimentary series (Lochkovian and Pragian rocks) overlying an angular unconformity.

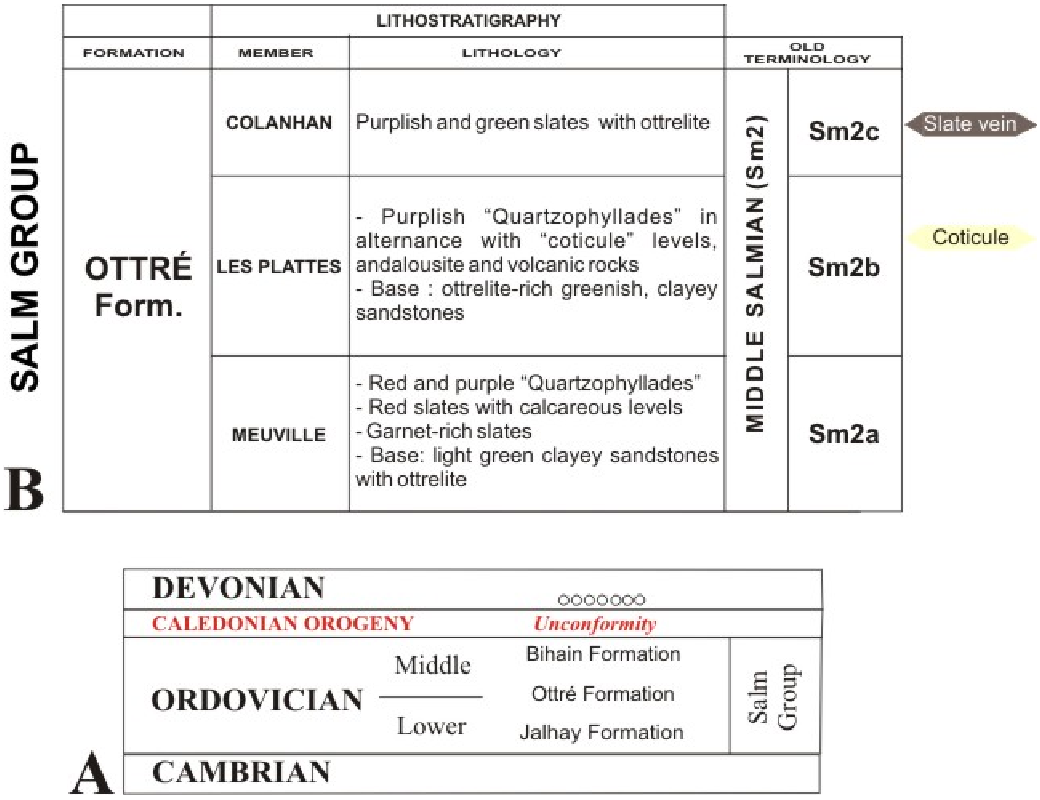

Figure 3 – A. Stratigraphy of the main stage and detailed view on the Ordovician formations of the Stavelot Venn Massif. B. Detailed lithostratigraphy of the Ottré Formation which contains the slate and coticule veins exploited in the Pays de Salm.

GIS MANAGEMENT

In 2004, the Geological Survey of Belgium (GSB) launched the first Belgian program of computerized management of underground workings in the commune of Vielsalm (Devleeschouwer et al., 2005). It concerned the creation and the development of a GIS (Geographical Information System) tool that could obviously centralize dispersed data of different natures and facilitates the management of the abandoned underground workings located in the municipality of Vielsalm.

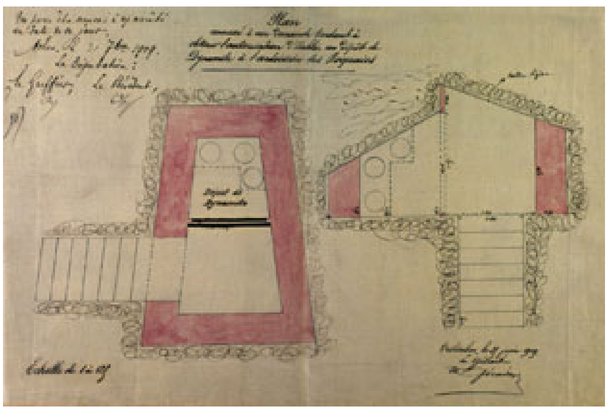

Figure 4 – Old plan (dated 1909) of a dynamite deposit for the slate mine of The Roquaies, Vielsalm. Archives of the Federal Belgian State, Arlon.

The objectives of the GIS tool were triple: the country planning especially the identification of potential collapse risk zones, the preservation of natural (animal and vegetal) biodiversity and finally the conservation of the industrial and cultural heritage. The exploitation of the coticule in trenches evolved to underground workings through the diggings of many shallow shafts from which a superimposed system of sinuous galleries followed the coticule layers. Initially, the slate veins were extracted in open pits; then 150 to 450 meters long galleries were dug into the hillside until they reached the slate vein layers. The maximum depth of a slate vein mine could reach 60 to 70 meters due to several superimposed exploited levels. The lower levels are generally flooded today but the dewatered galleries and their exits are practically unknown.

The landscape was strongly changed after these extractive activities. Open-air natural sites (quarry walls and spoil heaps) are colonized by exceptional plants (bryophytes and rare brackens). Underground quarries are the shelter of many kinds of bats. The particular geochemistry of the slightly metamorphosed Caledonian fields, rich in manganese allowed the formation of many rare minerals (first world occurrences). For these reasons, these sites are sometimes ransacked and were progressively transformed in natural reserves to manage and to protect these treasures for future generations.

Figure 5 – Main entrance of the Old Rock underground quarry where coticule and slate veins were mined in the hillside of the Salm valley, Vielsalm. This underground site is now legally recognized as an underground cavity of scientific interest since the 8th September 2008 (Moniteur Belge) for protecting bats population (Photo X. Devleeschouwer).

Figure 6 – Cryptogramma crispa, a very rare fern on a spoil heap of slates, Thier des carrières, Vielsalm (Photo S. Rouxhet).

Figure 7 – Crystal of ardennite, from Salmchâteau (Vielsalm), 0.4x0.2 mm (Photo. J. Dehove).

GEOLOGICAL HERITAGE

In 1980, the coticule museum (Salmchâteau, Vielsalm) was opened in an ancient workshop preparing the razor hones. It highlights the work of a "unique" material in the world and perpetuates its memory and local traditional extractive activities.

Natives of this region are proud to say that everything can be made with slate material. The Salm region is particularly rich in big built, funeral or small heritage or finally daily objects. Furniture, decoration, toys, but also tools and accessories specific for some jobs were also produced.

Figure 8 – Table plate made with purplish slate of Vielsalm and decorated with coticule incrustations; 19th century, private collection.

Geology, mine plans, natural reserves, museums, geotouristic roads, biological, architectural and mining heritage as well as local curiosities are so many layers of information that are integrated into the GIS. The layers permit to manage the past, to integrate the present activities and to protect the most sensitive underground sites.

Figure 9 – Funeral cross (height: 1.1 m) sculpted in the purplish slate of Vielsalm, cementery of Petit-Thiers, anno 1822 (Photo C. Legros).

Published in december 2008, the book « Ardoise et coticule en Terre de Salm. Des Pierres et des Hommes » attempts to popularize this rock heritage to the public. It will create a link between geological history of the Stavelot-Venn Massif, technical and mining history, biological and architectural patrimonies. Details about the book regarding different chapters, authors and price are accessible on the following website: http://www.naturalsciences.be/institute/structure/geology/gsb_website/products/geosciences/geo2

Figure 10 – Sloping roof made of crossed-slates called "cwerbas" in the Vielsalm area. Flanks of the slate roof are composed of thick purplish slates with various size called "cherbins", Lierneux (Photo C. Legros).

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HOW CAN A COMPLEX GEOTOURIST MAP BE MADE MORE EFFECTIVE? POPULARISATION OF THE TSANFLEURON HERITAGE (VALAIS, SWITZERLAND)

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KEY WORDS: map, popularisation, geotourism.

INTRODUCTION

This paper results from a study carried out in the Tsanfleuron-Sanetsch karstic area (Valais, Switzerland). The objective of the study was to develop geotourist products (educational panels, geotourist map and material for school children) aimed at promoting the geoheritage of the area and created on the request of the municipality of Savièse (Valais, Switzerland). The paper presents some questions raised during the creation process of the geotourist map, following the guiding principles proposed by Coratza and Regolini-Bissig (2009). It comments and illustrates these principles, with a focus on design choices, which is an essential point to increase a map's effectiveness.

CONTEXT OF THE AREA

The map covers more than 50 km^2 between the Sanetsch pass in the east and the top station of the cable car Glacier 3000 on the Tsanfleuron Glacier in the west. The *lapiés* of Tsanfleuron (karstic area) are situated between the glacier front and the pass (fig. 1 and 2).

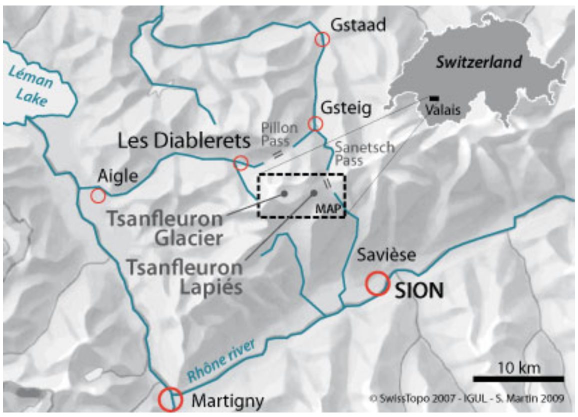

Figure 1 – Situation of Tsanfleuron (S. Martin)

The karstic area covers a wide plateau pending to the east and belonging to the Diablerets nappe, part of the Helvetic domain. Maire (1976) pointed out the morphologic difference between the lower area, with various and well-shaped karstic landforms, and the upper part mostly affected by glacial processes. Between them, well-preserved moraines show the maximal extension of the glacier during the Little Ice Age (LIA). Additionally, there are many interactions between glacial and karstic processes: carbonate crusts, glacio-karstic dolines, *Schichttreppenkarst*.

The region is also known for the rich geological and hydrogeological features (Reynard, 2008). In order to focus on one main message, we chose to concentrate only on the karstic and glacial phenomena and processes.

ELABORATING THE GEOTOURIST MAP

GUIDING PRINCIPLES

General principles for interpretative map design are proposed by Bailey *et al.* (2007). Coratza and Regolini-Bissig (2009) adapted them to the particular case of geomorphosite mapping and identified and described nine components (Table 1, the category “costs” is omitted).

A map is considered as a communication tool. Thus, it is essential to know, firstly, what information will be passed on to whom. The first step is, therefore, to evidence what the map’s **purposes** are and who the potential **users** are. Both will influence nearly all of the further aspects.

The Tsanfleuron-Sanetsch map is clearly intended for **non-specialists** (in the sense of Carton *et al.*, 2005), even if we did not carry out detailed research on potential users. Nevertheless, users are not considered as a homogeneous group (Table 1): they follow different paths (or stay in one place), have different interests – sightseeing, hiking, relaxing, even skiing – and they do not spend the same amount of time in the area.

The main **purpose** of the map is to promote the geoheritage. The focus is set on glacial and karstic processes and their interactions. This constitutes the **theme** of the map. In addition, a geotourist map meets secondary aims that should also have been defined. Apart from educational information, orientation and practical information are also considered.

Once the first two components (users, purpose) were defined, it appeared that the map was quite complex. Having multiple purposes means dealing with more than one information layer. Furthermore, heterogeneous audience entails multi-level reading. Both require the scale, dimensionality and size to be adapted to several, and different, needs. In other words, the components "users" and "purpose" define the cartographic **design** (Slocum *et al.*, 2009).

DESIGN QUESTIONS

From a visual point of view, the first place should be reserved for elements necessary to meet the chosen map's purposes. In other words, visual hierarchy (Slocum *et al.*, 2009) should fit the information hierarchy. Consequently, Coratza and Regolini-Bissig (2009) recommend to avoid having too many details on the map. This is possible by analysing user needs and keeping to the defined purpose of the map (explain the geomorphology and the dynamics, orientate people,…). We, therefore, tried to make a map with as few textual elements as possible, a short legend, a small number of colours and without unnecessary graphical signs. Additional reflections partly based on visual variables theory (Bertin, 1967; MacEachren, 1994) were made: use of colours, design of pictograms and choice of background.

Table 1 – Guiding principles (according to Coratza and Regolini-Bissig, 2009) for the map of Tsanfleuron-Sanetsch

Map components	Guiding questions	Guiding principles adopted for the geotourist map of Sanetsch-Tsanfleuron
1. Users	Who is the intended audience?	a. upper part (glacier): tourists (mainly foreigners) coming for a one-day trip, but generally stay on the glacier. b. lower part (Sanetsch pass, karstic area): local people, families coming for a one-day trip. c. whole area: hikers going through the *lapiés* of Tsanfleuron.
2. Purpose	What is the purpose of the map?	Category of "promotion maps" (Bissig, 2009) with particular aims: orientation, basic tourist information and educational elements. It should help the users to understand the main geomorphological components of the landscape (see Theme).
3. Theme	What is going to be revealed with the map?	Focus on the interaction of glacial and karstic processes that have shaped the landscape.
4. Level	What complexity of information is desired / required?	According to the diversity of users, the map should allow 2 levels of complexity: general information (visual) and more detailed, but still popularised, information (textual).
5. Scale	What is the area to be covered?	The area covers the trails between main access points (Sanetsch pass and Glacier 3000 station) and the places of interest (whole *lapiés* and glacier of Tsanfleuron).
6. Dimensionality	How to show the morphology of the mapped area?	Orthophoto whose relief is shown by a superimposed hillshaded layer (based on a 25m DEM).
7. Design	How to produce maps that look good and are easy to understand?	See DESIGN QUESTIONS and LAYER DESIGN CHOICES.
8. Form and size	For what purpose and in which context is the map going to be used?	Available on the spot, the map should be used as a guide, to consult on the way in complement to a topographical map, but also in interaction with educational boards visible in the field.

LAYER DESIGN CHOICES

ORIENTATION

As a geotourist map is, firstly, a map, it contributes to build spatial knowledge of the represented area. In other words, the map should allow the users to know where they are (location), where they go (routes), and to understand the landscape they walk in (area) (Golledge, 1992). Thus, thanks to some indirect experiences of space – like reading a map – the users can develop a *configurational knowledge* of the area (Golledge and Stimson, 1997; Bailey *et al.,* 2007). It is not only a question of orientation, but also a necessary step to communicate spatial phenomena such as, for example, geomorphological process interactions. Therefore, spatial indications on the map should be chosen according to the educational purpose rather than on basic orientation criteria.

In the Tsanfleuron map, only items that people can see (such as ski lifts or hydrographical network) or need to use (the few buildings and the paths) were kept. The heavy visual load of a topographical map could be avoided by using a hypsometric coloured layer with a hillshaded background. This leaves place for other information and seems to facilitate the attractiveness of the map (Patterson, 2002).

As the path network is quite simple in the area, and well indicated in the field, a high level of generalisation of the paths seemed to be precise enough for users of categories a and b (Table 1). Hikers coming in the area (category c, Table 1) are normally already equipped with a topographical map. For them, we conserved some elements that favour the dialogue between the geotourist and the topographical maps: same place names (glaciers, summits), orientation to the north, coordinates the on edges.

PRACTICAL INFORMATION

Similar reflection was led to sort basic tourist information to put on the map. Because visitors speak various languages, we tried to avoid having too much text and we used explicit pictograms to replace text on the map and in the legend.

Changeable information such as timetables or price lists was rejected. Information useful to plan a short trip while being already on the spot was on the contrary indicated on the map: time of the walk between two points, destinations outside of the map's boundaries, transportation (bus stops, cable cars, car parks), tourist facilities. As mentioned, transportation and facilities are also useful for orientation.

In addition, we adapted to the larger scale of the map the idea of indicating the best time for visiting a site according to the position of the sun (Carton *et al.*, 2005).

EDUCATIONAL INFORMATION

The scientific content of a geotourist map can vary in size and type. It is, therefore, difficult to follow general rules on this point. Coratza and Regolini-Bissig (2009) recommend "to portray information sequentially rather than simultaneously by making several thematic maps, instead of overloading a document" and to limit the number of themes revealed at one time. Two remarks may be added to this. Firstly, a map is not always the best way to communicate; sometimes, diagrams or text are more effective, for example to explain a process or to show a continuous evolution. Secondly, the distribution of information between different media (maps and others) implies keeping and reinforcing the links required for general comprehension of the subject and multi-level reading.

In the Tsanfleuron-Sanetsch map, the information is organised in two levels. On the front, the map presents the global spatial structure according to the theme: the areas where glacial, karstic or glacio-karstic processes prevail are displayed using three different colours and pictograms. On the back, those elements are repeated and, therefore, link each mapped area with textual information and diagrams giving more details on the process.

Along the trail, four explanatory panels offer an additional level of information with numerous illustrations and a more global description of the context: geology, hydrography, hydrogeology, geomorphology and historical rock falls. The same colour code is used on the panels and the map, allowing interaction between both media.

SYNTHESIS AND CONCLUSION

The essential step in the mapping process is to define a sound framework: who are the users, what are the purpose(s) and, then, what is the theme? One could first use the questions and categories proposed by Coratza and Regolini-Bissig (2009). Sometimes, a further level of detail is required to define the type of users or the secondary aims of the map. The other choices (design, complexity…) must be coherent with this framework.

The mapping process is often submitted to several other constraints: required content, scale, form or costs, because it is done on commission. Then the guiding principles could be a useful tool to discuss with the leaders before the project – in our case, the public authorities – and to support the geographer's point of view.

As an effective map should also look good, it is useful to entrust the final design of the document to a graphic designer whose different approach could greatly improve the map. This leaves also more time to evaluate its effectiveness with future users.

Finally, integrating the geotourist map in a wider educational project using diverse media could be a good way to increase the quality of communication. Keeping strong links between the different media requires greater attention.

PERSPECTIVES

The main challenge in mapping processes is to manage a large amount of information and at the same time to keep the map readable. Multiple maps can help to organise sequentially the information (by theme or purpose) but this solution requires more space, which is not always compatible with the constraints of form, size and cost.

Interaction – one of the principles proposed by Bailey *et al.* (2007) – can be a solution to complex map content. The map becomes an interface that allows the user to access specific data related to a place or a theme. Thus, multi-level reading and information sorting are greatly facilitated. By using GPS, the information can even be directly linked with the user's position.

These technical solutions offer good perspectives by increasing interactivity and broadening the audience of interpretative maps. However, information sorting or classification and design questions remain all the more essential to ensure map's effectiveness.

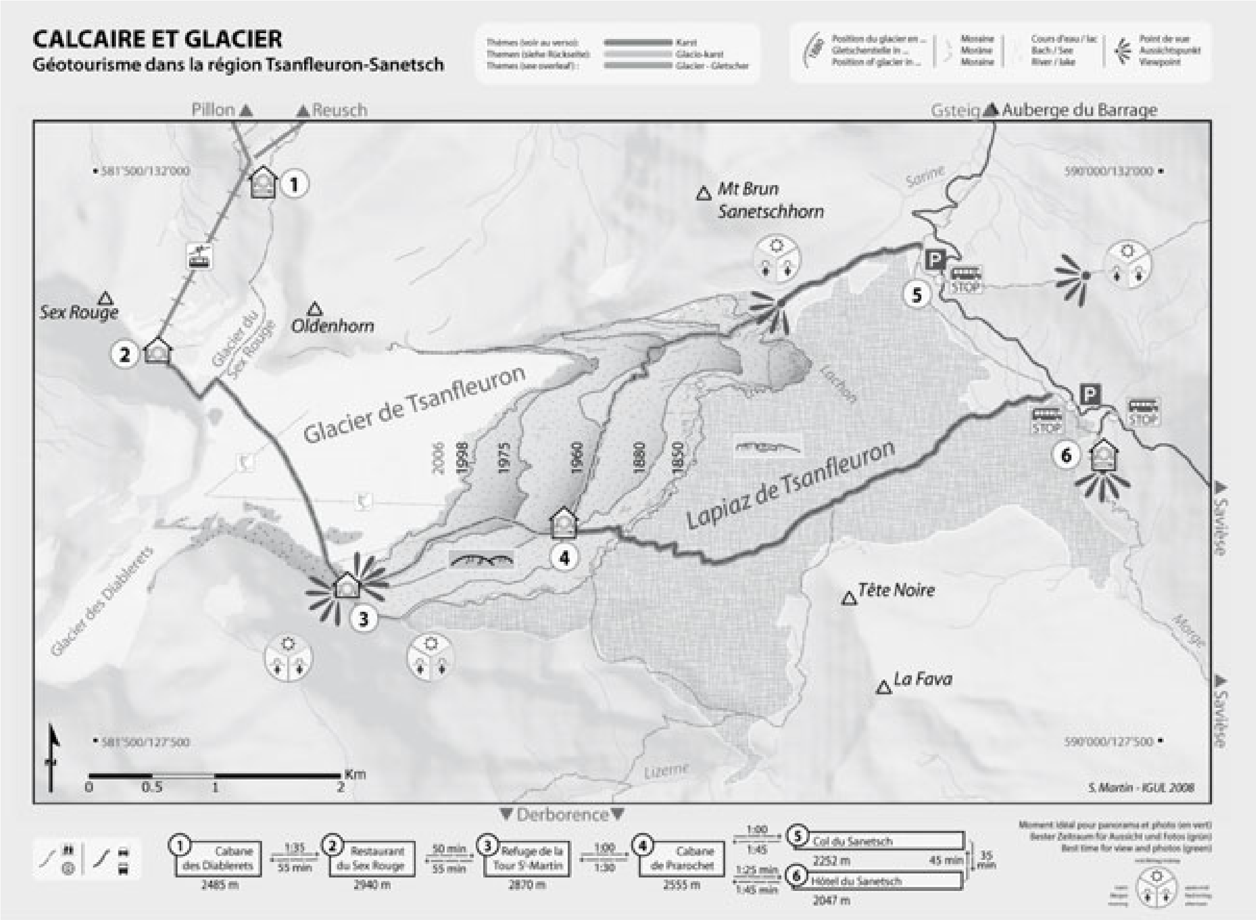

Figure 2 – Layers and legend of the geotourist map of Tsanfleuron-Sanetsch (special grayscale version).

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GEOLOGICAL AND CULTURAL HERITAGE IN THE NATURAL PARKS AND RESERVES OF SICILY (SOUTHERN ITALY)

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KEY WORDS: Geothematic Cartography, Sicily (Italy), Calabria-Peloritani Arc, Apenninic-Maghrebian Chain, Natural Parks and Reserves, Geological Landscape, Geosites, Geo-archaeologic and Architectonic Emergences, Basilian and Teutonic itineraries.

FOREWORD

Sicily (Southern Italy) exhibits a complex geological architecture involving the Orogenic Domains composed of the Calabria-Peloritani Arc, the Apenninic-Maghrebian Chain, and the Pelagian-Sicilian thrust system. The Foreland Domain is represented by the Hyblean Plateau and by the Sciacca area (Figure 1*).*

This complicate tectonic setting is responsible for the strong different morphology of island and, consequently, for a specific development of biotic characteristics. The mountainous areas are located in the North-Central and North-Eastern Sicily, where the *Natural Parks* of *Madonie, Nebrodi, Alcantara* and *Etna,* in addition to many Natural Reserves, are concentrated (Fig. 1).

This work aims to realize the first *Geological Map of the Natural Parks and Reserves of Sicily* at scale 1:250.000, with Illustrative Notes, and three Geothematic Maps at different scale, involving the *Natural Park of Nebrodi*, the protected areas included in the new project of the *Natural Park of Peloritani*, and the *Monte Pellegrino and Favorita Natural Reserves*, with relative Guidebooks (Table 1 and Fig. 1).

The present study is inserted in the context of a multidisciplinary project, organized by researchers of Catania, Messina and Palermo Universities, finalized to fitting out a Thematic Cartography as territorial planning tool for the management and development of Sicilian protected areas. The research is based on the several geological data and maps carried out by the same Authors in the last twenty years in Southern Italy.

Table 1 – Thematic Maps of chosen Sicilian natural protected areas.

Map	Protected area	Province	Geological Domain
1	Park of Nebrodi	Messina Catania Enna	Apenninic-Maghrebian Chain Calabria-Peloritani Arc Hyblean Foreland (Etna Mt.)
	Geological and Cultural Heritage Map of Natural Regional Park of Nebrodi, Scale 1:50.000 (North-Central Sicily)		
2	*A* - Bosco di Malabotta Reserve	Messina	Calabria-Peloritani Arc
	B - Fiumedinisi and Monte Scuderi Reserve		
	C - Isola Bella Reserve		
	D - Laghetti di Marinello Reserve		
	E - Laguna di Capo Peloro Reserve		
	Geological and Cultural Heritage Map of the Natural Regional Park of Peloritani, Scale 1:50.000 (NE Sicily) ***A* to *C* = reserves included in the projected Park;** ***D* and *E* = reserves object of cartographic inserts at scale 1:10.000**		
3	Monte Pellegrino and Favorita Reserves	Palermo	Apenninic-Maghrebian Chain
	Geo-Tourist Map of the Monte Pellegrino and Favorita Natural Reserves, Scale 1:10.000 (NW Sicily)		

GEOLOGICAL SETTING

The *Geological and Cultural Heritage Map of the Natural Park of Nebrodi*, at scale 1:50.000, involves units of the Apenninic-Maghrebian Chain and the Calabria-Peloritani Arc (Table 1 and Fig. 1).

The *Apenninic-Maghrebian Chain* is a roof thrust system, overridden by the Calabria-Peloritani edifice and thrust over the Pelagian Sicilian thrust system. It belongs to the Sicilian orogenic domains extending continuously as far as Morocco.

This chain originated since Late Oligocene times, following the incorporation of the deep basins and the carbonate platforms, that originally laid between the European and African margins: the Alpine Tethys basin, the Panormide platform, the Palaeo-Ionian basin (Lentini et al., 2006).

The Park of Nebrodi is composed of Palaeozoic up to Tertiary sequences belonging to the southernmost sector of the Calabria-Peloritani Arc, and to the Apenninic-Maghrebian Chain (Sicilide units and Numidian Flysch).

The tectonic units of the Peloritani Mts. (*San Marco d'Alunzio Unit*) crop out in the north-eastern sector of the Park; the Sicilide (*Troina, Nicosia, Monte Soro)* Units extend in the central and southern area of the Park; the Numidian flysch (*Nicosia, Monte Salici* and *Maragone Units*) represents first the foreland-fordeep terrigenous deposits above the Panormide and Imerese sequences, and since Middle Miocene it was progressively deformed and detached during the Tyrrhenian tectonic stage.

This flysch extensively crop out in the central-western and northern areas of the Park. Since Late Miocene the Apenninic-Maghrebian Chain, and passively the Calabria-Peloritani Arc, overrode the Pelagian-Sicilian thrust system. This latter originated by the deformation of the foreland margins in contemporaneous with the opening of the Tyrrhenian basin. At present time it represents a deep seated thrust system, which extends northwards beneath the allochthonous chains, reaching the Tyrrhenian margin.

The still active tectonic movements of this deep system influence the geodynamic and morphological evolution of the roof thrust system, which is exposed in the area of the Park.

Since Late Miocene and during Plio-Pleistocene times the whole orogen has been affected by a NW-SE oriented fault system, with a dextral component (South Tyrrhenian system) and by NE-SW sinistral faults. Further N-S oriented normal faults and south-verging thrusts compose a general structural framework, clearly connected with the Tyrrhenian basin opening.

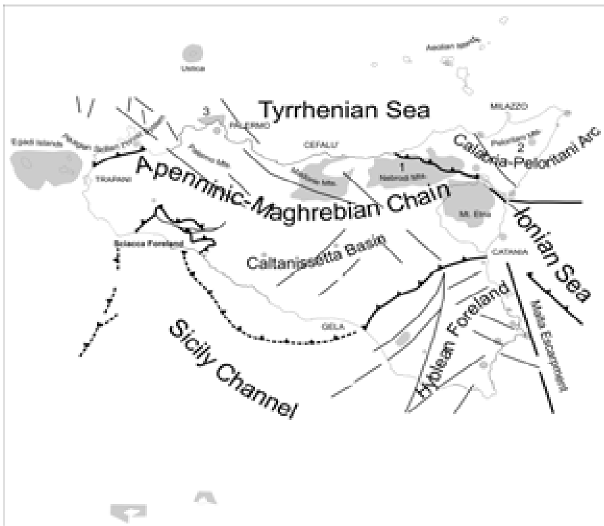

Figure 1 – Tectonic sketch Map of Sicily with Natural protected Areas. 1, 2 and 3 = Areas of the Thematic Maps.

The *Geological and Cultural Heritage Map of the Natural Park of Peloritani,* at scale 1: 50.000, involves the central and eastern part of Peloritani Mts. (Table 1 and Fig. 1).

The *Peloritani Mts.* consist of the southernmost part of the Calabria-Peloritani Arc, which corresponds to the highest structural layer and the innermost allochthonous orogenic domain of Sicily.

This segment has been recently interpreted (Guerrera et al., 1993; Perrone et al., 2006 and references therein) as originated from the delamination of a Jurassic-Cretaceous *Mesomediterranean Microplate*. Since Early Oligocene it gave rise to basement nappes and then the whole edifice has been orogenically transported onto the Apenninic-Maghrebian Chain towards the African Plate.

The structural setting of this edifice involves nine tectonic units (going to bottom, *Aspromonte, Mela, Piraino, Mandanici, Alì, Fondachelli, S. Marco d'Alunzio, Longi-Taormina, Capo Sant'Andrea Units)*.

The units consist both of Pre-Palaeozoic and Palaeozoic basements affected by a Variscan metamorphism and locally intruded by Late-Variscan plutonics, and of remnants of the original Meso-Cenozoic cover. The Oligo-Miocene orogenesis was responsible for the present stacking of nappes, implying cataclastic effects and metamorphic re-equilibration (Messina et al., 2004; Somma et al., 2005a and b; Bonardi et al., 2008).

Burdigalian siliciclastic turbidite deposits (*Capo d'Orlando Fm.*) unconformably covered and sealed the Peloritani nappe stack, that is thus postdated.

Post-Burdigalian folds and thrusts, as well as different Plio-Pleistocene fault systems affected the Peloritani edifice, which was overlaid by Middle Miocene to Recent sedimentary deposits (Carbone et al., 2008; Lentini et al., 2000a and b, 2008).

The *Geotourist Map of Monte Pellegrino and Favorita Natural Reserves* at scale 1:10.000, involves the Palermo Mts. belonging to the Panormide Units (Apenninic-Maghrebian Chain) (Table 1 and Fig. 1).

In this sector the Panormide carbonate platforms and Numidian cover thrust over the Imerese sequences and all together overrode the Pelagian-Sicilian thrust system, that crops out in the M. Kumeta and Rocca Busambra ridges.

THEMATISM OF MAPS

We have used themes, known in the International Cartography, which shows a relevant interest in the studied territories.

The themes are: Geological Landscape, different in type (*structural, petrographic, mineralogical, sedimentologic, stratigraphic, palaeontological and morphological*) Geosites and Geotopes; georesources (quarries and mines); geo-archaeologic and architectonic (monumental and minor) emergences.

For an optimum fruition of this geological and correlated cultural heritage, different thematic itineraries have been also traced in the maps. Among them, the Basilian and Teutonic routes have a peculiar importance delineating roads of communication and power of the Sicilian Monastic settlements between the XI and XIII centuries.

The itineraries have been discussed and illustrated in the specific Guidebooks.

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SOIL AND WINE – AN INITIATIVE TO ENFORCE SOIL AWARENESS IN LOWER FRANCONIA

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KEY WORDS: Public soil-awareness, soil profiles, viniculture, Lower Franconia, parental Mesozoic rocks

Abstract:

The Bavarian State Ministry of the Environment and Public Health is aware of the fact that soils, as part of our essential natural resources, need to be protected. Soil protection is very much a matter of public awareness. In order to achieve this goal, various measures have been taken all across the country. As Lower Franconia is closely attached to wine, it seemed to be a good idea to link soil to wine and hence kick off the project “Soil & Wine”. Soil awareness is promoted via soil plots located in wine yards at geologically relevant sites alongside major touristic routes.

Objectives

Soil protection is a crucial element in the aims of the Bavarian environmental policy. Enforcing soil protection merely by law would surely be insufficient. We believe that public notion and awareness of the fragility of soils is an indispensable component in our goal to protect soils.
To focus and promote public attention on the topic of soils the local state office for water management in Bad Kissingen – responsible for all matters of preventive soil protection including those concerning soil awareness in the governmental district of Lower Franconia - installed so called soil plots in wine yards, preferably alongside frequented touristic routes in geologically significant sites. The initiative aims to combine the pleasure of wine with the treasure of soil.

Conception

The relationship between geology and soil on the one hand and viniculture on the other hand, can be demonstrated impressionable by exposing soil profiles to (non scientific) visitors encouraging them to step into the opened soil profiles.
The general surrounding geological conditions in Lower Franconia with its wide variety on stunning quarries of mesozoic rocks ranging from Lower Triassic sediments (Buntsandstein), Middle Triassic sediments (Muschelkalk) to Upper Triassic sediments (Keuper) in combination with an excellent touristic infrastructure such as bike and hiking trails alongside the river Main and high class accommodation facilities from Aschaffenburg to Zeil am Main provide a perfect basis for this venture.

Results

All soil plots provide protective roofs and descriptive posters with handouts giving information on the intention of the project, landscape genesis, geology, soil science and viniculture (Fig. 1). The textual parts in the posters are authored in a simple manner aiming not only to educate, but also to entertain (edutainment). Many embedded charts loosen up the descriptive posters.
Up to now four soil plots have been erected: at the Hallburg, the Vogelsburg, in Castell and in Handthal. All four sites expose unique soil profiles allowing a detailed insight into soil genesis. At Handthal a vertisol from clay of the Middle Keuper (Myophorienschichten) has been excavated. The profile it self proved to be highly fragile forcing us to take preventive measures against collapse by fixing a mesh wire fence (Fig. 2). This again initiated a quite prolific discussion amongst professionals of how to conserve exposed fragile soil profiles in general.

Preview

As feedback occurs to be favourable, indicating that we are apparently moving in the right direction, furthermore soil plots are planned. These will be located further west giving insight to soil genesis deriving mainly from Buntsandstein and Muschelkalk (Fig. 3). Finally we intend to publish a brochure presenting all established soil profiles in Lower Franconia similar to the outstanding publication of Rheinhessenwein e.v. (2004).

Figure 1 - Soil plot with poster at the Hallburg

Figure 2 - Soil plot preserved with mesh wire

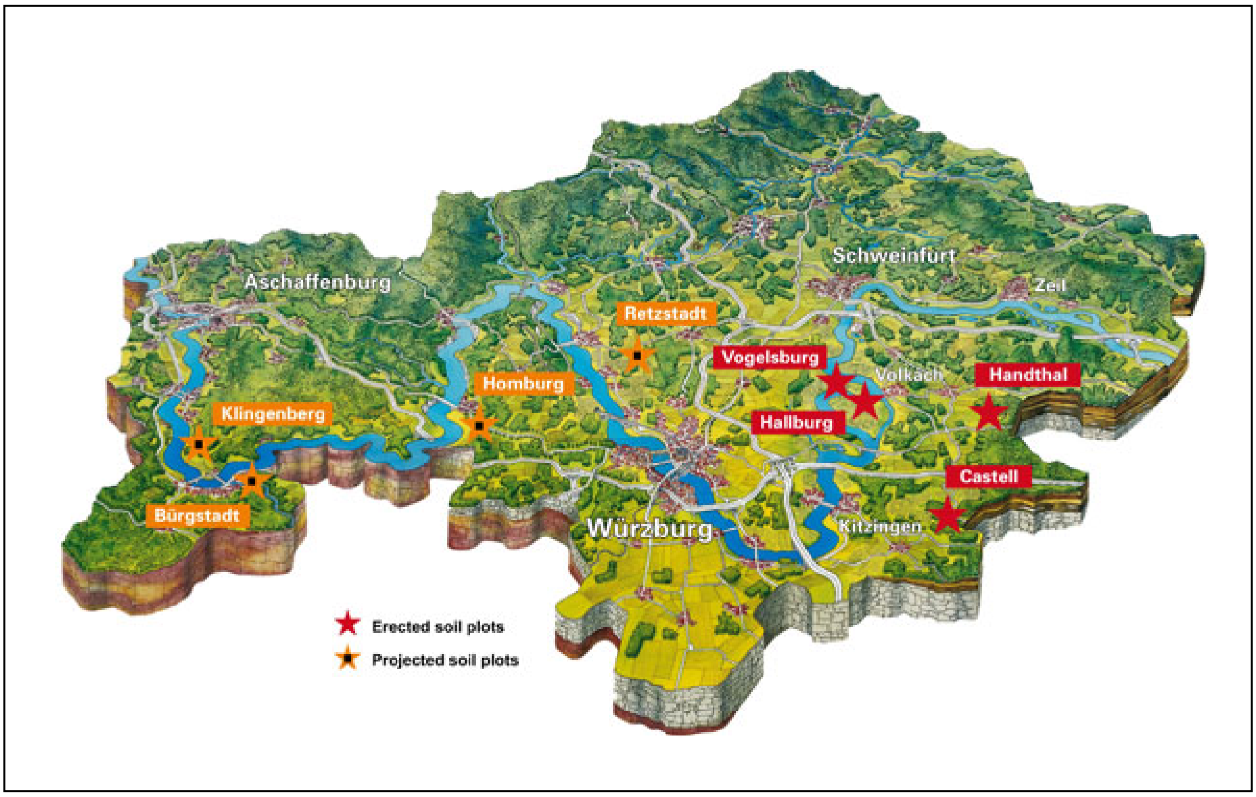

Figure 3 – Panoramic view on the location of soil plots in Lower Franconia

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ZONATION OF IRAN'S GEOTOURISM POTENTIAL REGIONS

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KEY WORDS: Zonation, geotourism of Iran,

ABSRACT

The increasing development of geotouristic trends in the world and considering abiotic nature phenomena among nature-based tourism would have important role in sustainable development of the different regions of the countries.
Studying and zonation of abiotic nature elements via geotourism provide good opportunity for optimal using of natural environments. Also, we needs zonationing, brooming and recognizing of all features of Iran for proper registration and protection of national natural wealth in all corner of the country .In the current study, with considering of Ross Dowling and David Newsome's philosophies, theoretical standards and on the basis of information and data layers such as geological and geomorophological zonation maps, distribution of Iran's mines and Iran's fault map, etc, We tried to compose them via GIS. Finally, the zonation maps of Iran's abiotic nature have been plotted. This study will provide better understanding of Iran's abiotic natures and mines regions for future management. After plotting all of the data have been classified as geological and geomorphological geotourism, mining heritage geotourism, adventure based geotourism and finally anthropological geotourism areas and issues, respectively by ranking them to 1,2.3 priorities in Iran.

INTRODUCTION

In recent years, geotourism has therefore developed into a very appealing concept, attracting a variety of people with diverse interests — particularly from the tourism industry and government sectors as well as environmental and conservation groups (see, for example, Megerle and Pauls, 2003). The increasing demand for `geo' has led to the development of geotourism attractions based on geological formations and adds another dimension and diversity to the natural area tourism product. Today's society has increased people's need to know the value of stones and scenery (i.e Grauvogel, 1994& Opaschowsky, 1989).

OVERVIEW

Iran -the study area- with the extension of 1,648,195 square kilometres is the 16th largest country in the world. It has a population of over 70 million people. Iran is in the north hemisphere and eastern hemisphere in Asia and in the western part of Iran's plateau and is one of the Middle East countries. Iran also shares borders with Iraq, Turkey, Armenia, Azerbaidjan, Turkmenistan, Afghanistan and Pakistan. It is considered as a mountainous country and more than half of the area, are covered by mountains .The highest point in Iran is Mount Damavand (5671 m) and its lowest part is the Caspian coast, 28 m lower than sea level. The difference between temperatures in various parts of the country at the same time is often as much as 40°C. This is due to the existence of its mountain ranges and vast desert lands, both of which have a big influence on the climatic conditions of the country**.** The country has been labeled a 'geologists' paradise' or 'the 1.5-million-km^2 geological museum'.

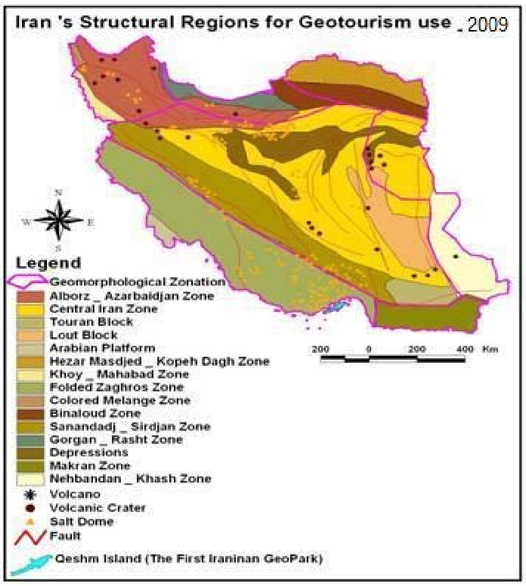

Figure 1- Structural and geomorphological zonation

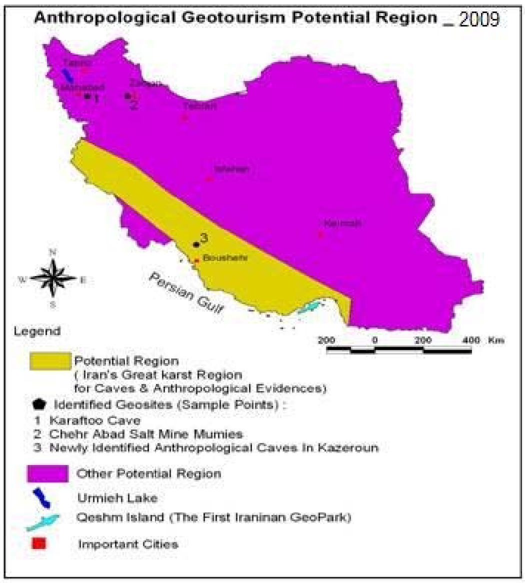

Figure 2: Anthropological Geotourism Potential zone of Iran

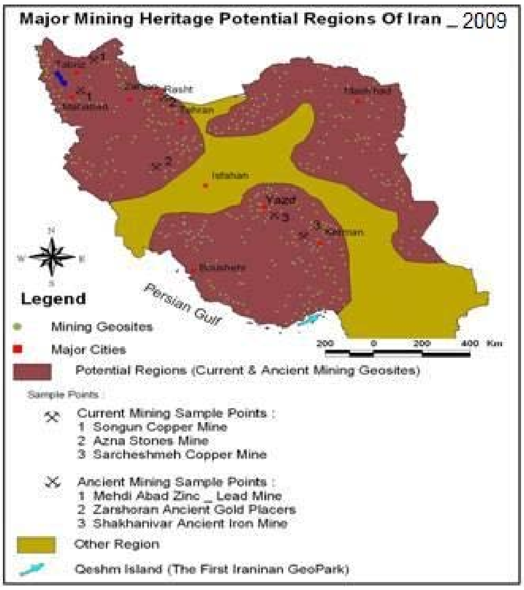

Figure 3: Current Mining& Mining Heritage zonation map of Iran

DEFINITIONS AND CONCEPTS

Pforr and Megerle(2006) mentioned that Geotourism is an expression of a growing trend to experience the natural and cultural landscape in contrast to the common urbanized lifestyle — a contemporary phenomenon that has become evident worldwide since the late 1980s.
Felix Tongul(2006) defines geotourism as: Geotourism is refer to the utilization of geological heritage resources for education-based tourism. The term `geotourism' was defined by Frey in the 1998 meeting of the German Geological Society as follows:
Geotourism means interdisciplinary cooperation within an economic, success-oriented and fast-moving discipline that speaks its own language." Geotourism is a new occupational and business sector. According to Dowling 's and Newsome's viewpoints, geotourism is a specialized form of tourism in that the focus of attention is the geosite. Recently Nekuie-sadry's *Fundamental of Geotourism : With Emphasis On Iran* (published by Samt (The Organization for Researching and Composing University Textbooks in the Humanities in I.R. Iran),2009)defines geotourism as: " Geo-tourism is knowledge-based tourism, as an interdisciplinary integration of the tourism industry with conservation and interpretation of abiotic nature attributes, besides considering related cultural issues, within the geo-sites for the general public ".

METHODS AND ANALYSIS

In the existing study, on the basis of information and data layers such as geomorphological regionalization map of Iran, distribution of Iran's mines, Iran's geological structural zonation map, salt domes, volcanoes, cones and faults' maps of Iran, data layers and recognizing general characteristics of each regions have been planned.

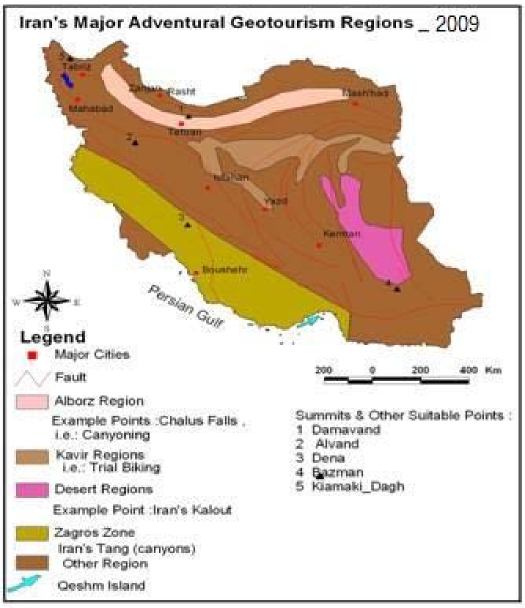

Figure 4. Adventural Geotourism Potential zonation map of Iran

Theoric criteria and ideas of Ross Dowling and David Newsome have been used.
Since the educational geotourism is besaed on structural regionalization of the country , at present

study, the map of regionalization of abiotic nature and geotouritic regions of Iran have been plotted to find the comparative potentials and future applications of geotourism for different regions of Iran in six academic stages by Showing spatial data of geotorstic regions of Iran .

RESULT AND DISCUSSION

The basis for land use and environmental planning is geographic studies. So, geographic recognition of Iran makes possible the adaptation basis and logical policies in the framework of environment planning. In this specific field, Information increasingly through different ways like monitoring,research,data basis and informational systems, information exchanges , expanding and owning information defining natural systems and reciprocal effect with (Dovers, 1995, 142) is received. Research activities is very essential for trying to prove local sustainable development through geotourism.Geotourism development needs a basic and enough knowledge and a proper interchange of information and expert and professional knowledge among decision makers as a mechanism for sustainable locally development(Magerle and Pffor, 2006).

To divide landforms according to their shapes, and three dimentional criterium and theoric criterian of Ross Dowling and David Newsome and relative homogeneity of shapes have been nominated and plotted and by means of diagrams(see figures: 1 to 4) ,existing differential heritage including mining, geomorphological and geological heritage have been determined , Figure 1, shows that, all corner of Iran are suitable for educational geotourism purposes.

By means of differing the layers and recognizing general characteristics of each area via theoric criteria of Dowling and Newsome in table 1, Iran geotourism `is divided into 6 parts and priority in order to national infrastructures and the near future development potentials ,respectively 1-6 (see table 1):

Priority	GEOTOURISM TYPE	Potential Major Regions of Iran	No. of Regions
1	Geotourism in a Geopark	Qeshm Island	1
2	Volcanic Village's Geotourism	Kandevan and Meymand *	2 major points
3	Geology and Geomorphology /(Educational Geotourism)	All Regions of Iran with all road profiles **	-
4	Anthropological Geotourism	Chehrabad Salt Mine in Zandjan and Zagros Zone's Caves such as Karaftoo and Khesht & Komaradj in Kazerun Region(See Figure 3).	2
5	Mining Heritage Geotourism	Three major regions in Iran, example points such as : Sungun & Sarcheshme Copper mining & Mehdi-Abad old Zinc mining Geosites(See Figure 4).	3
6	Adventural and workout Geotourism***	Centeral Regions of Iran(Kavir and Desert regions of Iran),Zaghros region(Tangs (Canyons) ,caves(Great Karstic zone) ,falls,lakes)and Alborz's (Falls, Canyon,Ranges) and other points Kiyamaki- dagh mountain, Alvand-kuh ,... (See Figure 5)	4

* The two villages of Kandovan (northwest Iran) and Meymand (southeast Iran) comprise houses cut into the volcanic rocks. Kandovan is located at the foot of Mount Sahand, where the shelters have been dug out of hardened ashes or lahar beds . Meymand village is approximately 2000 years old. Here the house walls are built of volcanic conglomerate and hardened ashes. The carved structures include a mosque (which is the largest opening). a school, a public bath, and a structure that seems to have been used as a fire temple.

** The country has been labelled a 'geologists' paradise' or 'the 1.5-million-km^2 geological museum'.

*** Proposed Type of Geotouristic Activity in these suitable regions and points are including Mountain-bike riding , Off-road vehicles (ORVs)riding and(ATVs) riding … Base-umping,Bangee Jumping,.., Rock climbing, Canoeing, , , Tubing,,canyoning ..

Table 1: Iran's Geotourism Regions and Points

CONCLUSION

General information about Iran's geology and geomorphology and mining sites distributions and regions where it occurs, combination of different data layers and preparation of geotourism zonation maps of Iran proved to be high potential and good wealth in spatial distribution of mining sites and geomorphological and geological diversities of Iran and led to geotouristic regions with extream potentials.

Because of variances of points and semi-dry climate and other geosystem influencing factors such as existence of the hottest deserts in Iran for adventure geotourism, Iran is propered for geotourism industry development.

With considering future field brooming projects, detail analysis via GISs in six geotouristic zones and in different provinces of Iran is necessary to be performed, by governmental and non-governmental sectors.

So, after Gheshm Geopark located in Persian Gulf, geology/geomorphology geotourism, (or educational geotourism) and volcanic villages will have a lot of potential for geotourism development. The zonation of meantioned potentials is just one step and this is generally regionalized as the potentials of major geotouristic regions in Iran.

It is hoped that the academics and government and private sectors will become more aware of their country's wealth. In many parts of Iran, thousands of geosites await discovery and to be developed as natural area tourism products. It is clear that the future development of geotourism requires comprehensive land use planning via field work and GISs analyzing and detail geosite exploration.

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"SELENITE AND SENILITY" GEOTOURISM FOR THE OLD AGE IN THE SANTERNO VALLEY (NORTHERN APENNINES, ITALY)

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KEY WORDS: geotourism; selenite; senility; Santerno Valley; northern Apennine

INTRODUCTION

The "Selenite and Senility" project aims at the valorization of the geological peculiarities of the Santerno Valley (Northern Apennine, Italy). The project name comes from its main targets. First, the name "selenite" derives from the more relevant geological character of the Santerno Valley, the Gessoso-Solfifera Formation. Secondly, the choice of the geotouristic network has been made putting old-aged people, with their needs, timing and curiosity, as the main beneficiary of the project. The same purposes guided the elderly scientists Leonardo da Vinci (1454-1519) and Giuseppe Scarabelli (1820-1905) to the discovery of the Romagna hills (Mariani and Marabini, 2004, 2005).
In order to make the important scientific aspect of the project accessible to a non specialist public, we choose to present the single geological themes by means of legends, paleontological and landscape aspects. Moreover, the peculiar scientific characters can be implemented by historic, arts, tradition and enogastronomic elements.
Besides, one of the original aspects of the project is the viewpoint of the Nordic Walking, a new sport which consists in walking -but not only- with specific poles. Avventurainfinita, the first sport association of this kind in Bologna promotes every aspect of Nordic Walking in the context of geotourism.

GEOLOGICAL BACKGROUND

Large-scale reading of the geological history of the Santerno River Valley is simple. Its presentation consists of group themes going from the mountain territory to the Imola area and thus analysing progressively recent rocks and events (Vai, 1984; Societa' Geologica Italiana, 1990). The first formation that we encounter is the "A*rgille Scagliose*", formed by mainly clay allochthonous terranes. These rocks are the result of long transport (from the Mesozoic up to Miocene and Pliocene), of materials which belonged to the bottom of an ancient ocean extending in the present areas of Liguria and Piemonte, and hence called Liguridi. Thus, these rocks look very chaotic and have lost any stratification. Clays are the dominant lithotype sometimes bearing, intercalated or floating, heterogeneous blocks belonging to other formations.
The next Formation is the older autochthonous formation of the Santerno Valley: the *Marnoso-arenacea Formation.* The turbiditic flisch of this formation are interpreted as the filling of a great basin (foredeep) with elongation parallel to the Apennines and migrating in the NE direction between the Langhian and Tortonian. This huge sedimentary basin is more than 300 km long, 40 km wide and more than 3000 m thick.
About 8 million years (Ma) ago there was a sudden break in the rhitmic sedimentation process of the Marnoso-arenacea, with a general enhancement of sea-level with deposition of clay and marly sediments. At the end of this period, about 6 Ma ago, the Mediterranean Sea was characterised by a sudden sea-level decrease, which brought to the complete isolation of the sea from both the Atlantic and the Indian Oceans. This catastrophic event is recorded as the Messinian salinity crisis, which ended with deposition of gypsum and salts from sea water. These process repeated for 18 times, forming the typical alternation of gypsum and salts with clay layers, which constitute the *Gessoso-solfifera Formation.* In the studied area it crops out with the beautiful Vena del Gesso Romagnola (Mariani et al. 2007).
In the Pliocene and lower Pleistocene a huge deposition of very fine-grained clay materials follows, as a consequence of rising of sea-level and at the same time lowering of sea floor. This is the *Argille Azzurre Formation,* covering the entire Pianura Padana and characterised by the typical gully ("calanque") landscape (Fig. 1).
Another character of these stratified clays is the abundance of both fossils (Bivalves, Gastropods…) and plants (seeds and plant fragments).
The slow deposition of the Argille Azzurre stopped around 1 Ma ago, when starts the emersion of the

Apennine chain. In this new litoral setting, the *“Sabbie gialle”* deposited, with clean and stratified sandstones bearing abundant sea and mainland fossils.
The “Sabbie gialle” represents the last unit of sea and coastal environment. Then, the Quaternary deposits are mostly linked to the action of rivers. Their erosion and sedimentation processes are witnessed by *fluvial terraces*.
A further element of interest is represented by hydrocarbons and mineralized waters springs. These are usually sulphurous and salty waters (sodium chlorine). The first type should be related to gypsum dissolution, even if it is not sure that they derive only from the Gessoso-solfifera or also from the older triassic gypsum deposits. More certain is the interpretation of salty waters as “depth waters” (“fossils”) of sedimentary basins, which were covered by huge covers of impermeable rocks, such as for instance the Pliocene clays.

Figure 1 – The characteristic “calanque” landscape near Imola.

GEOTOURISTIC ITINERARY

The geotouristic iitinerary is described through the different geological formations which are related to their more attractive peculiarities.

– <u>“Argille scagliose”</u> <u>and “Pietre del Diavolo”</u>. The landscape is dominated by barren soil, rare vegetation, grass and shrubs, gentle hills and gullies with common landslides. Blocks sometimes merge from clays. Among these blocks, the more curious are the ophiolites (from ancient greek *ofis*, snake and *lithos*, rock): that means “the snake-looking rocks”. Many legends were born around these rocks, describing them as meteorites fragments, or remnants of ancient fights between god and devil, between Saints and Devil (hence the name of “Pietre del Diavolo”-Devil Stones). A famous example is the Jurassic Sasso di San Zenobi (Fig. 2).

Figure 2 – The Sasso di San Zenobi ophiolite.

– <u>"Strato Contessa": cliffs and cascades in the Marnoso-arenacea</u>. Leaving the Argille Scagliose there is a sudden change in the course of the Santerno river which flows between the high and steep wall rocks of the Marnoso-arenacea Formation, forming cascades. In places layers are very altered by tectonics as in the case of the amazing "Scarampola cliffs" (Fig. 3), in front of a huge monocline. Moreover, in the Santerno Valley it is possible to observe the more famous guide-layer of the northern Apennine: the Contessa Layer, the first guide level recognised for the Marnoso-arenacea. It can be followed for more than 150 km, through the vallies of Umbria, Marche, Toscana and Romagna, progressively diminishing its thickness, up to the Santerno Valley.

Figure 3 –"Scarampola cliffs" in the Marnoso-arenacea Formation.

– <u>Shining mountains</u>. The Vena del Gesso profile is unmistakable. It represents one of the more interesting geological elements of the valley, both from a scientific viewpoint (as witness of the Messinian salinity crisis) and for its landscape importance (Region Park since 2005). The outcrop looks spectacular both at the large scale (as the Riva di San Biagio wall) (Fig. 4) and in detail, with beautiful large selenite crystals. Interesting is also the Monte Penzola overthrust, site which also gives a nice view over the Santerno Valley.

Figure 4 – Riva di San Biagio, Vena del Gesso.

– <u>Sharks and corals in the Imola gullies</u>. The Argille Azzurre landscape is characterised by either cultivated land or by the characteristic barren territory of the gullies, which show seasonal flowering of brooms. These clays are very rich in fossils deposited on the bottom of a deep sea, which formed after the sedimentation of the Gessoso-solfifera Formation and lasted for nearly 5 million years. Fossils are constituted mainly by molluscs, by minor corals and plants, and very rare shark teeth. In this area it is also possible to observe the Pliocene/Pleistocene boundary, corresponding to two sandstone layers in the ancient Codrignano sluice.

– <u>"Imola beach": the beach of rhinos, elephants and hyppos</u>. Around 700000 years ago the sea level was as high as the city of Imola. A sand beach formed, similar to the nowadays beaches of Ravenna and Ferrara. The proof of the beach hypothesis is given by fossils. The finding of terrestrial mammal remains and shells of marine species prompts for the transitional continental-marine environment. Further proofs are given by sedimentology observations such as sandstone laminations and the occurrence of tempestite levels. An example is found in a small cave within the Parco delle Acque Minerali (Mineral Waters Park) in Imola (Marabini et al., 2008).

– <u>Fluvial terraces on the Santerno.</u> The Sabbie Gialle Formation is the last witness of sea occurrence in the Santerno Valley. Then, intense was the erosion process of rivers, which created various orders of fluvial terraces. These are well preserved at Castel del Rio and Fontanelice, continuously exposed on the left Santerno bank between Borgo Tossignano and Imola (Cesari et al., 2006). Alluvial terraces are very interesting since they keep witness of human presence from the prehistoric age. Archeological findings are common, from stones to bricks to bronze statues and helmets.

- Water jets and boiling muds. A last, but not least, fascinating aspect is the widespread occurrence of mineralized waters and gas springs, which form either "fires" (dry springs, in particular in the Argille Scagliose) or mud pots ("salse" in the Argille Azzurre). Frequent is also the occurrence of white crystals patina on the gullies, formed after evaporation of salt waters. Most of these phenomena have been originally studied, with beautiful drawings, since the 18Th century.

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GEOLOGICAL HERITAGE OF ALBANIAN ALPS

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KEY WORDS: In Albanian Alps included some ecosystems with rare natural beauties. Wonderful alpine mountainous landscape with a diversified flora that developed mainly at carbonate rocks, typical cataracts, water resources seemed at the rivers,streams or natural superficial springs form,composed the base and existence for these ecosystems.

GEOLOGICAL HERITAGE

In Albanian Alps included some ecosystems with rare natural beauties.Wonderful alpine mountainous
Landscape with a diversified flora that developed mainly at carbonate rocks, typical cataracts, water resources seemed at the rivers, streams or natural superficial springs form, composed the base and existence for these ecosystems. The mountains with their diversified contracts give the best possibilities winter and summer sports development as climbing, skies, horsemanship, kayak using in canyons, amateur fishing in canyons and speedy rivers and mountainous cyclist. High elevation over the sea level, dictate fresh clime up to cold, but very healthy. The environment, because of the distance from industrial centres, has more possibilities to protect better than other parts of our country.The life in Albanian Alps with a big diversify of natural landscape, folklore, canon, history, etc. present a wonderful region for geo-touristic mountainous development.
The Alps included between two cities as Shkodra and Bajram Curri that serve as waiting and initiation points towards the alpine beauties. Some small villages offering accommodation for tourists as touristic villages: Tamara, Lepusha, Vukel, Vermoshi, Boga, Thethi, Valbona, Rragami. Last years, Albanian Alps have been the object for numerous geo scientific, folkloristic,historical, geo-touristic, environmental studies that studied the fixed regions into the Alps territory.
As result of all the above mentioned factors, the Albanian Alps offer numerous possibilities for Geo-tourism development at these areas:

1. Geoturizem, Albanian Alps include some wonderful nature phenomenon: -geo-sites,geo-monuments,-karst Foto 1

Photo 1 – Rapsh-Starja,Karst.

2.Winter sports, mountaineering, ski, creeping in ice, etc.
3.Summery sports as mountainous going, rocky creeping, mountainous cyclist, kayak, oar age, horsemanship, hunting, etc.
4. Visits in ecosystems, forests, lakes, rivers, etc. *Foto 2*

Photo 2 – Valbona, lake.

The development of Albanian Alps Zone, realization every day and more for state structure and their policy makers and for the local community give every time in addition the premises for protection and development of mountainous ecosystems from the more beautifulness of our country.
This is related with sustainable life development in these zones that abandoning with velocity from peoples which have not real possibility for a normal living because of the benefits that offering from this zone are bed management, unexposed in front of national and international tourism. Stimulation and development of these natural resources, protecting strongly the environment, based in analogue European regions development, will compose a hard base for abandonment prevention of dwelling from the habitants of these zones. For this reason we are presenting this new potential for development the regions Alps where the Alps located.

CORRELATION OF THE GEOLOGICAL MAPS 1:50 000 SCALE OF THE ALBANIAN - MONTENEGRO BORDER AREA

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KEY WORDS: Geological studie of Albania and Montenego have attracted the interest of several geoscientists since 19-th century. But the systematic investigations on both countries started after the 2nd World War. Several geological studies, including the geological mapping of various scales (1:10 000, 1:25 000, 1:50 000, 1:200 000, 1:250 000 and 1:500 000) have been carried out during this period.

Correlation of the geological maps

Some joint projects to unify the main data on the geological-tectonic structures, lithological composition and the ages of the formations on both sides of the border between the countries, have been undertaken these last years and the results are encouraging. The mutual cooperation between the respective scientific institutions is very important taking into account the participation of both countries in the compilation of the New Geological Map of Europe 1:500 000 scale.

The implementation of the 1:50 000 scale mappings of the border area is indispensable. The correlation of these maps is realized through geological observations, sampling and other geological works. The implementation of the new geological maps 1:50 000 will serve as a good scientific basis for further studies in the field of earth sciences in the region.

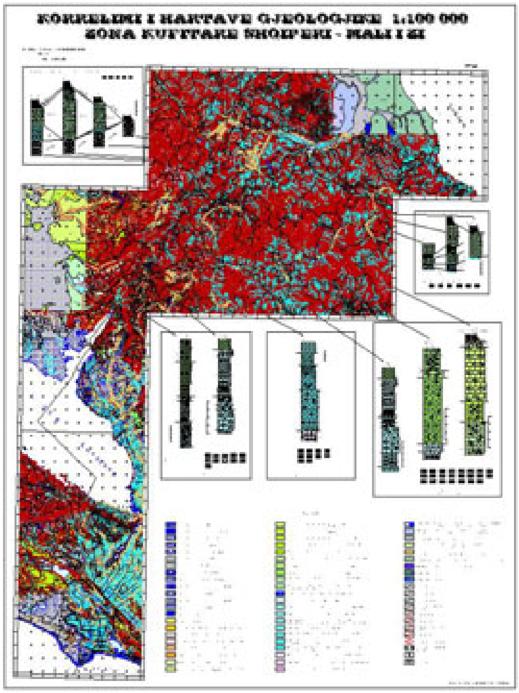
The common observations and geological investigations along the interboundary line have leaded to the correlation of the Ionian, Kruja (Gavrovo), Krasta-Cukali (Ollonos-Pindos), Mirdita (Subpelagonian) tectonic zones and Inner Depressions as well as the correlation of the geological and ore bearing structures and other formations along the respective inter-boundary line.

The comparison of data on the stratigraphy, petrology, mineralogy etc., of different geological units has been carried out as well.

During this cooperation it is worked with topographic sheets scale 1:50 000, on which were plotted the geological data in digital form (AutoCAD Map 2000).

The final result is the publication of 9 geological sheets 1:50 000 scale and explanatory texts for each of them, for all the inter-boundary line between the countries. The following unified sheets 1:50 000 scale were published: Fig.1 Albanian-Montenegro border area

1. Sheet 1 Vermoshi
2. Sheet 2 Gucia
3. Sheet 3 Stanet e Sublices.
4. Sheet 4 Rapsh-Starja
5 Sheet 5 Tamara
6. Sheet 6 Thethi
7. Sheet 8 Kopliku
8. Sheet 14 Shiroka
9. Sheet 20 Velipoja.



There have been compiled and published the inter-boundary geological maps scale 1:50 000.

Scientific interpretation of geological phenomena based on modern approaches.
Compilation of a database aiming to the planning of a rational national management and exploitation of raw materials, water resources, environmental protection, ore minerals etc.
The geological maps 1:50 000 scale will be useful to various geo-scientific institutions (public and private) in both countries, in the Balkan region and in Europe.

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HOW WAS LAKE DERBORENCE (VS, SWITZERLAND) FORMED? POPULARISATION OF GEOSCIENCES BY MEANS OF A GEOTOURIST MAP

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KEY WORDS: map, popularisation, geotourism

INTRODUCTION

This paper presents the guiding principles and different steps that led to the preparation of a geotourist map of Lake Derborence (Valais, Switzerland). The map combines geoscientific information about the creation of the lake, hiking trail classification and useful tourist information. It was elaborated by the participants of the workshop "Mapping Geoheritage" held from 17 to 20 June 2008 at the University of Lausanne (Switzerland).

GEOGRAPHICAL AND GEOMORPHOLOGICAL OUTLINE OF THE MAPPED AREA

Derborence is a mountain site (1462 m) located in the south-western Swiss Alps (Fig. 1). Huge rock escarpments close the valley in the North and East. The Derbonne river flows from the south-west into Lake Derborence before joining the Lizerne river.

Because of the late transport connection to the Rhône valley, Derborence was preserved from mass tourism and outgrowth of infrastructure. With the increase of the individual traffic and the construction of parking lots near the lake, the place has now become a popular daytrip destination.

The valley shows a high diversity of active geomorphological processes including all common phenomena for alpine regions (fluvial, glacial, periglacial, gravitational, karst). The main geomorphologic attraction is Lake Derborence whose origin is due to large rockslides that occurred in 1714 and 1749 (Bekker, 1883; Mariétan, 1960). The first rockslide can presumably be attributed to slope instabilities caused by an earthquake that happened on 11th August, 1712 in western Switzerland. The second rockslide dammed the Derbonne river and led to the creation of the lake. The Derborence cirque was recognised as a geosite of national significance by the Swiss Academy of Sciences, as an example of a large historical rockslide. It is also a natural reserve protecting a primary forest, untouched since the rockslides isolated it on a steep slope to the south of Lake Derborence.

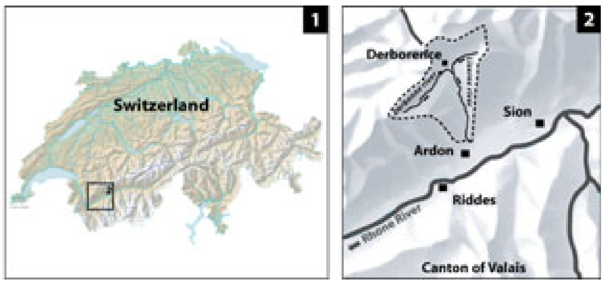

Figure 1 – Situation of Derborence.

GUIDING PRINCIPLES FOR THE GEOTOURIST MAP OF LAKE DERBORENCE

When preparing material for people not familiarised with Geosciences, it is important to create products for specific target groups (families, senior citizen, amateurs, etc) and to adapt the content to their previous knowledge and conceptions of geoscientific processes (Megerle, 2008; Reynard & Berrebi, 2008). This is also true for geotourist maps: the map reading exercise *per se* and the geoscientific legend totally unknown by the user represent a difficulty that should not be underestimated (Kealy, 1998).

In order to create an easily readable map, the guiding principles proposed by Coratza & Regolini-Bissig (2009) were followed (Tabl. 1). According to these authors, it is important to clearly define the intended audience and the purpose of the map. Furthermore, features to be shown on the map should be limited. It was, therefore, decided to produce a map for families – the main group of visitors of the site – that explains the creation of Lake Derborence (main tourist and geomorphological attraction). Other interesting geomorphological features in the region were voluntary left for further popularisation projects.

Map components	Guiding questions (Coratza & Regolini-Bissig, 2009)	Guiding principles adopted for the geotourist map of Lake Derborence
User	Who is the intended audience?	Families that come to the Lake Derborence for a daytrip.
Purpose	What is the purpose of the map?	It gives basic geoscientific information about the origin of Lake Derborence and nearby tourist facilities.
Theme	What is going to be revealed with the map?	The map provides the answer to the question: How was Lake Derborence created?
Level	What complexity of the information is desired / required?	The map should be as simple as possible and self-explanatory (no additional written information). It focuses on: - chronological order of the events that created and modified the lake - tourist facilities in the area - trail morphology and natural hazards along the trail.
Scale	What is the area to be covered?	The area shown on the map includes the lake, the walls from where the mass movements started, part of the mass movement deposits as well as the main tourist facilities.
Dimensionality	How to show the morphology of the mapped area?	We experimented with different map backgrounds (digital terrain models, satellite imagery, aerial photographs) to see which seems most appropriate for families.
Design	How to produce maps that look good and are easy to understand?	By using sequences or “zooms” to focus on specific information or themes not all the information is presented at the same time, which simplifies the reading of the map.
Form and size	For what purpose and in which context is the map going to be used?	We plan a large scale map (A0) shown on a panel located at the car park of Lake Derborence. With the help of this map, families should be introduced to the singularity of the lake.

Table 1 – Guiding principles for the geotourist map of Lake Derborence.

INFORMATION LAYERS

The geotourist map is composed of elements that help to interpret the landscape (geoscientific information) and that give practical information for the exploration of the region. In order to emphasise the relief contrasts and to suggest intuitively the relationships existing between the landforms and the lake formation, the topographic map was overlapped, in transparency, by a hill-shade relief derived from the digital elevation model of the area (obtained from radar with a 2 metre resolution). The trail around the lake was subdivided into different segments according to the morphological and structural-physical characteristics of the paths. Finally, a layer of general tourist information was produced.

GEOSCIENTIFIC INFORMATION

The scientific content of the geotourist map was selected and organised in order to delineate both the geomorphological evolution of the area and the on-going morphodynamic processes. A classical geomorphological legend, simplified to an extreme degree in order to facilitate the understanding, was used.

Following the guiding principles (Table 1) it was decided to represent the processes involved in the formation and evolution of Lake Derborence on three maps.

In the first map, different colours indicate the detachment areas of the two rockslides. To show the magnitude of the rockslides, the area covered by deposits was illustrated. Even if it is difficult to differentiate the two rockslide deposits, two arrows were represented to indicate the main trajectories of each landslide.

The second map shows the preferential direction of the debris-flow channels and sectors where debris accumulate in classical fan-shaped deposits, radically reducing the size of the lake.

In the third map (Fig. 2) the human intervention – an artificial levee, built to deviate debris flows in a south-east direction and to prevent the complete filling of the lake – was highlighted. The abandoned debris channel and related alluvial fan (at present partially vegetated) is clearly differentiated from the new channel created by the deviation of the original debris channel.

The series of maps suggests the chronological succession, giving complete information on past events and current processes affecting the area. They allow the users (families) to understand the different processes that created and modified Lake Derborence.

TRAIL CLASSIFICATION

Mapping trails in relation to geotourist activities involves the analysis of a series of natural aspects, which may render passage difficult or

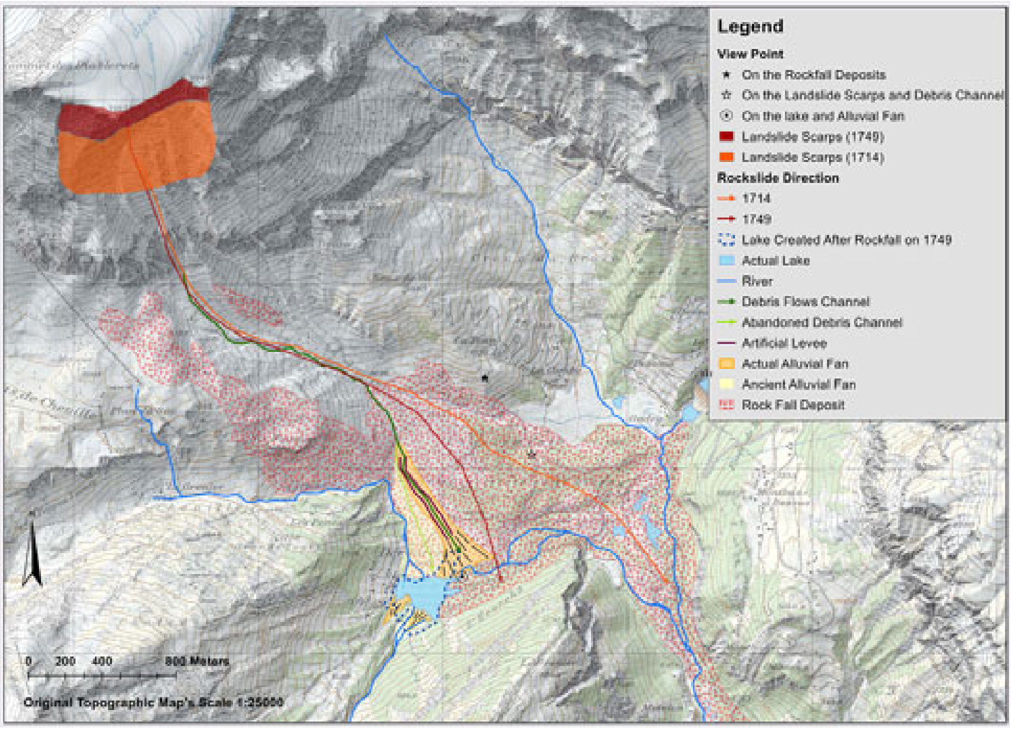

Figure 2 – Map showing Lake Derborence in its current extension and on going geomorpholgic processes.

may represent a hazard for hikers (Brandolini *et al.*, 2007). For subdividing the trails into segments with homogenous characteristics, all the morphological and structural-physical elements of the paths, which make their use more or less suitable for different users (length, difference of level, location, bed type, morphology, and transversal profile, width, steepness, slope aspect and morphology above and below the trail, presence of vegetation, protection and safety structures, state of conservation and signalisation) were considered (Pelfini *et al.*, 2007; 2009).

For an excursion just around the lake of Derborence, considering the typical family tourist audience, characterised by poor training, skills, equipment and knowledge of the environment, it is also important to give information about the potential interaction between weather conditions and elements of the trail, which, for instance, in case of a sudden rainstorm, could increase the vulnerability of the hikers due to the presence of a slippery path or cause the triggering of geomorphological hazards.

Following these criteria, the trail located around Derborence lake was demarked in sections with homogeneous features as shown in Table 2. The trail is mainly located along the rock fall deposit in the slope just a few meters above the lake, or along the plane alluvial fan and the Derbonne river bed. In general, it is a narrow trail, debris covered or uneven with roots and rock blocks. The trail, approximately 1,5 km long, extends along the primary forest of Derborence and along the meadows around the lake. The state of conservation is quite good, with the exception of the sector along the right bank of Derbonne river, where erosional phenomena affect the trail and flooding is frequent (Fig. 3).

trail section number or georeferentiation	-------
length	80 m
difference of level	2 m
location	foot of the slope along the river
trail bed type	dirty trail with wet stretches
trail bed morphology	flat
transversal profile	flat or downhill
width	transit 1 hiker
steepness	0°
slope morphology above the trail	steep
slope morphology below the trail	flat
slope aspect	NW
presence of vegetation	arboreous
protection and safety structures	absent or destroyed
state of conservation	bad
signalisation	absent or destroyed

Table 2 – Trail classification: example of the section along Derbonne river, tributary of Lake Derborence.

The main features of the path and eventually the potential presence of hazards can be synthesised in symbols, to apply in the geotourist maps next to the corresponding stretch of trail (Fig. 4).

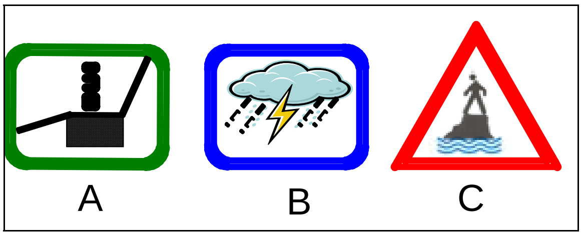

Fig. 4 – Examples of symbols to apply in the geotourist map, giving information about a trail section characterised by a narrow and uneven path where only 1 hiker can transit (A), that in case of heavy rainfall (B) could be affected by flooding hazard (C).

TOURIST FACILITIES

For a geotourist map to be complete, information about nearby tourist facilities is indispensable. All the useful data were gathered during field investigation and then visualised as a separate layer, using international symbols, instantly recognisable by tourists. Elements such as a restaurant, hotel, post-box, road signs, car parks, bus stop, information panels, picnic area as well as areas of primary forest and natural reserve were taken into account. The location of viewpoints, where the visitor can admire the best sights to the lake and geomorphological features, is also very important. A few of such points were determined (Fig. 2). In this way, families get all the necessary information to plan their visit, move around safely and find the most attractive places.

SYNTHESIS

From this example several conclusions may be derived. First of all, as already shown by Coratza & Regolini-Bissig (2009), a fine analysis of the potential user groups is necessary, before the map production, in order to select the information to represent. Secondly, the use of several maps avoids concentrating too much information – difficult to read and interpret – on the same support. Thirdly, if the target group is formed of families or children, as it is the case in this example, the geoscientific content should be reduced to a very simple message (here the factors explaining the lake formation and the processes responsible for its evolution through time). Finally, the most appropriate map background has to evaluated on the basis of several trials.

PERSPECTIVES

Geotourist mapping is a quite recent topic. Several empirical studies and maps were produced during the last decade and recently some attempts to conceptualise were made. One issue is now to develop schemes allowing the various levels of information to be assembled into an appealing design. In the future, geotourist information should also be linked to geoconservation data. The challenge is, therefore, to make the public understand not only the geological processes and their evolution (aim of the geotourist map), but also the fragility of some landforms and the necessity to protect the geosphere as it is already the case of the biosphere.

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