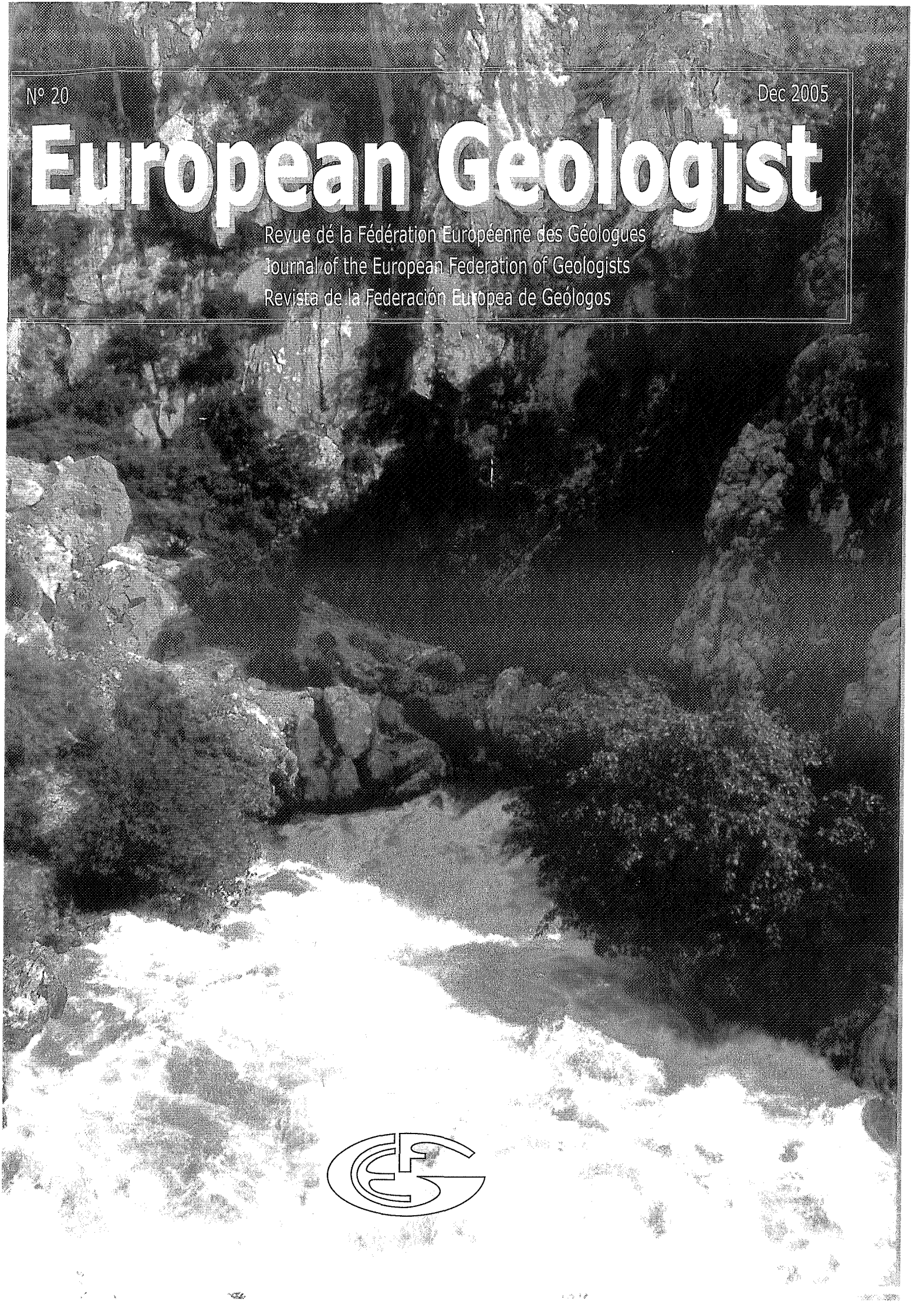
Nº 20 Dec 2005

European Geologist

Revue dé la Fédération Européenne des Géologues
Journal of the European Federation of Geologists
Revista de la Federación Europea de Geólogos



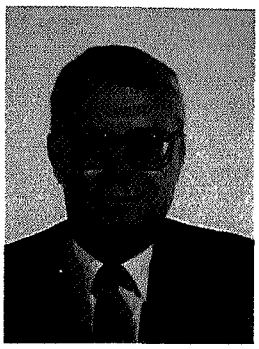
EUROPEAN GEOLOGIST

is published by the
European Federation of Geologists
C/o Service Geologique de Belgique
Rue Jenner 13
B-1000 Bruxelles, Belgium
Tel:+32 2 7887636
Fax: +32 2 6477359
efgbrussels@tiscalinet.be
www.eurogeologists.de

Foreword

Excellence and responsibility

by EurGeol. Prof. Dr. István Bérczi, President



Dear Readers,

Leading personalities in the contemporary world have been frequently tempted to talk only about rights and forget the counterbalance, responsibility. Those who resist this temptation and highlight responsibilities too, are easily and simply branded either as naïve or as authoritarian or populist. Although the neglect of responsibilities may please a part of society, this popularity can easily backfire: people regularly entertained by such a biased view of the world will be unaware of how to defend themselves actively against both natural and social catastrophies. Consequently, in the case of any emergency - when rights do not count - people will still refer to their rights and demand actions from others (mostly national or local authorities). This mentality is a real danger to modern society.

EFG represents a group of professionals, who have been

- Aware of responsibilities throughout the EFG's 25 years of existence as testified by brochures, dossiers, working group reports, declarations
- Open for a professional dialogue across political boundaries, well ahead of the political changes in Europe
- Aware of the importance of the contribution of Earth Sciences and Technology to defend society from natural and subsequent social catastrophies
- Aware of the role of the basic Earth Science education of non-professionals to foster generations dedicated to preserve the geo- and bio-diversity of the globe.

Recent developments both in environmental, geo-hazard, together with mineral and energy commodities' management – natural catastrophies, subsequent social, political unrest in many parts of the world jeopardizing the transport routes of mineral and energy commodities from the producers to the consumers, reserve and resource management issues casting a shadow on the long term sustainability in the mineral and energy industry – are new warning signs for responsible Earth Sciences professionals all over the world in general and in Europe in particular to:

- reconsider the quantity, economics and strategic role of mineral and energy resources (beneath ground resources) in the European soil, with a concomitant reconsideration of the business structure of the extraction industry in Europe
- reconsider the role of Earth Sciences and Technology in strategically managing near surface resources (soil, water, waste disposal)
- reconsider the role of Earth Sciences and Technology in the protection of society by proper land use planning and national/regional development, thereby mitigating the impact of geological hazards
- reconsider the strategy of managing above ground resources (education, training, CPD, organizational, governance skill) in the extracting industry.

These points set a serious challenge to professional geologists. They can be implemented only by close co-operation with regional and global professional associations to demonstrate the commitment of our members to the integrity of the Earth Sciences and to the four pillars of the EurGeol. title concept (Qualification, Excellence, Code of Ethics, Life-Long Learning). This level of professional excellence has to provide a significant contribution to and monitoring of the Bologna process, which in turn is the pre-requisite of the implementation of the visions in the Lisbon Declaration.

To these gargantuan jobs, I wish you, on behalf of the new presidency of the EFG, Good Luck.

Table of Contents

Although the articles in this Magazine are subjected to scientific editing, they are not peer-reviewed.

EUROPEAN GEOLOGIST

EDITOR
Maureen Mc Corry
Harper-mccorry@tele2adsl.dk

ASSISTANT EDITOR
Steen Laursen
steen.l@ursen.dk

EDITORIAL BOARD
Christer Åkerman
Carlo Enrico Bravi
Translations by:
Antoine Bouvier
Manuel Regueiro

Printed by
Knud Graphic Consult
Majorvangen 3, Næsby
DK 5270 Odense N
Denmark
kak@nal-net.dk

Cover photograph
Karst spring at the Adriatic coast in Montenegro
(Photo: Vladimir Zivanovic)

Photograph this page
Young Malian girl pumping water
(Photo: CGG)

ISSN: 1028 - 267X

Land use and environmental decision-making in Ireland

by Donal Daly[1]

Humankind has much to lose if the relationship with the geological environment is not managed effectively. Decision-makers must use geoscientific information and expertise in land use and environmental planning as a means of achieving the maximum long-term benefit for all. The required information is now available, as are the means of communicating and utilizing the information effectively. Groundwater protection schemes are being used in Ireland as a means of integrating geoscientific information into land use and environmental decision-making. Delivery as digital GIS datasets and via the internet is encouraging and facilitating this process.

L'humanité a beaucoup à perdre si la relation avec l'environnement géologique n'est pas prise en compte efficacement. Les décisionnaires doivent utiliser les informations géoscientifiques et l'expertise disponibles dans les domaines de l'utilisation du sol et de la planification environnementale pour le bénéfice de tous à long terme. L'information nécessaire est maintenant disponible, tout comme les moyens pour la communiquer et l'utiliser de façon efficace. Les Plans de Protection des Eaux Souterraines sont utilisés en Irlande comme un moyen d'intégration de l'information géoscientifique dans la prise de décision concernant l'utilisation du sol et l'environnement. L''information numérique disponible sous forme de Systèmes d'informations géographiques (SIG) et sur Internet encourage et facilite ce processus.

La humanidad tiene mucho que perder si no se gestiona adecuadamente su relación con el ambiente geológico. Los responsasables de la toma de decisiones deben utilizar la información geocientífica y la ayuda de expertos para la planificación del territorio y medioambiental, cómo un medio para obtener a largo plazo el máximo beneficio para todos. Actualmente se dispone de la información necesaria, así como de los medios de comunicación y uso de la información de manera eficaz. En Irlanda los Modelos de Protección y Gestión de Aguas Subterráneas se usan como medio de integración de la información geocientífica a la planificación del uso del suelo y a la toma de decisiones en temas relacionados con el medio ambiente. La disponibilidad de los datos en forma digital de Sistemas de Información Geográfica (GIS) a través de Internet fomenta y facilita este proceso

Pressures on the environment are growing in Ireland, arising from social and economic developments that entail the exploitation of natural resources and the generation of wastes. In the past decade, there has been unprecedented economic development (Environmental Protection Agency, 2004); GDP per person has increased from well below the EU average to near the top of the range. The population has also grown strongly (Environmental Protection Agency, 2004), especially in counties adjacent to Dublin. In addition, a high proportion (~35%) of new houses is 'one off', and is not served by public sewerage schemes. As a consequence of these changes, we are not only placing an increasing demand on resources such as land, energy and water, but also increasing the volume of waste generated. Impacts such as eutrophication of rivers, lakes and estuaries, pollution of wells and springs by microbial pathogens, high nitrates in groundwater in some aquifers and increasing emissions of greenhouses gases all reflect the pressures on the environment. The location, design and management of potentially polluting developments, together with the safe disposal of wastes, whether, for instance, in landfills, by on-site wastewater treatment systems or by landspreading, have become increasingly important issues.

Land use planning and environmental planning are the main approaches used in Ireland for trying to achieve a balance between the need to protect both the environment and human health, and the need for development. However, land use planning is a dynamic process with social, economic and environmental interests and impacts influencing the use of land and water to varying degrees. In a rural area, for example, farming, housing, industry, tourism, conservation, waste disposal and water supply are potentially conflicting interests, and may compete for priority. While impacts on air, flora, fauna, visual amenity, etc., are important issues, water is usually the dominant environmental issue in decision-making.

The key requirements for optimal decision-making are considered to be the following:

- using a risk-based approach, including an appropriate conceptual understanding of the underground
- understanding the role of rocks, soils and groundwater in attenuating and transmitting pollutants
- acquiring and making available accurate and relevant information on rocks and groundwater
- integrating relevant geoscientific layers of information, usually using a GIS, into the planning and management of development on and under the Earth's surface

[1]Geological Survey of Ireland

- communicating relevant information effectively to regulators, developers, consultants and the general public.

In Ireland, these requirements are encompassed in groundwater protection schemes (Department of the Environment and Local Government *et al.*, 1999a), as outlined below.

The groundwater protection scheme in Ireland – a risk-based tool for effective land-use planning

The generic groundwater protection scheme used in Ireland is based on the integration of four components:

1. groundwater vulnerability maps
2. source protection area maps
3. aquifer maps
4. groundwater protection responses, which relate to the risk posed by a particular potentially polluting activity, and set out recommended planning and development controls.

The first three components are linked to provide land surface zones.

Groundwater vulnerability maps

Groundwater vulnerability is a term used to represent the 'intrinsic geological and hydrogeological characteristics that determine the ease with which groundwater may be contaminated by human activities'. It is assessed on the basis of the (largely) vertical transport of recharge water and contaminants from the point of release of contaminants to the first groundwater encountered, whether in a bedrock or sand/gravel aquifer.

The characteristics of individual contaminants are not taken into account in vulnerability assessment and mapping. (However, they are an important factor in hazard assessment and in determining groundwater protection responses for particular hazards.) As a consequence, account is only taken of those properties and attributes that are relevant for all types of contaminants, and in particular for conservative contaminants which behave like water itself.

There are two core elements in vulnerability assessment and mapping:

- the protection provided by the geological materials/layers along the pathway, overlying the groundwater. In Ireland, these layers consist of subsoils (Quaternary deposits), and in the case of sand/gravel aquifers, the unsaturated zone
- type of recharge (point or diffuse), which expresses the degree to which the protection provided by the geological materials (or overlying layers) is bypassed. This element takes account of karst areas where there is point recharge at swallow holes, collapse features, etc., resulting in rapid flow to groundwater that bypasses the subsoils and provides minimal attenuation before groundwater (the target) is reached.

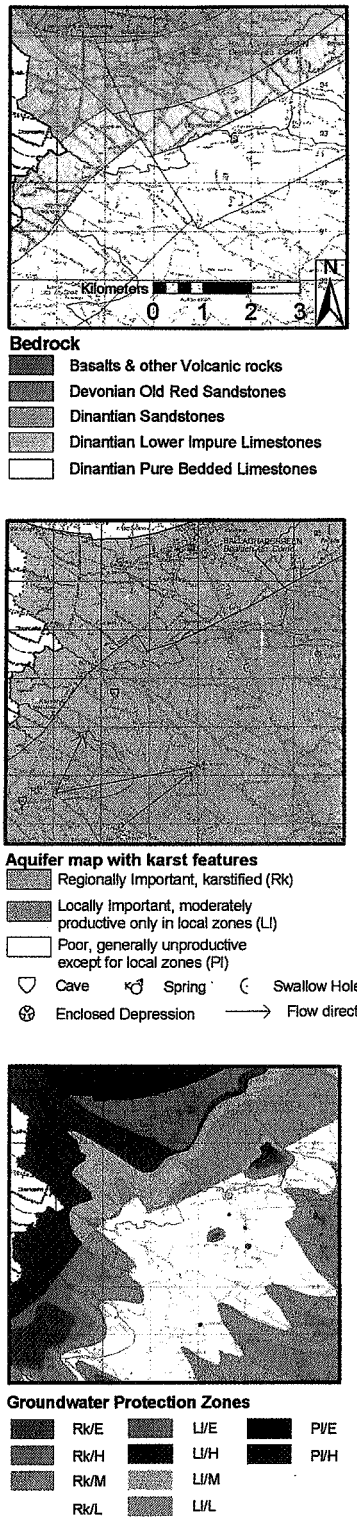


Figure 1. Bedrock, subsoils, aquifer, vulnerability and groundwater protection zone maps from Roscommon GWPS

Four groundwater vulnerability, categories are used in the scheme – extreme (E), high (H), moderate (M) and low (L). The hydrogeological basis for mapping these categories is summarized in Table 1. On vulnerability maps, the extreme (E) category, which is based on a 3 m depth to rock contour, is sub-divided into 'outcrop and shallow rock' (generally <1 m soil/subsoil thickness) and '1-3 m subsoil thickness'.

Vulnerability Rating	Hydrogeological Requirements				
	Subsoil Permeability (Type) and Thickness			Unsaturated Zone	Recharge Type/Karst Feature
	high permeability (*sand/gravel*)	moderate permeability (e.g. *sandy till*)	low permeability (e.g. *clayey till, clay*)	(*sand/gravel* aquifers only)	
Extreme (E)	0 - 3.0 m	0 - 3.0 m	0 - 3.0 m	0 - 3.0 m	point (<30 m radius)
High (H)	>3.0 m	3.0 - 10.0 m	3.0 - 5.0 m	>3.0 m	diffuse
Moderate (M)	N/A	>10.0 m	5.0 - 10.0	N/A	diffuse
Low (L)	N/A	N/A	>10.0 m	N/A	diffuse

Notes: i) N/A = not applicable.

Table 1. Vulnerability mapping guidelines

VULNERABILITY	SOURCE PROTECTION		RESOURCE PROTECTION Aquifer Category						
			Regionally Imp.		Locally Imp.		Poor Aquifers		
RATING	*Inner*	*Outer*	*Rk*	*Rf/Rg*	*Lk/Lm/Lg*	*Ll*	*Pl*	*Pu*	
Extreme (E)	SI/E	SO/E	Rk/E	Rf/E	Lm/E	Ll/E	Pl/E	Pu/E	↓
High (H)	SI/H	SO/H	Rk/H	Rf/H	Lm/H	Ll/H	Pl/H	Pu/H	↓
Moderate (M)	SI/M	SO/M	Rk/M	Rf/M	Lm/M	Ll/M	Pl/M	Pu/M	↓
Low (L)	SI/L	SO/L	Rk/L	Rf/L	Lm/L	Ll/L	Pl/L	Pu/L	↓
	→	→	→	→	→	→	→	→	→

Table 2. Matrix of groundwater protection zones (Arrows indicate directions of decreasing risk)

VULNERABILITY	SOURCE PROTECTION AREA		RESOURCE PROTECTION Aquifer Category					
			Regionally Important (R)		*Locally Important (L)*		*Poor Aquifers (P)*	
RATING	*Inner*	*Outer*	*Rk*	*Rf/Rg*	*Lm/Lg*	*Ll*	*Pl*	*Pu*
Extreme (E)	R4	R4	R4	R4	R3[2]	R2[2]	R2[2]	R2[1]
High (H)	R4	R4	R4	R4	R3[1]	R2[1]	R2[1]	R1
Moderate (M)	R4	R4	R4	R3[1]	R2[2]	R2[1]	R2[1]	R1
Low (L)	R4	R3[1]	R3[1]	R3[1]	R1	R1	R1	R1

Table 3. Response matrix for landfills (Department of the Environment and Local Government et al., 1999b)

Groundwater source protection zones

Two source protection areas (SPAs) are delineated around a public supply well or spring: an Inner Protection Area (SI), defined by a 100-day travel time within the aquifer from any point below the water table to the source, and an Outer Protection Area (SO), encompassing the remainder of the source catchment area or zone of contribution (ZOC). The SPAs are combined with the vulnerability map to give the groundwater source protection zones, as shown in Table 2.

The boundaries of the SPAs are based on the horizontal flow of water to the source, whereas the vertical movement of water and contaminants to the bedrock aquifer is taken into account in the vulnerability rating.

Groundwater resource protection zones

For any region, the area outside the source protection zones is classified into one of three basic resource categories depending mainly on their permeability, areal extent, and storage capacity. Each category is further split into two or three sub-categories, according to the type and variability of permeability:

- Regionally Important Aquifers (R): These are sub-divided into 'Rg' (Sand/Gravel Aquifers), 'Rk' (Karst Limestone Aquifers) and 'Rf' (Aquifers with Fissure Flow).
- Locally Important Aquifers (L): These are sub-divided into 'Lk' (Karst Aquifers), 'Lm' (Generally Moderately Productive), 'Ll' (Productive only in Local Zones) and 'Lg' (Sand/Gravel).
- Poor Aquifers (P): These are sub-divided into 'Pl' (Generally Unproductive except for Local Zones) and 'Pu' (Generally Unproductive).

Groundwater protection zones

Groundwater protection zone are produced by combining the vulnerability, source protection area and the aquifer categories (see Table 2). The combining of geological and hydrogeological maps to give the groundwater protection zone map is illustrated in Figure 1. Each protection zone has a code that represents both the groundwater value (use for public supply or aquifer category) and the groundwater vulnerability. In essence, the code represents a simple, but useful, conceptual hydrogeological model of the area delimited by the zone. Thus, for any site or area, a groundwater protection category exists that influences the degree of protection required for the groundwater beneath that site.

Groundwater protection responses

Risk management for potentially polluting activities within the groundwater protection scheme is by means of groundwater protection responses for each activity. Groundwater protection responses set out recommended responses to development showing (a) whether such a development is likely to be acceptable, (b) what further

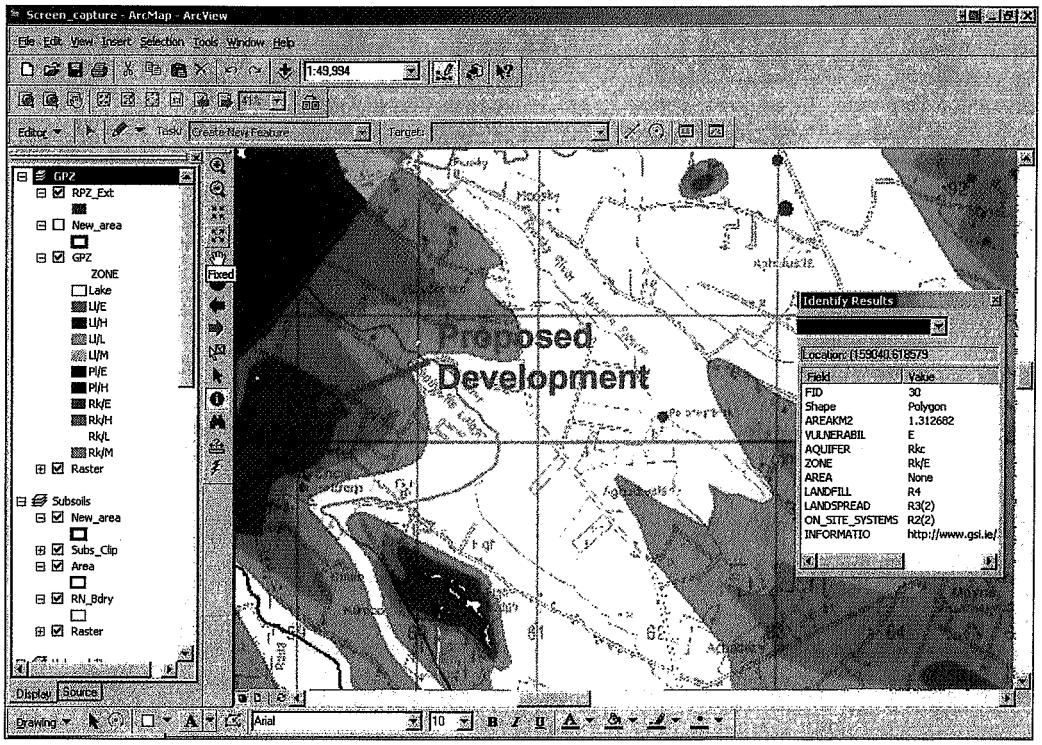


Figure 2. Screen capture from the County Roscommon GWPS GIS, showing protection zones and responses for a proposed development.

investigations may be necessary, and (c) what planning or licensing conditions may be necessary. They take account of the elements of risk, i.e. the hazard posed by the proposed action, the groundwater vulnerability, the location relative to wells and springs, and the aquifer category. Responses have been published for landfills, land spreading of organic wastes, on-site wastewater treatment systems, and are nearing completion for petrol stations, constructed wetlands and earth-lined slurry stores. It is likely that these responses will become part of the WFD Programme of Measures.

Four levels of response (R) to the risk of a potentially polluting activity are determined:

- R1 acceptable subject to normal good practice
- $R2^{1,2,3}$ acceptable in principle, subject to conditions in notes 1, 2, 3, etc. (The number and content of the notes varies depending on the zone and the activity)
- $R3^{1,2,3}$ not acceptable in principle; some exceptions may be allowed subject to the conditions in notes 1, 2, 3, etc
- R4 not acceptable.

The response matrix for landfills is given in Table 3 as an example.

Examples of response categories are as follows:

$R2^2$ acceptable subject to guidance outlined in the EPA Landfill Design Manual or conditions of a waste licence:

- special attention should be given to checking for the presence of high permeability zones. If such zones are present then the landfill should only be allowed if it can be proven that the risk of leachate movement to these zones is insignificant. Special attention must be given to existing wells down-gradient of the site and to the projected future development of the aquifer
- groundwater control measures such as cut-off walls or interceptor drains may be necessary to control high water table or the head of leachate may be required to be maintained at a level lower than the water table depending on site conditions.

$R3^1$ Not generally acceptable, unless it can be shown that:

- the groundwater in the aquifer is confined or
- there will be no significant impact on the groundwater and
- it is not practicable to find a site in a lower risk area.

Communicating with decision-makers, developers and the general public

The Role of Geographic Information Systems (GISs)

In recent years, the delivery of groundwater protection schemes to local authorities has been enhanced by the incorporation of the land use zoning maps and the responses into a digital GIS dataset, registered to the Ordnance Survey map base. The GIS dataset delivered to users (in particular, local authorities and the EPA) includes complete county coverage by discrete polygons, where each polygon contains values for the following:

- groundwater vulnerability rating
- aquifer category
- groundwater protection zone classification and
- response codes for
  - landfill
  - landspreading
  - on-site wastewater treatment systems.

An individual location can be queried and the values for all the above parameters can be obtained instantly for that location. This can be of particular value when a regulator is considering a specific planning or licensing application for a development at a site. In Figure 2, a portion of a county groundwater protection scheme is shown with the land surface zoning and responses for a specific site marked on the map.

Using the internet

The groundwater maps (aquifer, vulnerability and groundwater protection zone) for eleven counties can now be viewed on the GSI website (www.gsi.ie). Querying the website enables not only the aquifer

category, vulnerability and groundwater protection zone for any site/area to be ascertained, but also the groundwater protection responses. In addition, country-wide bedrock unit and aquifer maps can be viewed, free of charge, by public servants, consultants, academics, students and members of the public.

Conclusions

The interaction between human activities and the natural environment is a key element in the well-being of both the environment and humans as an integral component of the environment. Groundwater protection schemes, as used in Ireland, are a means of a) enabling the acquisition, processing and evaluation of relevant geological and hydrogeological information and b) integrating this information into land use and environmental decision-making. In addition, they are used in assessing environmental impact statements, planning and undertaking groundwater monitoring networks, locating water supplies and in infrastructure planning, and can be adapted to include risk to surface water. By utilizing GIS and the internet, the results are made available not only to decision-makers in regulatory bodies, but also to consultants, students, members of the public and others.

Acknowledgements

The development of the groundwater protection scheme concept in Ireland and its implementation has been aided by colleagues, too numerous to list here, both inside and outside the Geological Survey, in Ireland and abroad.

References

Department of the Environment and Local Government, Environmental Protection Agency & Geological Survey of Ireland. 1999a. *A scheme for the protection of groundwater.* Geological Survey of Ireland, Dublin.

Department of the Environment and Local Government, Environmental Protection Agency & Geological Survey of Ireland. 1999b. *Groundwater protection responses for landfills*. Geological Survey of Ireland, Dublin.

Environmental Protection Agency, 2004. *Ireland's Environment.* Environmental Protection Agency

This paper is published with the permission of Dr. Peadar McArdle, Director, Geological Survey of Ireland. It is based on the following publication: Daly, D. 2004. Groundwater At Risk in Ireland – Putting Geoscientific Information and Maps at the Core of Land Use and Environmental Decision-making. John Jackson Lecture. RDS Occasional Papers in Irish Science and Technology. Number Twenty-Eight. 32pp.

EFG and the EC Floods Directive

by Herald Ligtenberg

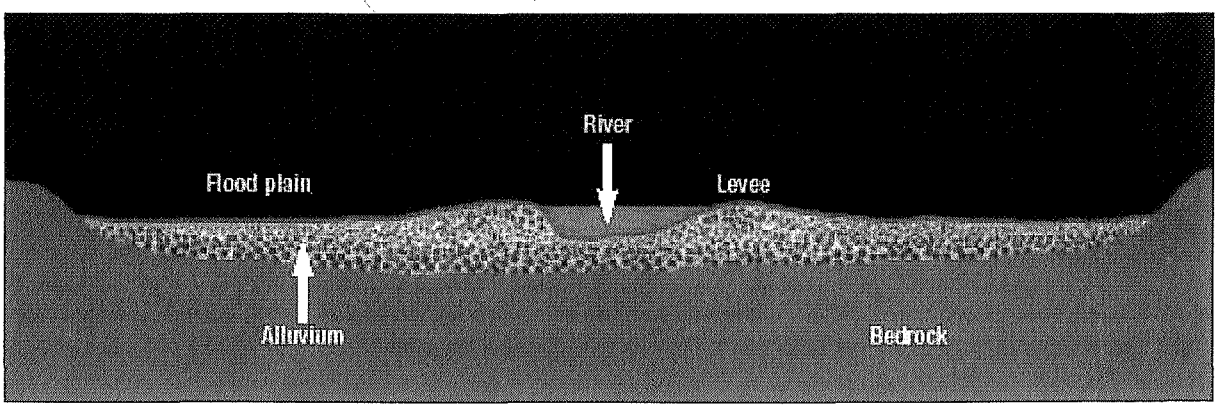
The European Commission, DG Environment sector on water-related issues, is working on a special Floods Directive. It will include guidelines and procedures that should be applied in each EU country to reduce the impact of floods throughout Europe. Understanding the subsurface is crucial in most flood cases.

It is of great importance that geology is taken into account in the Floods Directive. Therefore, the EFG office director Isabel Fernandez, the coordinator of the EFG expert group on natural hazards Herald Ligtenberg, and natural hazards expert Marino Trimboli visited the European Commission in May 2005 to discuss our possible involvement by means of advice from a geological perspective.

The visit resulted in the active involvement of our expert group on natural hazards (approx. 40 members) in an online EC questionnaire. Subsequently, a concise document with recommendations for the Floods Directive has been written by this expert group (see following page). This document was presented to the European Commission at a special stakeholders meeting in September, in which the EFG was invited to participate.

The European Commission has subsequently initiated special working groups that will address different flood issues. One working group will deal with weather forecasting; a second group will focus on flood risk mapping; a third group will focus on land use planning. The second and third EC working groups are of particular interest to us. The EFG is planning to actively participate in these working groups, most probably by assigning two members of our expert group on natural hazards.

We are pleased to see that the European Commission shows a continuous increase in interest in geology and a continuous increase in the acceptance of its importance in natural hazards issues. Together with the expert group we will continue to contribute and to provide high quality advice to the European Commission.



Top left: Flood event in United Kingdom, 1999. (courtesy BGS, © NERC)
Bottom: Schematic illustration of cross-section through river plain system (courtesy GSL)

Geo-scientific recommendations for the Floods Directive

Flooding is any abnormally high water flow that overruns the natural or artificial confining boundaries of the waterways. Single events can result in heavy tolls of death and can cause significant damage to properties, historical heritage, infrastructure and set-back of regional economy, as we especially have noticed in the European floods in the last decade. Floods are caused not only by rain but also by man-made changes to the earth's surface, e.g. farming, deforestation and urbanisation (especially of alluvial fans, in mountain regions, and flood plains). These actions increase runoff from rains, and storms that previously would have caused no flooding inundate vast areas today.

Construction in vulnerable areas should be avoided when possible, or else prevention and mitigation measures should be taken. The first and most important step is to identify the high-risk areas through risk maps showing flood probabilities.

Geology should be an integral part of flood prevention and protection. Weather forecasting is of course a first priority in flood prediction, but detailed knowledge of the subsurface is crucial in flood prevention and protection; imagine the subsurface behaving as a sponge or a seal. We therefore see it as our responsible task to provide practical advice from a geo-scientific perspective.

From a geo-scientific perspective, we recommend the following:

1. Creating flood hazard and risk maps of river basins and coastal areas

It is important: to take into account the subsurface by using geological and geomorphologic maps, mostly available at National/Regional Geological Surveys, National Basin Authorities or National Environmental Protection Agencies.

- The complete natural floodplain should be taken into account as zone of flood risk, instead of statistical historical records of the last e.g. 100 years (in many countries flood hazard analysis are done taking into account reference return periods of 200 and 500 yrs.). Adopting the complete natural floodplain would include areas likely to flood in some worst-case future climatic scenarios.
- Construction of flood defence systems should be designed with specific geological & geomorphologic studies analyzing erosion (historical evolution of coasts and river banks) and solid carrying capacity of rivers (consult geological maps) to avoid building on top of old river bed deposits or other negative effects. These would function as underground water migration pathways towards the other side of the flood defence systems and thereby make the flood defence system dysfunctional.

Take into account other related natural hazards on flood risk maps, for example the vulnerability for landslides.

Flood and landslide risk maps should be fully adopted in land-use planning procedures. All land management and planning instruments must be realized with the support of specific geological hazard studies within a "Basin Plan".

Flood hazard and risk maps are dynamic and require periodic actualization.

2. Raise awareness and educate people

Efforts must be made to increase the level of public awareness regarding the causes and effects of natural hazards. People living in vulnerable areas, e.g. in valleys affected by repeated flooding, should be aware of the potential risk and possible measures they can take to protect their lives and possessions. Local authorities must know when to alert the population and how to engage disaster management teams.

The more that can be achieved at a local plan, the better immediate measures. Education and practical instruction ought to be implemented at different levels in society: at public schools, via seminars, educational brochures as well as specific information to local politicians and decision makers. Measures may also be directed towards the tourist industry, including brochures and videos describing natural hazards in vulnerable parts of the world where tourism is important.

The European Federation of Geologists (EFG) can assist in editing schoolbooks, producing pamphlets and to arrange seminars in all member countries (to the general public, as well as special education to policy-makers and land-use planners). Efforts can be focussed on the specific priority schemes in each country.

3. Geo-scientific investigations to check the quality of water defence systems

Flood defence systems will deteriorate with time due to many factors, including ground erosion, slope instability, animal digging and vehicle traffic. The only accurate method for the identification of damaged flood defences can be carried out by means of geophysical techniques, which identifies differences in physical characteristics of rocks and soils.

The Flood Directive should include detailed geophysical, engineering geological and geotechnical investigations of flood defence systems in areas at higher risk (e.g. in areas with high population) to detect weak sections in dikes at an early stage.

The European Federation of Geologists can make recommendations to the type of geophysical and geotechnical methods to be applied and can provide experts to consult the European Commission and national governments in the procedure to be taken.

4. Set up expert teams at national or river basin level

It is recommended to set up expert teams at national or river basin level to quickly investigate the complete fluvial system to locate zones at high risk, to locate zones that are suitable for retention areas, to locate zones that require high priority in geophysical quality evaluation of flood defence systems, and so on. These teams should comprise hydrologists, geologists, geophysicists, remote sensing experts and engineering geologists.

Flood risk due to the tsunami

by D Vatvani[1] and J Boon[1]

The tsunami that ravaged the Indian Ocean in December 2004 cost many human lives and caused vast damage along coastal areas in India, Andaman Islands, Thailand, Sri Lanka and Indonesia. Unawareness and lack of preparation for the impact of the flood waves aggravated the level of damage and the death toll. Accurate prediction of the arrival times and heights of tsunamis or availability of risk maps showing vulnerable areas that are prone to flooding could have saved some lives and reduced damage to key infrastructure.

Le tsunami qui a affecté l'Océan Indien, en décembre 2004, a provoqué la mort d'un grand nombre de personnes et causé des dommages très importants le long des cotes, en Inde, aux îles Andaman, en Thaïlande, au Sri Lanka et en Indonésie. La méconnaissance du phénomène et l'impréparation face à l'impact des vagues et à l'inondation ont aggravé le bilan des dommages et pertes en vies humaines. Une prédiction précise (heure et amplitude) de l'arrivée du tsunami ou la mise à disposition des cartes de risques indiquant les régions vulnérables et inondables aurait sauvé des vies et réduit les dommages aux infrastructures de base.

El tsunami que devastó el océano índico en diciembre de 2004 costó muchas visa humanas y causó inmensos daños a lo largo de la costa de India, las islas Andaman, Tailandia, Sri Lanka, e Indonesia. La ignorancia y la falta de preparación para el impacto de la avenida de olas agravaron los daños y la cantidad de muertos. Una precisa predicción de los tiempos de llegada y altura de los tsunamis o la disponibilidad de mapas de riesgo mostrando las zonas vulnerables que eran susceptibles de inundarse podría haber salvado algunas vidas y reducido el daño a infraestructuras clave

Numerical models may be used to better understand the dynamics of tsunami generation, propagation and inundation. This knowledge should be made available to authorities and the general public in comprehensible language accompanied by easily understood risk maps.

WL | Delft Hydraulics has simulated the tsunami propagation of the 2004 Boxing Day tsunami and the flooding it caused in Banda Aceh and has compared the results with observed data (Fig.1).

Comparison of tsunami propagation with satellite altimeter data

Four radar altimeters coincidentally captured sea level heights over the Indian Ocean during the first few hours after the 26 December 2004 earthquake. TOPEX/ Poseidon and Jason-1 satellites mapped the Indian Ocean about 2 hours after the tsunami started; Envisat satellite after 3 hours 15 minutes and the US Navy GEOSAT

[1]WL | Delft Hydraulics. 2629 HD Delft, The Netherlands
Deepak.vatnani@wldelft.nl
Johan.boon@wldelft.nl

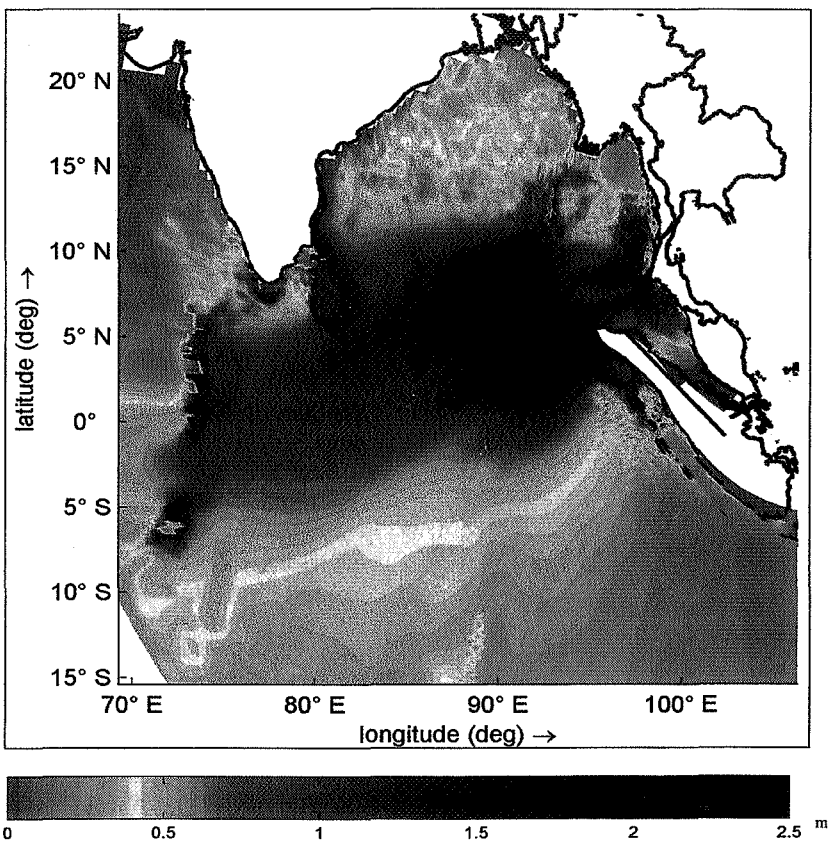


Figure 1. Computed maximum Boxing Day 2004 tsunami wave heights (in meters).

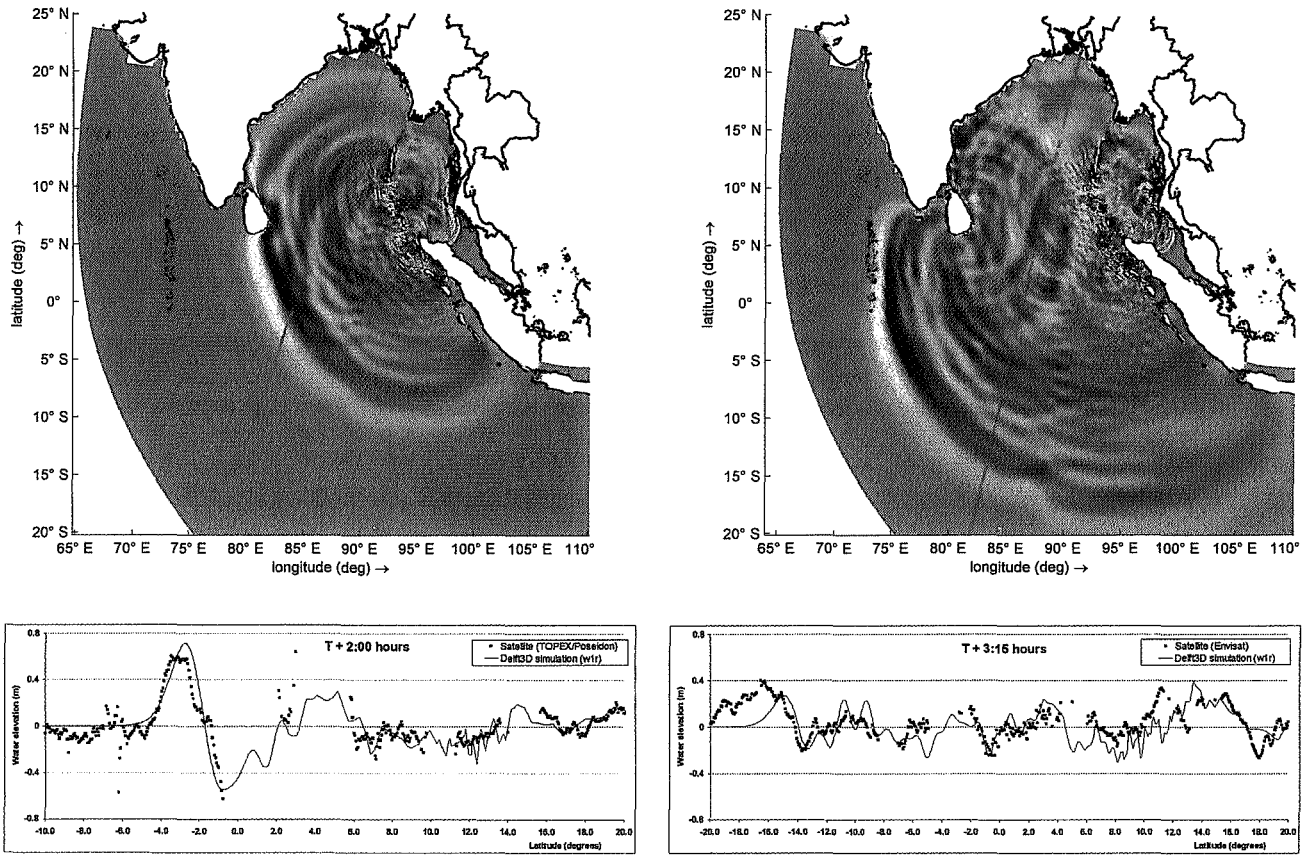


Figure 2. Computed (blue line) and observed (dotted line) tsunami wave heights along the TOPEX/Poseidon and Envisat satellite tracks (red line) at: a. T+2:00 UTC (left) and b. at T+3:15 UTC (right).

Figure 3. Simulated flooded area (shown in red) in Northern Aceh after the 2004 Boxing Day tsunami.

follow-on satellite (GFO) recorded the tsunami wave more than 7 hours after it started. Details of the flight paths and the measured tsunami heights can be found at the NOAA web-site. Along the flight paths of the satellites, measured data are compared with simulation results (Fig.2).

The Aceh flooding and flood risk mapping

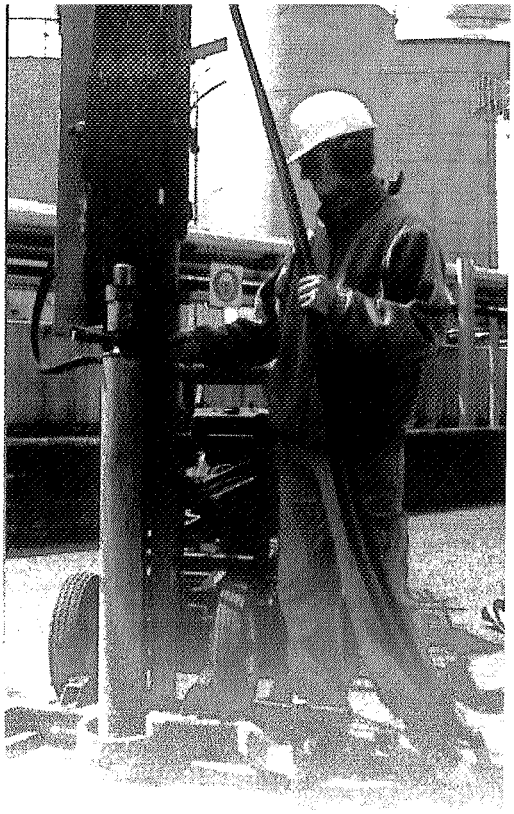
A local fine grid model was set-up to simulate the flooding in Aceh province in Indonesia. The simulated inundation and run-up heights at a number of locations have been compared with the survey data that was compiled by the International Banda Aceh Tsunami Survey Team. They are found to be in good agreements with the data.

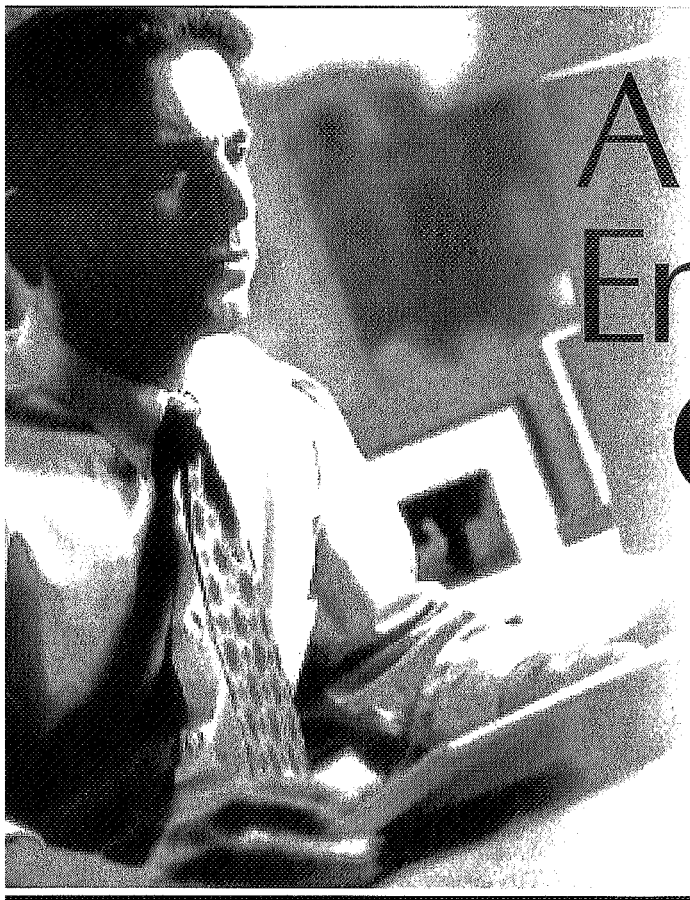
In view of the disastrous effects of the tsunami, various measures are being contemplated to improve the protection of the region. Adequate measures to facilitate a sustainable "flood and tsunami-proof" long-term regional development can be designed provided reliable estimates of tsunami heights, arrival times and the associated flood risks can be ascertained. Furthermore, the tsunami threats that previously were overlooked for existing infrastructure such as harbours, power plants and other important utilities may need to be re-evaluated.

Results presented in Figure 3 (compare with e.g. the satellite picture taken by IKONOS -CRISP, 2004 of the same area) shows that the model has a good potential to generate accurate flood risk maps that can be used for disaster prevention, relief operations, risk assessment and development planning.

ENVIRONMENTAL

White
Young
Green





A Professional Environmental Consultancy

www.wyg.com

Air
Water
Soil
Noise
Waste
Ecology
Training
GIS

Dublin
Tel. +353 (0)1 2931200
eMail: dublin@wyg.com

Belfast
Tel: (028) 90706000
eMail: belfast@wyg.com

Cork
Tel. +353 (0) 21 4861488
eMail: cork@wyg.com

Derry
Tel. +353 (028) 71371105
eMail: derry@wyg.com

Geology-based methodologies for visualizing inland floodplains and understanding fluvial processes

by John N Carney[1] and Bruce Napier[1]

Floodplains pose a major hazard to development, largely because they naturally contain excess water when the capacity of the main river channel is exceeded. Statistical/hydrological methods can define various flooding limits, but geological maps are also valuable because they allow floodplains to be readily visualized as natural landforms occupied by distinctive deposits. Geological maps can also indicate floodable ground lying outside statistically calculated flood-risk envelopes, and they show smaller, tributary floodplains that may not have been investigated for flood-risk. Laser-based micro-topographic surveys dramatically illustrate the fluvial anatomy of floodplains and are essential for modelling and predicting the likely course of a severe flood event, thus providing information for floodplain management and planning decisions.

L'inondation des plaines constitue un risque majeur à leur aménagement, essentiellement parce qu'elles jouent le rôle de réservoir quand les capacités de rétention du lit principal de la rivière sont dépassées. Des méthodes statistiques/hydrogéologiques peuvent définir différentes limites d'inondation mais les cartes géologiques ont aussi un grand intérêt car elles permettent de visualiser aisément la géomorphologie et la nature lithologique des dépôts des plaines inondables. Les cartes géologiques sont également capables de préciser les limites des zones inondables situées à l'extérieur des périmètres fournis par les études statistiques en indiquant des secteurs inondables de superficie moins importante en relation avec les affluents. Des études de topographie de détail en utilisant le laser illustrent de façon dramatique les axes d'écoulement en plaines inondables et sont capitales pour modéliser et prévoir les traits caractéristiques d'une inondation importante, permettant ainsi de prendre les décisions qui s'imposent pour la gestion et l'aménagement des zones inondables.

Las llanuras de inundación representan un elevado riesgo para el desarrollo, fundamentalmente porque retienen de manera natural el exceso de agua cuando se sobrepasa la capacidad del cauce del río. Los métodos estadísticos/hidrológicos pueden definir diversos límites de las inundaciones, pero los mapas geológicos son también útiles porque permiten la rápida visualización de las llanuras aluviales como formas naturales ocupadas por depósitos muy representativos. Los mapas geológicos pueden indicar también los terrenos inundables que se encuentran fuera de los entornos de riegos de avenidas estadísticamente calculados y pueden indicar llanuras de inundación tributarias más pequeñas para las que puede no haberse investigado su riesgo de avenidas. Las investigaciones micro-topográficas con láser ilustran dramáticamente la anatomía fluvial de las llanuras de inundación y son esenciales para la modelización y predicción del posible curso de una inundación grave, proporcionando información para la gestión de la llanura de inundación y las decisiones de planificación.

Floodplains are flattish valley floors that provide a natural conduit and temporary storage area for water during exceptionally high flows, when the capacity of the main river channel is exceeded. Throughout Europe there are abundant recent examples of how flooding of these tracts can pose a hazard to existing development, and there is currently a major debate over the best ways to 'manage' floodplains to offset the risk that they will present if predictions of increasingly severe storm events are fulfilled. Typical questions being asked are: whether floodplains should be managed in a sustainable manner, in harmony with their environments, or whether their natural functions and processes should be subordinated in an effort to defend, at all costs, buildings and infrastructure on floodplains? Underpinning these impending decisions is an increasing body of scientific information from a wide range of disciplines (such as climatology and hydrology). This article explains why geology, and the allied science of geomorphology, should be taken into account during the complex processes that are involved in floodplain management and flood-risk assessment.

[1]*British Geological Survey, Keyworth, Nottingham, NG12 5GG*

Conceptual problems of floodplain definition

The prevalent climate of concern over flooding risk, and the plethora of initiatives that are being followed, has only served to increase confusion over what floodplains actually are. Floodplains have been defined in many ways, but in modern hydrological parlance there is often a trend to use terms such as 'flooding limit' synonymously with 'floodplain'. An example

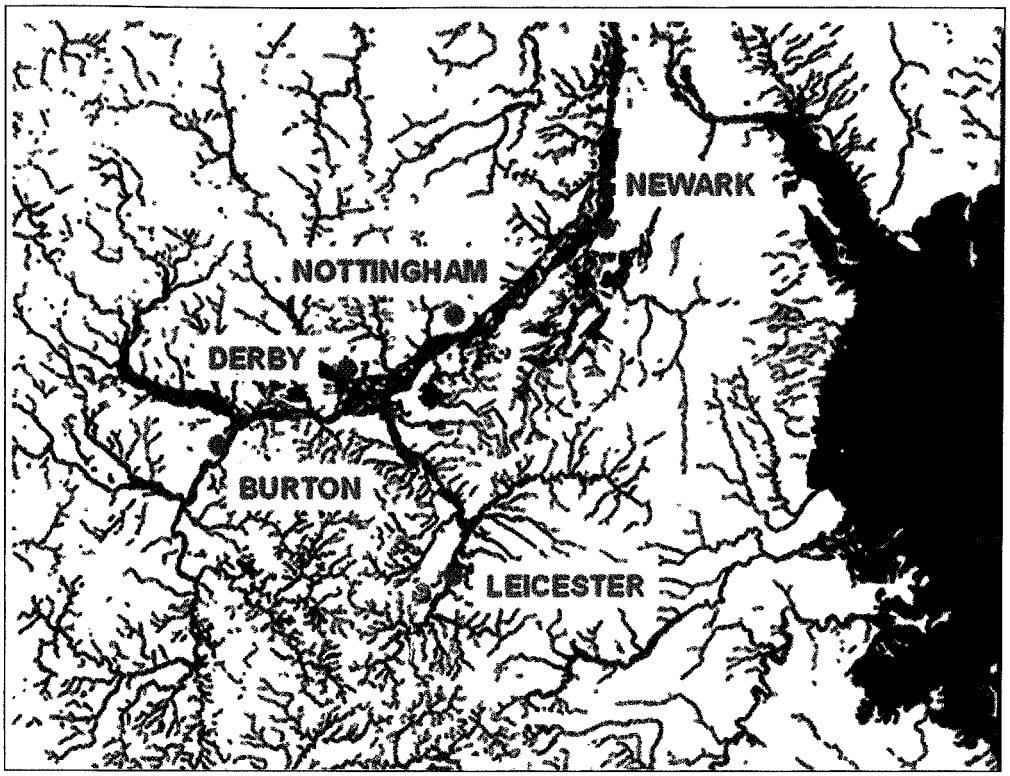


Figure 1. Distribution of floodplain alluvium in the East Midlands, UK. Extracted from DIG-MapGB (BGS digital geological map of Great Britain).

of such terminology can be found in the UK government's paper for England: 'Development and Flood Risk' (Planning and Policy Guidance Note No. 25). This maintains that the limits of the floodplains are "*based on the approximate extent of floods with a 1% annual probability of occurrence for rivers..... under present expectations or, where this is greater, the extent of the highest known flood*". With this combined statistical and historical approach there can be any number of different 'floodplains' represented in a single river valley (or coastal tract), depending on the excess limit chosen. This introduces problems for those not familiar with statistical methods who are seeking to envisage and understand floodplains. Here, we suggest that to assist public perceptions of the floodplain and its limits, as well as a catalyst to geoscientific studies relevant to floodplain management, it may be equally important to *visualize the floodplain as a natural physical entity.*

Visualizing floodplains on geological maps

Geologists (and geomorphologists) would suggest that statistically calculated flooding limits simply constitute probability envelopes within the wider context of the natural, or geological, floodplain. Floodplains are seen as distinctive landforms, the boundaries of which can be constrained by observation and which directly relate to fluvial geomorphological processes. The limits of the geological floodplain can be systematically surveyed on the ground, and are thus easy to visualize and depict on maps. In addition, a distinctive suite of Quaternary deposits defines the floodplain tract. Such deposits can be identified on the ground and it is now possible to demonstrate their distribution by utilizing new-generation airborne techniques, such as LiDAR, as outlined below. In Europe, the results of this work are the geological survey maps, commonly available digitally as well as in the more traditional hard-copy formats, which are the principal, and in most cases, only record of floodplain geology (Fig. 1).

In detail, geological maps show that the lowest-lying tracts in the floodplain correspond to the extent of *alluvium*, which represents the clay, silt, sand and gravel deposits laid down by fluvial processes, such as meander migration, channel switching and overbank flooding of the modern river channel. Many larger floodplains include additional areas of raised, sandy ground adjacent to and contiguous with the alluvium outcrops. These areas represent a slightly older development of the floodplain, which was abandoned following the most recent episode of base level lowering and incision of the main stream. In the UK they are generically known as the 'first terrace' or the *'floodplain terrace'* (Fig. 2a). Depending upon its height, the floodplain terrace may be partly or wholly inundated during extreme flood events and so, adopting a precautionary approach to flood hazard assessment, it should logically be included within the modern floodplain system. Therefore, the natural geological limits of the floodplain are taken at the break in slope that marks the back-edge of the alluvium or floodplain terrace, and the change to rising ground behind this. Older and higher river terraces, which are commonly perched on a 'step' consisting of bedrock, are not considered to be part of the floodplain. Boreholes can be useful for identifying alluvium or terrace deposits in urban areas, and for clarifying their composition and physical properties at depth.

The relationship between geology and surface inland flooding

To test whether geological maps can provide a suitable earth-science framework in which to consider the extent and effects of flooding, the British Geological Survey (BGS) commissioned an aerial survey across a large part of the River Trent, in England, during a major flooding event that occurred early in November 2000.

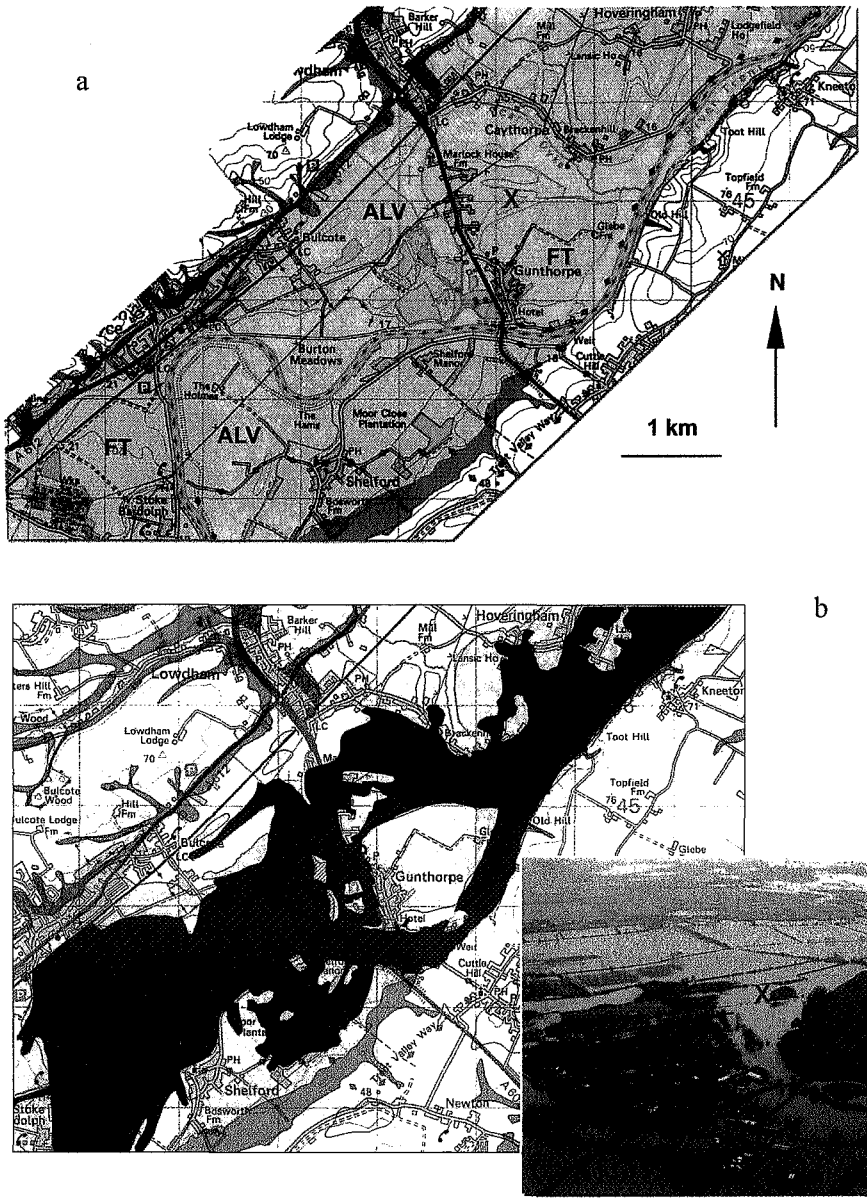


Figure 2 a. Simplified Quaternary geology of the River Trent floodplain 9 km east of Nottingham. The 'geological' floodplain is defined by outcrops of alluvium (ALV) and floodplain terrace (FT). Direction of river flow is towards the north-east.

b. The same map, showing the observed inundation extent (blue areas) of the November 2000 flood. Note that the floodplain terrace outcrops represent flood-retardant areas, and that some tracts of alluvium were also not flooded.

c. Aerial photograph of the flooding, viewed towards the NE, with location point (x) also shown on Figures 2a and b. Topography © Crown copyright. All rights reserved NERC100017897/2005.

It was found that large tracts of the alluvium, and the lower, degraded parts of the flood-retardant areas occupied by the floodplain terrace, were inundated (Figs 2b, c) during an event estimated by the UK Environment Agency to have a 1-in-35 year return period. Other parts of the floodplain alluvium, and in particular the higher ground occupied by the floodplain terrace, remained dry. Such areas, however, could be at risk from flooding during more severe events, such as the 100 year, or 1% flood. Recent statistical estimates of the 1% flood limit suggest that about 80% of the geological floodplain shown in Figure 2a would be inundated, in which case the remaining outcrops of alluvium or floodplain terrace lying outside of this may be indicating areas that would be at risk during, say, a 200 or 300 year flood event. In the UK there are many smaller, tributary floodplains (Fig. 1) for which statistical flood risk assessments may never be carried out. For these tracts of ground, the principal indication of floodplain extent, and hence of potential flood hazard, will be the geological maps showing floodplain deposits, perhaps in conjunction with local historical and anecdotal evidence of flooding.

Options for sustainable floodplain management

The flooding issue has stimulated much research into the scientific and societal aspects of floodplains. In the UK, organizations such as DEFRA (Department for the Environment, Food and Rural Affairs) and the Environment Agency are leading the development of strategies to manage floodplains better. The flood management options range from direct intervention ('hard engineering'), such as the construction of flood banks (particularly in existing urban areas), the re-routing of the main channel and excavation of flood reservoirs, to more natural 'soft' measures such as improved farming practices, afforestation of the catchments, and 'managed retreat'.

The 'managed retreat' option is mainly designed for non-urban locations. It involves the removal of artificial defences, allowing floodwaters to more readily occupy the lower-lying parts of the floodplain. This option aims to return the floodplain to its natural storage capabilities, thus reducing the eventual flood peak and mitigating the

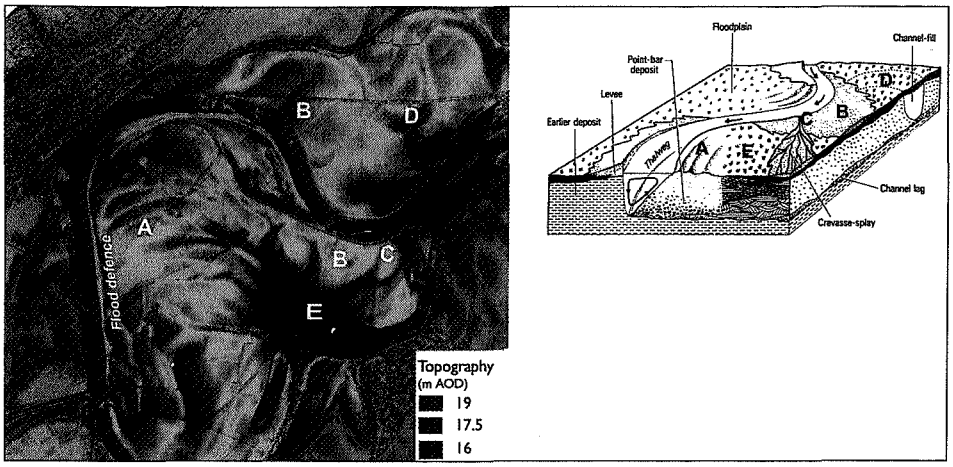


Figure 3. Airborne laser image (LiDAR method) showing the micro-topography and main alluvial elements of the Trent floodplain for the southern part of Figure 2a, with colour-enhanced contouring at 50 cm intervals. The block diagram (from Collinson, 1978) shows the fluvial elements within a floodplain bordering a typical meandering channel, with letters indicating their equivalents identified on the LiDAR image.
Source: LiDAR data © UK Environment Agency. BGS reprocessed image © NERC. All rights are reserved by the copyright proprietors.

damaging effects of flooding downstream. A second advantage is that it would create, or re-create, original fluvial habitats and ecosystems, such as seasonal wetlands, which have all but disappeared from many embanked floodplain tracts that have been 'reclaimed' for arable farming and other purposes. If sustainable management scenarios are adopted, however, it will be necessary to assess the fluvial response of the river system at times of flood, for a range of possible scenarios.

Understanding fluvial processes on floodplains

Although standard geological maps visualize the natural floodplain and its limits in broad outline, they cannot provide the type of high-resolution analysis of fluvial processes and fluvial domains that is necessary to inform planners and developers about how the floodplain will respond to severe climatic events. To achieve this, geological maps can be considered in conjunction with accurate ground elevation models provided by the new-generation LiDAR techniques of micro-topographical surveying. These elevation models (Fig. 3) can have a vertical height resolution of as little as 15 cm., sufficient to detect subtle topographical changes that characterize floodplains, which commonly have a height range of between 1 and 3 m. The topographical features revealed by LiDAR surveys will include river terraces and also erosional and depositional elements related to the modern alluvium; therefore, they form the basis for the interpretation and analysis of different domains within the entire fluvial system (Fig. 3).

The features outlined by the topographical model (Fig. 3) can be used to predict the water flow paths, and the progressive development of the flood, if defences were breached or removed and the floodplain allowed to revert to its natural state in a 'managed retreat' scenario. The model, which shows arcuate gravel ridges (at A), predicts the northwards migration of the main meander, with consequent erosion of its outer bank. At high peak flows, water from the trunk stream will overflow its levee via crevasse channels (C) that have been cut into the levee (B). The first area to be extensively inundated will be the natural, low-lying flood basin (E). The flood basin, therefore, functions as a natural storage area. It would also be a suitable area for wetlands restoration, were this to be considered as part of a floodplain management option. The LiDAR image can also be used to predict ground conditions on the floodplain, important when constructing flood defences. The point-bar complex (A) will mainly consist of sand and gravel; the levees (B) laminated silt and silty clay; and the flood basin (E) and abandoned channel (D) may be expected to contain layers of highly compressible material such as peat or organic-rich clay.

Conclusions

Geological maps at suitable scales can be used to portray the extent of floodplains as natural physical entities. They complement statistical calculations of flooding limits, produced by flood modelling. In addition, they can show areas of ground that may flood but that may not be revealed by the outlines determined by probabilistic methods, which are dependant on arbitrary choices of return period. In smaller river systems that have not been the subject of statistical hydrological studies, a geological map is frequently the most readily accessible record for showing the location of floodplain boundaries. Geological maps should, therefore, be included in any GIS-based flood-risk assessment, as a backdrop to layers that might include land-use and statistically calculated flood outlines. In conjunction with high-resolution, laser-based topographical surveys, the fluvial anatomy of floodplains can now be precisely determined. Using this imagery, the sciences of fluvial geology and geomorphology have much to contribute to studies that seek to model the development of a flood, and the response of the floodplain to severe flooding events.

Acknowledgements

The authors thank D Entwisle and N S Jones for their comments on a previous draft.

References

Collinson, J. D. 1978. Alluvial sediments. In, *Sedimentary environments and facies* (H. G. Reading, ed.). Blackwell: Oxford, 15-60.

This article was published with the permission of the Executive Director, British Geological Survey.

Investigating remedies for nickel contamination in groundwater

by S.L.S. Stipp[1] and L. Karlby[2]

The bryozoan chalk of eastern Denmark contains pyrite with trace concentrations of nickel. This nickel is released to groundwater when the pyrite oxidizes, resulting in naturally-derived contamination of drinking water from chalk aquifers. Political aversion to water treatment motivates municipal government to find natural ways to minimize Ni concentration in order to meet safety limits. Investigations at several scales demonstrated that nickel can be immobilized within the calcite bulk provided there is time for reaction of groundwater with the porous matrix of the chalk. Where fast, high-volume pumping moves water through large fractures, Ni concentrations are high because contact with chalk surface area and time for reaction are minimal. Nickel immobilized within the calcite remains in the chalk as long as pH does not decrease to levels promoting dissolution

La craie à bryozoaires des régions est du Danemark contient de la pyrite et des concentrations de nickel sous forme de traces. Ce nickel est libéré dans les eaux souterraines quand la pyrite s'oxyde, provoquant une contamination naturelle de l'eau potable puisée dans les aquifères de la craie. L'aversion des Politiques à traiter l'eau pousse les responsables municipaux à trouver des raisons d'ordre naturel pour minimiser la quantité de nickel de façon à ce qu'elle soit en dessous des limites de sécurité. Les recherches menées à échelles différentes ont démontré que le nickel peut se fixer à l'intérieur de la masse de calcite dans la mesure où la réaction entre l'eau souterraine et la matrice poreuse de la craie a le temps de s'opérer. Là où le pompage est important et l'eau circule rapidement dans des fractures majeures, les concentrations en nickel sont élevées parce que les temps de contact de l'eau avec la craie sont très réduits. Le nickel fixé au sein de la calcite demeure dans la craie tant que le pH ne diminue pas en dessous de valeurs pour lesquelles il y a dissolution de la craie.

La creta con briozoos del este de Dinamarca contiene pirita con trazas de níquel. Este níquel se desprende en el agua subterránea cuando se oxida la pirita, lo que da como resultado la contaminación natural del agua potable de los acuíferos de la creta. La aversión de los políticos al tratamiento del agua hace que los municipios busquen métodos naturales para minimizar los contenidos en Ni en las aguas para que cumplan los límites de seguridad. Las investigaciones a diversas escalas han demostrado que se puede inmovilizar el níquel en la calcita si hay suficiente tiempo de reacción del agua subterránea con la matriz porosa de la creta. Allí donde se realizan bombeos de elevados volúmenes de agua a través de grandes fracturas, las concentraciones de Ni son elevadas porque el contacto con la superficie de la creta y el tiempo de reacción son mínimos. El níquel inmovilizado en la calcita permanece en la creta mientras el pH no disminuya a niveles que favorezcan la disolución.

Nickel (Ni^{2+}) is present in fairly high concentrations (10's to 100's ppb) in some Danish groundwater. It occurs naturally in the chalk bedrock as a trace component in pyrite and it enters the groundwater when pyrite dissolves. There is no established World Health Organization (WHO) limit for dissolved Ni, but the Danish limit is currently 20 ppb. High concentrations in drinking water or in vegetables lead to nickel allergies, manifested as painful skin irritation. Although Ni could easily be removed by water treatment, as is usually done in other countries, in Denmark, there is political resistance to water treatment. The argument is that if water is treated, people will be less careful and water will become more polluted, so raw groundwater is simply aerated, filtered through sand and sent to the consumer. Aeration allows O_2 to replace H_2S, then Fe(II) is oxidised to Fe(III), which precipitates as $Fe(OH)_3$ (ferrihydrite) and settles. In some localities, soluble Mn is also oxidized. Some heavy metals, including Ni, are trapped in the iron or manganese solids, but much remains soluble. Municipal governments deal with the requirements in one of two ways:

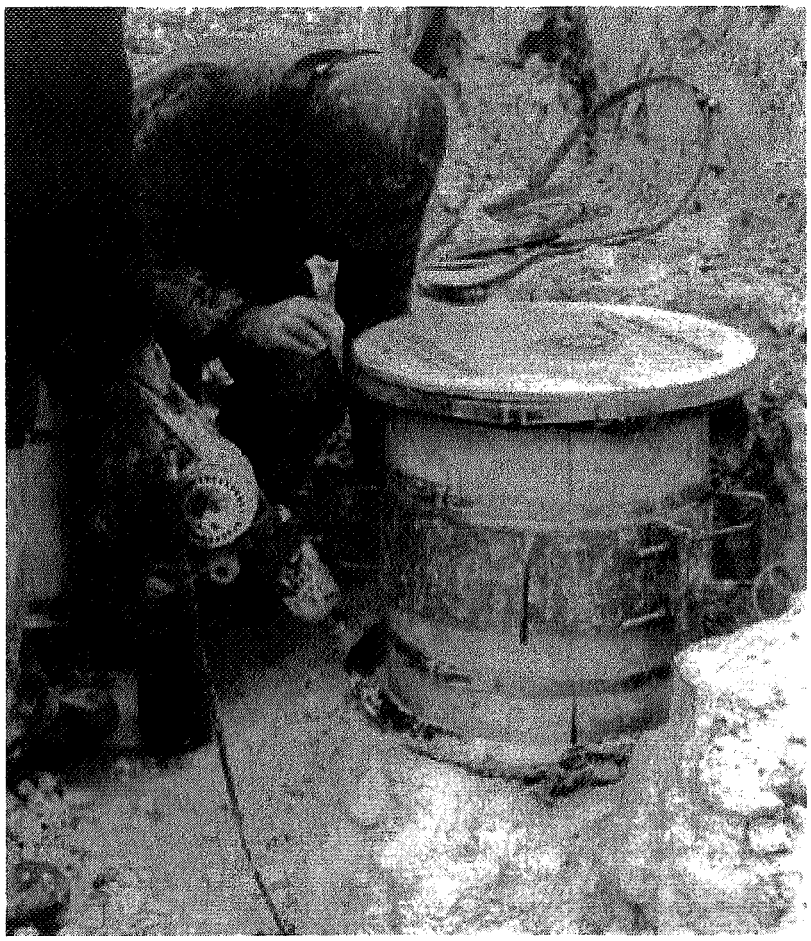
- they mix contaminated water with Ni-free water to produce an average that is below the limit
- many high concentration wells are simply closed and new ones are installed, at great cost to the taxpayer.

Municipalities have also been inventive with ways to minimize Ni concentrations naturally. If the water table is maintained at a constant height, exposure of pyrite to oxygen is minimized. This decreases pyrite dissolution rates, releasing less Ni to groundwater. Another strategy is to minimize the contact area between air and groundwater, to limit oxygen entry to the aquifer. Recent research has shown that groundwater nickel concentrations are significantly decreased when an

[1]NanoGeoScience, Geological Institute, University of Copenhagen, Denmark.
[2]Soil and Groundwater Department, Storstrøms Amt, Nykøbing Falster, Denmark

Figure 1. In order to get representative samples of the water conducting chalk, columns were drilled from the saturated zone. Initially, a hole was dug 4.5 to 5 m deep and water was continuously pumped away.

Figure 2. Columns 50 cm in length and diameter were drilled from the chalk and transported to the laboratory.



impermeable casing is added from the well head to below the water table, preventing entry of air as barometric pressure fluctuates. In spite of the partial success of these strategies, municipalities continue to hunt for new ways to further decrease dissolved nickel. In a large project supported by the Roskilde county government, consultants from Hedeselskabet and researchers from the Geological Institute, University of Copenhagen worked together to examine Ni behaviour in chalk. The purpose of the project was:

- to develop a method for studying fractured chalk in a system that would come as close as possible to field conditions, but that would allow controlled modification of parameters such as flow rate, Ni input, pH, pCO_2 and redox potential and
- to use that method to propose new strategies that could decrease raw water Ni concentration.

To achieve these goals, we used drilled cores that were large enough to capture representative, undisturbed fracture networks as well as small enough to reveal the micro- and nanoscale structures of the fossil biogenic calcite. We worked toward collecting information that would result in definition of the processes responsible for Ni uptake in the chalk and on the Fe- and Mn-hydroxides lining the fracture walls by examining reactions at several length scales. Once mechanisms of uptake and release were known, better strategies for minimizing Ni mobilization would be possible.

Large intact columns

In general, problems with field studies include the lack of ability to control solution conditions and a desire to avoid adding more contamination to the groundwater. When working with low concentrations of contaminants, it can also be problematic to detect measurable concentrations in the experimental monitoring wells. So often, laboratory scale studies are done instead, but for decades, geochemists, hydrogeologists and engineers have struggled with the problems of scaling laboratory data to field dimensions. The use of large columns helps to solve these problems. In the columns used for these studies, the natural fracture system was maintained intact and water could move both by advection in fractures and by diffusion through the pore spaces of the matrix. We took columns from the bryozoan chalk south of Copenhagen (Lille Skensved, Roskilde Amt), from

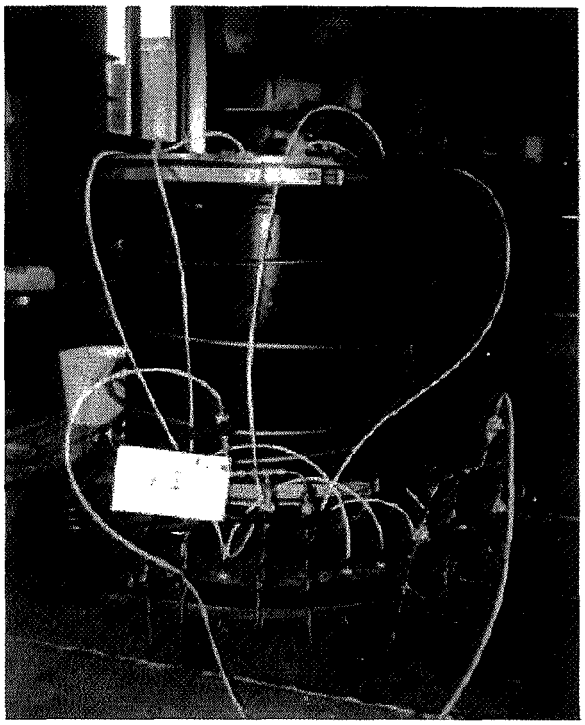


Figure 3. To maintain the properties of the chalk, the columns were kept at pressure and temperature conditions similar to the aquifer.

a zone where Ni concentrations are known to be high.

Once a suitable site had been chosen, a hole was dug 4.5 to 5 m deep (Fig. 1). Columns 50 cm in length and diameter were drilled from the freshly dewatered chalk (Fig. 2) and sealed into rubber sleeves. Liquid rubber was poured between the column and the sleeve to insure flow through the fractures and to prevent it being channelled along the outside edge. Teflon-lined steel plates that were fitted with input or outlet ports were attached at each end of the cores. The whole assembly was placed inside a steel cylinder that was equipped for cooling water flow and pressure control (Fig. 3). Temperature was maintained at 8° C, typical for Danish groundwater and pressure in the chamber was the same as would be felt by the rock in the aquifer.

For experiments, we used raw water taken from the nearby municipal water works to minimize dissolution or precipitation within the column. Water was input from the bottom with flow up, to avoid channelling. The first many column volumes that passed through showed no detectible change in composition or pH, demonstrating equilibrium in the column. The next step was to test the chalk's capacity to take up Ni from passing water. To show the rate of groundwater movement, we chose an ion to add to the water that would move with it and not react with the rock. Br^-, as a solution of 100 ppm KBr, was used as the conservative tracer. We also added Ni in the input water, sometimes in low (75 ppb) and sometimes in high (750 ppb) concentrations. The first experiments tested difference in uptake as flow rate varied. When water flow was slow, there was time for water to diffuse into the pore spaces of the matrix, so more Ni came into contact with the calcite of the matrix. When water flow was fast, it passed directly through the largest of the fractures, allowing little time for reaction.

Figure 4 shows a plot of the results from some of the experiments. Pump rate is shown by the red line, with units plotted on the right y-axis. Both Br^- and Ni^{2+} are plotted as relative concentration, C/C_0, which demonstrates the relationship between the input and output concentrations:

$$C/C_0 = \frac{(C_{output} - C_{raw})}{(C_{input} - C_{raw})}$$

Initial concentration of Ni^{2+} in the raw water was about 5 ppb.

The accumulated flow through the column is shown on the x-axis. At rapid flow rates (4 l/h), Br^- concentration in the output reaches 100% after 15 liters, but nickel concentrations lag considerably behind, indicating that nickel is removed from the water by the chalk. As fracture walls become saturated with nickel, output reaches 90%, but with lower pump rates (0.4 and 0.1 l/h) the chalk's uptake capacity increases. When 20 to 100 l of water have passed, only 45 to 50% of the input Ni is observed in the output. The pump rates were chosen to represent the water production from typical municipal water supply systems. Clearly, Ni concentration could be reduced in water supplies if pumping rates were decreased. A good strategy for decreasing nickel contamination would then be to pump at constant, slower rates from more wells, so that the

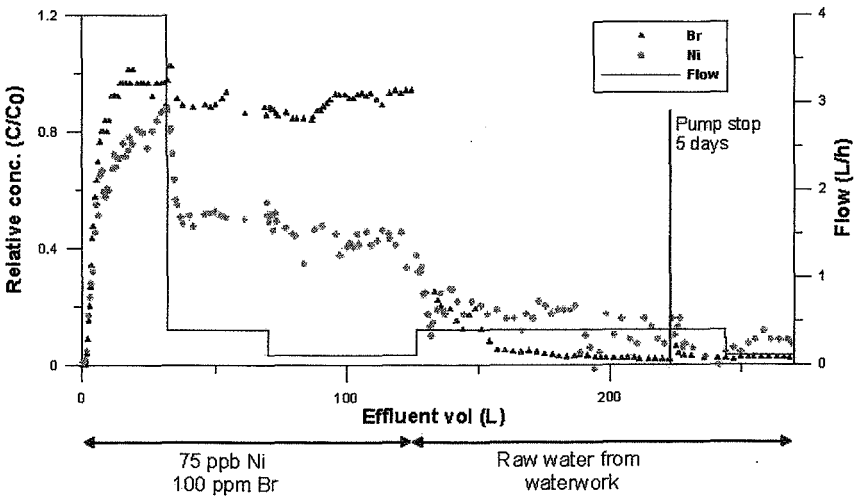
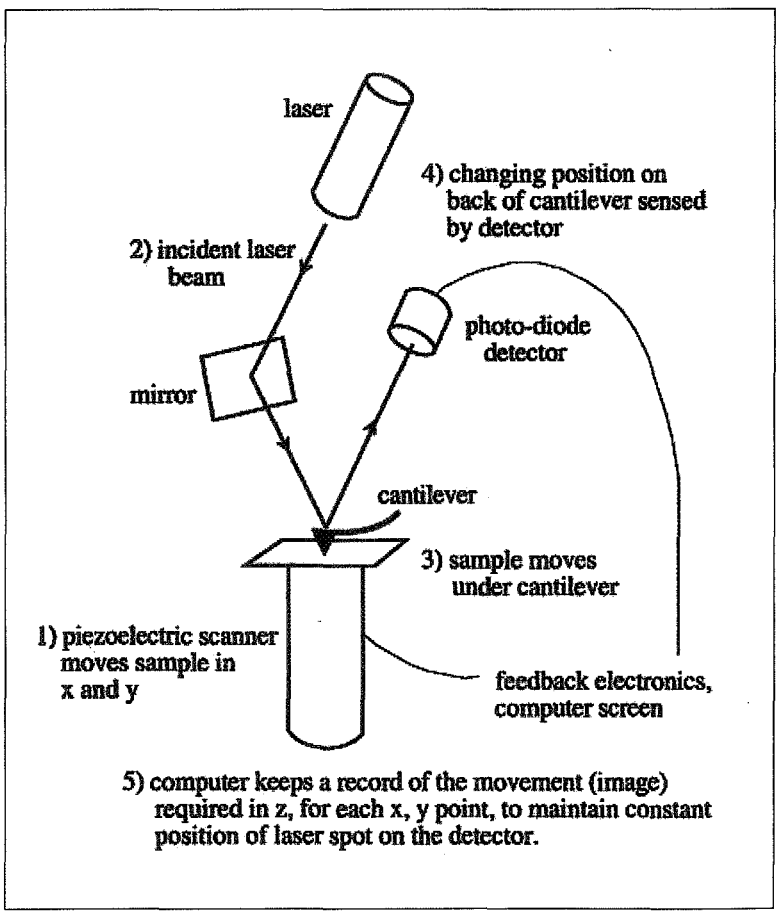


Figure 4. The flow rate has a considerable effect on nickel transportation. At high flow rates, nickel lags behind the conservative tracer but at low flow rates, nickel is transported significantly slower. This indicates that at high rates where fracture flow is dominating, adsorption is limited to fracture walls but when flow rates allow for further contact, the chalk matrix takes up additional nickel.

Figure 5. Experiments were conducted to determine the uptake mechanism of nickel by chalk. Results showed that nickel is not only adsorbed to the surface of calcite crystals but becomes incorporated.



groundwater table would be held at a constant level and water would be allowed to come in contact with the chalk matrix.

One interesting question is, 'Where is the nickel that is taken up?'. If it is adsorbed on surfaces, it can easily be released again when water composition changes. If it is co-precipitated in the calcite of the chalk, then it is immobilized within the bulk and will remain there until the calcite is dissolved. To test for the mechanism, we stopped the flow of Ni-containing water to the column at about 120 l and input raw water (Ni ~ 5 ppb) instead. During washout, Br^- decreased quickly. The tail of the curve shows that the last 10% took longer. This represents water that diffused out of the chalk matrix through small pore spaces where flow was slow. Although some Ni was washed out, concentration never reached background levels and a great deal remained in the column. This suggests that Ni is taken into the calcite as a result of recrystallization.

Uptake experiments

In order to predict stability over time, it is important to know if Ni is on the surface or immobilized in the calcite. Clearly, immobilization is preferable, so this hypothesis was tested in macroscopic 'wet chemistry' experiments. Calcite, $CaCO_3$, is known to allow substitution of cations in the Ca sites, particularly when charge is compatible. The Danish bryozoan chalk is nearly 100% calcite so considerable uptake is expected.

We used chalk taken from the column site and pure commercial calcite as control. Figure 5 shows the set up. The chalk was dried, crushed and sieved to produce particles of diameter 135 μm or less. The powder (45 g) was added to 450 ml of raw water, stirred and brought to equilibrium at groundwater temperature. The pH level was maintained constant at groundwater values (7.8 and 8.3) by bubbling with mixtures of CO_2 and N_2. Many experiments were carried out, under a series of conditions. We found that 90% of added Ni from both high (750 ppb) and low (75 ppb) concentration solutions was removed within a day and this Ni did not return to

Figure 6. With atomic force microscopy (AFM), the morphology of mineral surfaces can be observed at micrometer to Ångstrøm scale. A flat sample is brought in contact with an extremely sharp tip attached to a very soft cantilever. As the sample is scanned underneath the tip, forces of attraction and repulsion are felt. The movements of the tip are detected and are used to make an image of the surface.

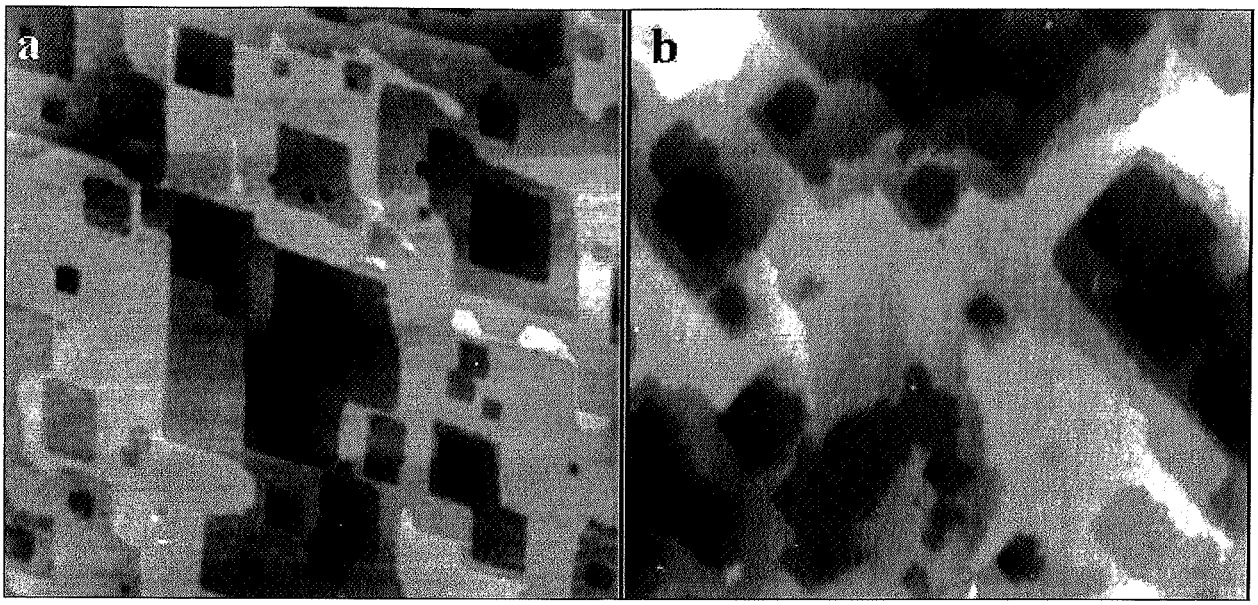


Figure 7. AFM height images of calcite exposed to a nickel bearing solution. Lighter colours represent topographically higher areas.
a. A freshly cleaved surface exposed to the solution shows etch pits typical for calcite.
b. When the same sample was investigated 18 days later, the surface was clearly recrystallizing allowing for incorporation of nickel into the structure of calcite.

solution during rinsing with raw water. From experiments where doses of Ni were added to the chalk suspension every day, removal continued and even after a month, we did not reach a saturation limit. When pH was decreased again by adding 100% CO_2, some Ni was released to solution, but less was released with each CO_2 titration; most remained in the chalk. All evidence points to the formation of Ni-calcite solid solution.

Atomic Scale Investigations

A final question is, 'How is the nickel incorporated into the calcite?'. In order to see what happens, we examined the surface of single crystals of pure calcite that had been exposed to Ni-bearing solutions using Atomic Force Microscopy. AFM is a technique that allows resolution in the micrometer (10^{-6} m) to ångström (10^{-10} m) size range. It uses a sharp tip mounted on a soft spring to feel the forces between itself and a surface. As a sample is moved underneath the tip, tip deflections are recorded as a function of location on the surface. The result is a map of the changes in force, allowing surface features to be seen.

Figure 6 shows schematically how the technique works. Figure 7a shows an image of a freshly cleaved sample of calcite that has been exposed to a Ni-bearing solution for a minute and dried. The rhombohedral pits are typical on the calcite dissolution surface. Layers are one layer of molecules thick, 3 Å. Ni is adsorbed on the surface. We cannot see it in the AFM picture but other studies proved that it was present (Hoffmann and Stipp, 2001). Figure 7b shows a different site on the same sample 18 days later, after storage in a dry atmosphere. The rhombic pits are still visible but now the edges of the layers are no longer straight. The rounding results when the top layer ions have moved from one place to another. This shows us that the surface of calcite is dynamic. If ions can move in air, they can certainly also move in water. The Ni that was adsorbed to the surface originally (Fig. 7a) remained with the sample during rearrangement and was incorporated as the calcite recrystallized. We see no difference in appearance of this Ni-exposed surface and surfaces exposed only to pure water, which allows us to interpret that calcite incorporates Ni into Ca sites. Thus we have proven that Ni enters the bulk of calcite and we can expect that the same mechanism would affect chalk.

Implications

The bryozoan chalk of Denmark has a high capacity to remove Ni from groundwater, provided the water does not pass rapidly through fractures but rather, that there is time for the reaction between the chalk and the matrix. In the context of municipal water supply, this means that groundwater contaminated with nickel from pyrite oxidation must be pumped slowly. In order to prevent release of trapped Ni at some time later, one needs only to insure that pH remains high enough to avoid chalk dissolution. This is not difficult because the buffer capacity of calcite insures pH of 7 or more, provided the proportion of CO_2 does not go over about 50% in the air in contact with water. In air, pCO_2 is 0.03% and in soil where bacteria are very busy, it can reach 10%. Thus, nickel is taken up within the bulk of calcite by the natural process of recrystallization and it remains there, out of reach of groundwater. This is good news for the water works and the consumer.

Acknowledgements

We thank Merete Olsen and Eskild Lund (Roskilde Amt), Jens Olsen (Skensved Waterworks), Peter R. Jørgensen, Anne Steensen Blicher, Martin Hoffmann, Mette Broholm, Niels Døssing Nørskov and Thomas H. Larsen (Hedeselskabet and Vagn Moser), Peter Venslev, Jan Aagaard, Birgit Damgaard, Knud Dideriksen, Bo Christiansen, Karsten Rud Pedersen and Hasse Milter (Geological Institute).

References

Hoffmann U. and Stipp S.L.S. 2001. The behaviour of Ni^{2+} on calcite surfaces. *Geochimica et Cosmochimica Acta* **65,** 4131-4139.

International Year of Planet Earth: on track for 2008

by Ted Nield[1]

The joint IUGS/UNESCO International Year of Planet Earth project is now firmly on track to achieve full UN General Assembly proclamation in December 2005. If all goes to plan, this will mark the beginning of the single biggest science and outreach project ever undertaken for the Earth sciences. Moreover, it will occur in tandem with a number of other Earth and natural environment-related initiatives, with whom agreement on basic objectives, cooperation and non-competition, was recently signed at a meeting in Celimontana, Italy. What now lies in prospect is a concerted awareness-raising campaign for Earth sciences in the broadest sense, stretching forward for a full decade from 2007.

This decision to seek full United Nations proclamation was based on the belief that such a proclamation would provide the best possible exposure to national governments from which the geosciences need strong political support, following decades of low levels of recognition. This is consistent with the International Year's aim, which is to improve the position of the geosciences within political agendas, as well as running substantial science and public outreach programmes. In March 2005, both Initiators (IUGS and UNESCO) reiterated their full support to the initiative, and the UNESCO Executive Board also voted to support the initiative nem. con.

The UNESCO resolution of 2005 asks that the International Year of Planet Earth by the UN be proclaimed for 2008. However, realizing its ambitious science and outreach programmes demands a period of at least three years, which will centre on that year; the Year's triennium will thus cover 2007-2009.

[1]Chair of the Outreach Programme Committee of the project, on rapid progress in 2005. Edits www.geolsoc.org and sub-edits *Geoscientist*. He is also Chair of the Association of British Science Writers, the UK national professional body for scientific journalists and authors.

Science Programme

The Year's Science Programme Committee (SPC), Chaired by Prof. Ed Derbyshire of Royal Holloway, London, developed its Terms of Reference in 2002. By means of a voting process involving the SPC and the IUGS Executive Committee, 8 science themes, all relevant to society, were selected in the autumn of 2003 from an original slate of 22 themes. A procedure was then initiated by which specialist Key Text Teams (see below) focused on specific questions within the 8 themes to be addressed in the triennium, given that tangible deliverables are a binding condition for any such UN proclamation. A ninth science theme on Soils was proposed in February 2004 at the request of the International Union of Soil Sciences (IUSS). Since September 2004 a tenth theme on 'Life', proposed by the German, French and Austrian Geological National Committees, has also been under active consideration.

Brochures have been published in hard copy on seven of the ten science themes (Climate, Health, Resources, Deep Earth, Hazards, Ocean and Soils), and have since been distributed. In addition, by May 2005 the Soils brochure was posted on the website. Many were taken up during the 32nd International Geological Congress held in August 2004, and during successive events. The science brochures are or will be printed with the financial support of many of the European geological surveys (Austria, Finland, Ireland, Norway, Spain, and Sweden). The remaining science brochures are in an advanced stage of production and will be published by mid-2005. All published brochures are downloadable from the Year's Web Site. www.yearofplanetearth.org.

The way the programmes will work will closely resemble the very successful International Geoscience Programme (IGCP), another joint IUGS/UNESCO Programme. As with the IGCP, the Year's geoscience programme will operate in a 'bottom-up' mode and be run by a scientific board, composed of one Implementation Team (IT) for each of the Themes. These ITs will be larger (some 7 - 8 experts) and will have a wider geographical representation than IGCP's Scientific Board. They will become effective shortly after tabling the Year on the UN General Assembly Agenda, their main task being attracting and evaluating Expressions of Interest in project development received from scientific groups around the world. Initial Expression of Interest forms are already available on www.yearofplanetearth.org

Outreach Programme

The Outreach Programme Committee has developed the above website, produced flyers, and released 10,000 general information brochures and leaflets. As with the science programme, the outreach programme will operate 'bottom-up'. Individuals and organizations, from geological societies to programme and film-makers, museums, community groups, teachers' groups and arts bodies, will be invited to

Theme	Leader	Members
Groundwater	Struckmeier (Ge)	Hill (USA), Horn (Ge), Jones (UK), Zhang (Cn)
Climate	Dodson (Au, now UK)	Alverson (USA, now UN), Nield (UK), Yuan (Cn), Yim (CN), Wiegand (Ge)
Health	Selinus (Se)	Centeno (USA), Finkelman (USA), Weinstein (Au), Derbyshire (UK)
Deep Earth	Cloetingh (Nl)	Ludden (Fr), Zoback (USA), Emmermann (Ge), Thybo (Dk), Horvath (Hu)
Megacities	Kraas (Ge))	Nennonen (Fi), Marker (UK), de Mulder (Nl)
Resources	Sinding-Larsen (No)	Shields (USA), Hovland (USA), Gleditsch (No), Leach (USA), Nurmi (Fi)
Hazards	Beer (Au)	Marsh (UK), Bobrowsky (Ca), Canuti (It), Cutter (USA), Alexander (UK), Babase (UN)
Ocean	Chen (Cn)	Lin (USA), Fischer (USA), Devey (Ge), Whitmarsh (UK)
Soils		Dent (UK), Hartemink (Nl), Kimble
Life	Not yet identified	Pending

submit proposals for realization through the Year. These will then be evaluated by specialist referees familiar with the outreach methods proposed.

Implementation of the outreach programme will be undertaken mainly at regional and local levels. Countries and regions will be encouraged to develop their own outreach programmes, as was successfully achieved by Germany in 2002. The contours of an outreach plan have already been established. Eight thousand copies of a separate outreach brochure, inviting individuals and organizations to propose projects, have been printed by courtesy of the Chinese Ministry of Land and Resources and are also available on www.yearofplanetearth.org. In addition, flyers on the essentiais of the International Year of Planet Earth have been produced and printed in English, French, Arabic, Russian, German and Spanish. A Chinese version will be printed shortly.

Advisory Group

Individuals wishing to contribute to the Initiative and to support various activities through the science and/or outreach programmes may be invited to become Senior Advisers. The individuals making up this group advise the Management Team on specific contributions to the activities for the Year. Senior Advisers are entitled to represent the International Year and are encouraged to publicize the Initiative as widely as possible. Currently there are 40 such Senior Advisors.

A small number of highly distinguished individuals have agreed to serve as Goodwill Ambassadors for the Year. These include people with prominent media profiles in the world's major language areas, who are willing to promote the Year and its activities. Patrons include Heads of State and other World leaders who have expressed their willingness to give their patronage to the International Year.

Geoscientific Support, Partners

Support from the geoscientific community has been massive. By mid-2003, three ICSU sister Unions (IUGG, IGU and IUSS) agreed to become Partners in this initiative, a move soon followed by ICSU's International Lithosphere Programme. Other such Partners are The Geological Society of London, the Geological Survey of the Netherlands (TNO-NITG) and the International Soil Reference and Information Centre (ISRIC). A consortium of three geoscientific associations/societies, affiliated to IUGS (IAEG, ISRM and ISSMGE) joined these Partners by Mid March 2005, the International Union for Quaternary Research (INQUA, the American Geological Institute (AGI) by mid June and the American Association of Petroleum Geologists (AAPG) by late June, 2005.

Associate Partners actively support the International Year of Planet Earth. They are invited to participate and bear co-responsibility in the Key-Text Teams securing representation of their scientific interests within the Year's Science programme. Associate Partners also have access to the outreach activities and may suggest such activities to the Outreach Programme Committee. They will be regularly informed of developments in the Year and they may contribute to the Year's website and receive the Year's digital presentations. If they wish, Associate Partners may choose to bear some financial responsibility for the International Year. Thus far, the eighteen international scientific organizations and programmes listed below have expressed their support for the International Year.

ICSU	International Council for Science
IOC	Intergovernmental Oceanographic Commission of UNESCO
IPA	International Permafrost Association
IAGOD	International Association on the Genesis of Ore Deposits
SEG	Society of Economic Geologists
SGA	Society for Geology Applied to Mineral Deposits
IAH	International Association of Hydrogeologists
IGCP	International Geoscience Programme IGCP
EFG	European Federation of Geoscientists
AARSE	African Association of Remote Sensing of the Environment.
SCA	Science Council of Asia
ProGEO	European Association for the Conservation of the Geological Heritage
SEPM	Society for Sedimentary Geology
CCOP	Coordinating Committee for Geoscience Programmes in East and Southeast Asia
GSAf	Geological Society of Africa
UNU	United Nations University
AGID	Association of Geoscientists for International Development
UN/ISDR	United Nations International Strategy for Disaster Reduction

Political support

At a high-level information meeting held at UNESCO headquarters in Paris on the 11 February 2004, six nations (China, Russia, Brazil, Argentina, Italy and Jordan) promised to support proclamation of the International Year of Planet Earth once proposed in the General Assembly of the UN. By 20 June 2005 , this level of political support had grown to 19 UN nations (Argentina, Austria, Brazil, China, Germany, India, Israel, Italy, Jordan, Kazakhstan, Lithuania, Mauritius, Mexico, Namibia, Netherlands, Pakistan, Romania, Russian Federation and South Africa) together representing over half the world's population.

The process of collecting political support by means of a nation's UN-diplomatic staff normally consists of three steps:

- collection of support by the national geoscience community
- collection of support at the political level by an appropriate Government Ministry
- support by UN-diplomats under instruction from their Ministries of Foreign Affairs.

As proclamation should comply with the rules and procedures by the UN General Assembly, the first available year for UN proclamation is 2008.

Three 'milestones' are discernible on the road map to UN Proclamation: adoption of a Declaration by the global geoscience community; adoption of a Resolution by UNESCO's Executive Board, and adoption of a Resolution by the UN General Assembly.

The first milestone was reached on August 26 2004 and the second on April 28 2005 when a Draft Resolution, tabled by the Permanent Delegation of the United Republic of Tanzania and inviting UNESCO's Director General to support all efforts leading to the United Nations General Assembly to declare the International Year of Planet Earth, was adopted unopposed.

Twenty five nations (Tanzania, Brazil, China, Burkina Faso, Turkey, Egypt, Ghana, Jamaica, Slovenia, Sri Lanka, Pakistan, Kenya, Ukraine, Algeria, Morocco, Russian Federation, Mozambique, Germany, Swaziland, Rwanda, Senegal, Mauritius, Italy, Namibia and Canada) voiced their full support at the 171st meeting of UNESCO's Executive Board. This brings the total of nations who expressed their political support to 36, representing over 3.7 billion people, 58% of the world population.

Country	Step 1	Step 2	Step 3
Algeria			☻
Argentina	☻		☻
Australia	☻	☻	☻
Austria	☻	☻	☻
Bosnia/Herzegovina	☻		
Brazil	☻		☻ ☻
Burkina Faso			☻
Cameroon	☻	☻	☺
Canada	☻	☻	☻
China	☻	☻	☻ ☻
Congo DR	☻		
Cuba	☻	☺	
Denmark	☻		
Egypt	☻		☻
Estonia	☻		
France	☻	☺	☺
Germany	☻	☻	☻ ☻
Ghana			☻
Hungary	☻		
Iceland	☻		
India	☻		☻
Indonesia	☻	☺	
Iran	☻		
Israel	☻	☻	☻
Italy	☻		☻ ☻
Jamaica			☻
Japan	☻	☺	
Jordan	☻		☻
Kazakhstan	☻	☻	☻
Kenya			☻
Lithuania	☻	☻	☻
Malaysia	☻	☺	
Mauritius			☻ ☻
Mexico	☻		☻
Mongolia	☻		
Morocco			☻
Mozambique	☻	☻	☻
Namibia	☻	☻	☻ ☻
Netherlands	☻	☻	☻
New Zealand	☻		☺
Norway	☻	☺	
Pakistan	☻		☻
Peru	☻		☻
Poland	☻	☻	
Romania	☻	☻	☻
Russian Federation	☻	☻	☻ ☻
Rwanda			☻
Saudi Arabia	☻		
Senegal			☻
Slovenia			☻
Spain	☻		☺
Sri Lanka			☻

Table: country support for the International Year as by 23 March 2005. ☻ step completed; ☻ active support in UNESCO's Executive Board; ☺ step in progress

A Draft Resolution on the proclamation of the International Year of Planet Earth in 2008 is placed on the Agenda of UNESCO's 33rd General Conference. After adoption, foreseen by 21 October, another Draft Resolution will be tabled without delay for the concurrent UN General Assembly. Again, the United Republic of Tanzania has taken the lead of a core group of some ten Nations co-sponsoring this Draft resolution. We anticipate adoption of the UN Year of Planet Earth (2008) by late December 2005.

Links with other initiatives

Apart from the forthcoming International Year of Deserts and Desertification (2006), three other Earth-related international year initiatives are currently in preparation for the period 2007-2009: the International Polar Year (IPY), the electronic Geophysical Year (*e*GY) and the International Heliophysical Year (IHY). Agreements on cooperation and partnership were signed with *e*GY on 20 February 2005 and with IHY on 28 July. On 6 and 7 September a meeting with the leaderships of all science year initiatives took place in Villa Celimontana, in Rome, Italy. All initiatives agreed on solid cooperation and involvement in each other's science and outreach programmes. That meeting resulted in a 'Celimontana Declaration' meant for broad dissemination. As the science programme of the International Year of Planet Earth and other science years comply well with the priorities set by the Global Earth Observation System of Systems (GEOSS), full cooperation with this body has been agreed as well.

Organization

The organizational structure of the International Year evolved as the Initiative grew in significance. By mid 2002, a Science Programme Committee (SPC) and an Outreach Programme Committee (OPC) had been installed. The SPC and OPC are chaired by Prof. Edward Derbyshire (University of London) and Dr. Ted Nield (Geological Society of London), respectively. Both hold a seat in the informal and temporary Management Team (MT). Regional representation in this Team is covered through China (Mr. Li Zhijian), the Russian Federation (Mr. Andrej Volkov), Africa (Dr. Felix Toteu, Cameroon) North America (Dr. Larry Woodfork, USA) and Latin America (Mr. Eduardo Rubio, Peru). Dr. Werner Janoschek (Past Secretary-General of IUGS) is the MT's Treasurer and Dr. Wolfgang Eder (former Director of UNESCO's Earth Science Division) acts as liaison with UNESCO. Dr. Marlan Downey has agreed to lead the Year's Development Committee. Dr. Eduardo de Mulder (Past-President of the IUGS) chairs the MT. The MT includes representatives of the *e*GY and IHY.

This configuration of the MT will be effective at least until the International Year of Planet Earth has been proclaimed by the UN General Assembly. During the last months of 2005 a formal organizational structure for the implementation of the International Year will be established. It will consist of a Board on which all stakeholders will be represented, a Secretariat to manage day-to-day operations, and an Advisory Group. This new organization for the Year might be placed under the patronage of UNESCO as the assumed UN's Executive Agency.

Around the shores of the Indian Ocean, 250,000 people are dead because, through a combination of poverty and government inaction based on ignorance of how much the Earth sciences have to offer, the proper mechanisms for early warning were not in place. Earth scientists must do more, though, than wring their hands. The International Year of Planet Earth project offers you the chance to achieve something truly important in raising the profile of our science where it really matters.

Log on to www.yearofplanetearth.org and be part of it!

Geólogos Del Mundo projects 2005

by Ángel Carbayo Olivares[1]

Geólogos Del Mundo provides below an update of its activities as of November 2005 with news of the progress of projects.

Country: Ecuador

Project: *Water supply to Chumabi (Ecuador).*

Financed by: Diputación of Zaragoza.

On-going works: Finished. Beneficiary 1,500 inhabitants (Ca 6 lt/sec).

Country: El Salvador, C.A.

Project: *Strengthening of the environmental units of the municipalities of the metropolitan area of San Salvador (El Salvador).*

Financed by: Diputación of Barcelona.

On-going works: Beneficiary 1,600,000 inhabitants -14 municipalities.

Project: *Strengthening management of natural resources and geological risks in the municipality of Jucuarán (El Salvador).*

Financed by: Generalitat of Cataluña.

On-going works: Beneficiary 50,000 inhabitants.

Project: *Public water supply using underground water for the villages of La Brea and Caribal, in the La Bananera Canton, municipality of Conchagua, dep. La Union (El Salvador).*

Financed by: The Nando Peretti Foundation.

On-going works: Completed field hydrogeology and mapping; completed inventory of all water points with water analysis. Drilled one production well (ca 25lt/sec). Under construction: water tanks and water distribution system. More than 4,000 people will be benefit from this project when completed.

Project: *Continuation of COSUDE project, with the accomplishment of the hydrogeological map in El Salvador and Nicaragua.*

Financed by: Agencia Suiza of Cooperación.

Project: *Enlargement of the project Strengthening and hydrogeological characterization of the water supply of San Antonio del Monte (El Salvador).*

Financed by: Ayuntamiento of Oviedo

On-going works: Beneficiary 2,000 inhabitants.

Country: Honduras, C.A.

Project: *Identification and characterization of the hydrogeological resources and geological hazards in the mountain range of Mico Quemado (Honduras).*

Financed by: Principado of Asturias.

On-going works: Beneficiary 6,000 inhabitants. Water distribution system is finished.

Project: *Public water supply using underground water for the community of Guaymitas and surroundings, El Progreso, Yoro department (Honduras).*

Financed by: The Nando Peretti Foundation.

On-going works: Beneficiary 6,000 inhabitants. Exploration drilling will start soon.

Project: *Public water supply using underground water for the community of Sartenejas, Danli, El Paraiso department (Honduras).*

Financed by: The Nando Peretti Foundation.

On-going works: Beneficiary 14,000 inhabitants. The water tank is under construction.

Country: Mali

Project: *Water supply to three rural villages of the Republic of Mali (Beo, Ealo y Madoulo).*

Financed by: NGO Manos Unidas and the Polytechnical University of Madrid.

On-going works: Finished. Three wells 1.80 m in diameter and with handled extraction to supply water for 1,500 inhabitants have been carried out.

Country: Sri Lanka

Project: *Soil mechanics report in order to build dwellings in two districts.*

Financed by: Cruz Roja Española.

On-going works: Finished.

Project: *Rebuilding of fresh water supply programme in the areas affected by the tsunami.*

Financed by: Cruz Roja Española and support sought from AECI.

On-going works: To begin in December.

Construction of an exploitation well in Madoulo - Mali

[1]President, Geólogos Del Mundo

CENTRAL OFFICE
Av. Reina Victoria 8, 4ºB 28003 Madrid
SPAIN
Tel: +34 91 553 24 03
Fax: +34 91 553 03 43
geologosdelmundo@icog.es

DELEGATION OF ARAGÓN
Av. Tenor Fleta, 42 1º 4ª 50007 Zaragoza
Tel/Fax: +34 976 37 35 02
icogaragon@icog.es

DELEGATION OF ASTURIAS
C/ Pérez Ayala 3, Esc. Izq.33007 Oviedo
Tel/Fax: +34 985 27 04 27
geologosdelmundo@hotmail.com
geologosdelmundo@icogasturias.e.telefonica.net

DELEGATION OF CATALUÑA
Av. Paralelo 144-146 bajos
08015 Barcelona
Tel: +34 93 539 48 71
Fax: +34 93 532 86 65
geolegsdelmon@hotmail.com

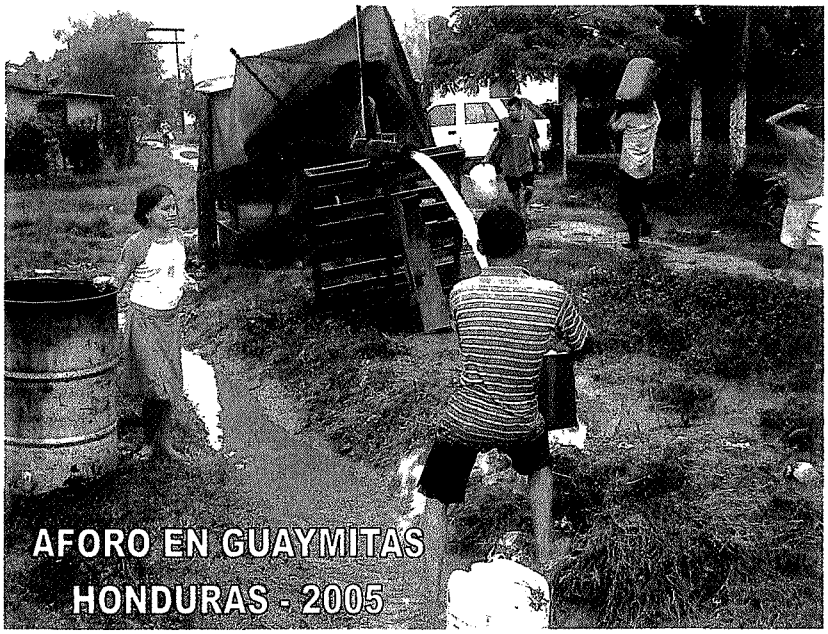
DELEGATION OF EL SALVADOR
Colonia Miramonte Calle Colima, 814
San Salvador, El Salvador, C.A.
Tel./fax: +00 503 22606340
geologosdelmundo@integra.com.sv

DELEGATE IN ITALY
C. E. Bravi Via ugo Foscolo 8
20121 Milano
Tel: +39 02.86460491
tuttibravi@tiscalinet.it

WORLD GEOLOGISTS SWEDEN
Carl-Lennart Axelsson
charlie_axelsson@golder.se

DELEGATE IN BRUSSELS
efgbrussels@tiscalinet.be

www.geologosdelmundo.org



Measurement of the water volume in Guaymitas - Honduras

European regions for Earth Sciences

by The Scientific Committee of the "European Congress on Geoscientific Cartography and Information Systems"[1]

Since 1992 the Regional Geological Surveys of Emilia-Romagna, Catalonia and Bavaria have developed a collaboration in the fields of Earth Sciences and Information Systems which has led to the organization of several sessions of the "European Congress on Regional Geoscientific Cartography and Information Systems". This collaboration is focused on the common interest to develop an integrated and multidisciplinary approach to applied Earth Sciences and increase the reliance on information systems for management of geo-environmental issues. To support this objective, the Secretariat of the European Soil Bureau Network and EuroGeoSurveys have been invited to become members of the Scientific Committee. The fifth session of the Congress will be held in Barcelona (13-16 June 2006).

Depuis 1992 les Services Géologiques des Régions Emilie-Romagne, Catalogne et Bavière ont développé une collaboration dans les domaines des Sciences de la Terre et des Systèmes d'Information. Celle-ci s'est notamment matérialisée par l'organisation de plusieurs séances du «*Congrès Européen sur la Cartographie Géoscientifique Régionale et les Systèmes d'Information*». Cette collaboration est centrée sur l'objectif partagé de développer une approche intégrée et multidisciplinaire des Sciences de la Terre appliquées et renforcer l'utilisation des systèmes d'information pour la gestion des problématiques géo-environnementales.Afin d'apporter leur appui à cet objectif l'"European Soil Bureau Network" (Réseau du Bureau Européen des Sols) et EuroGeoSurveys ont été invités à devenir membres du Comité Scientifique du Congrès La cinquième séance du Congrès se tiendra à Barcelone (13 au 16 Juin 2006).

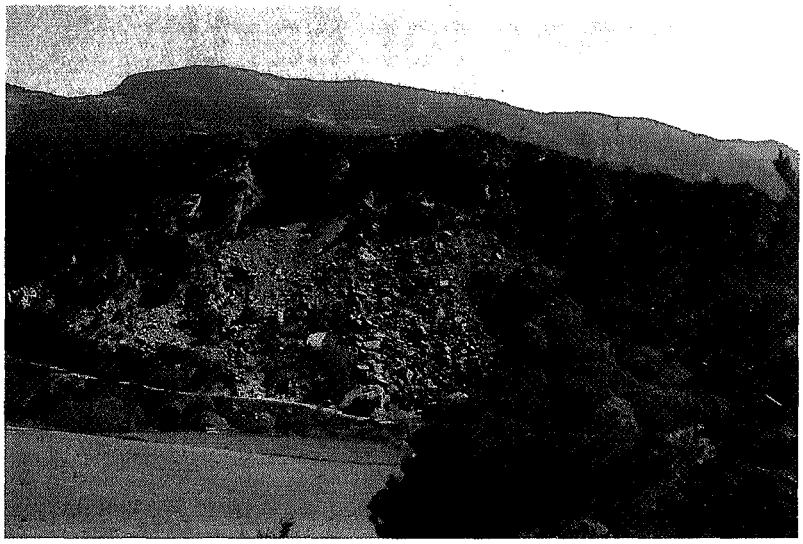
Desde 1992 los Servicios Geológicos de las Regiones de Emilia-Romaña, Cataluña y Baviera están desarrollando una colaboración en los campos de las Ciencias de la Tierra y los Sistemas de Información. Ello se ha materializado a través de la organización de varias sesiones del "*Congreso Europeo sobre Cartografía Geocientífica Regional y Sistemas de Información*". Dicha colaboración se centra en el doble objetivo de desarrollar una aproximación integrada y multidisciplinar a las aplicaciones de las Ciencias de la Tierra y en reforzar el uso de los sistemas de información para la gestión de problemáticas geo-medioambientales. El "European Soil Bureau Network" y EuroGeoSurveys fueron invitados a integrarse en el Comité Científico del Congreso y prestan, de esta manera, su apoyo al doble objetivo mencionado. La quinta sesión del Congreso se celebrará en Barcelona (del 13 al 16 de Junio de 2006).

In 1992, the Geological Surveys of Emilia-Romagna (Italy), Catalonia (Spain) and Bavaria (Germany) informally started an innovative collaboration in the fields of Earth Sciences and Information Systems. This close working partnership led to the organization of several sessions of the "European Congress on Regional Geoscientific Cartography and Information Systems" in Bologna (1994), Barcelona (1997), Munich (2000) and Bologna (2003). These congresses entailed effective co-operation across Europe between the Regional Geological Surveys, brought together numerous participants from many European countries, and even from Northern Africa and Asia, and produced important innovations and solutions regarding geo-environmental topics and information systems. Spontaneous cooperation between European regions has demonstrated that this could be a very effective way to bridge the gap between different traditions and methodologies and to begin sharing territorial and geo-environmental information at European level. To support this objective, the European Soil Bureau Network of the European Commission and EuroGeoSurveys have been invited to become members of the Scientific Committee.

[1]Antoni Roca and Xavier Berastegui (Istitut Cartogràfic de Catalunya)
Raffaele Pignone (Servizio Geologico Sismico e dei Suoli della Regione Emilia-Romagna)
Gian Paolo Artioli (Servizi Sistemi Informativi Geografici della Regione Emilia-Romagna)
Hubert Schmid and Ulrich Lagally (Bayerische Geologisches Landesamt)
Luca Montanarella (European Commission)
Patrice Christmann (EuroGeoSurveys)

Common areas of interest

Topics, such as climate change, soil conservation, quality and quantity of groundwater, extent of natural hazards, access to energy and mineral resources and popularization of geological knowledge, represent the common areas of interest of Geological Surveys and are of the highest significance for Europe's growth and sustainable development. Emilia-Romagna, Bavaria and Catalonia are particularly interested in developing and promoting an



A landslide has blocked a road in the catalan Pyrenees.

integrated and multidisciplinary approach to applied Earth Sciences and to further develop their on-line information systems (including metadata, data and thematic maps), in support of:

- policy making
- environmental management
- sustainable access to natural resources
- the mitigation of the impacts of natural hazards of geological origin
- the development of downstream services
- the information of the general public.

To make this possible, these regions organize joint advanced technical and professional training activities to implement the available technologies and develop common methodologies.

The role of geoscientists

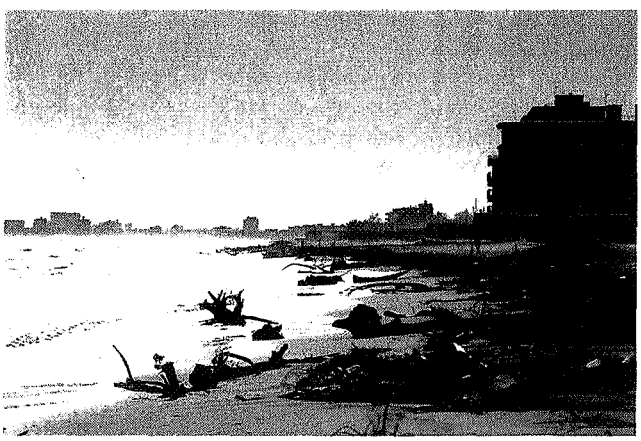
Today, an intimate understanding of the physical make-up of the territory and of its subsurface is vital for society, for the cities, business and industry, as well as to ensure the continued functioning of life-supporting ecosystems. In every country this understanding is a fundamental pre-requisite to any form of land use management, of the sustainable use of natural resources and of the prevention and mitigation of natural hazards. It is becoming increasingly evident that natural resources of geological origin, namely water, soil, mineral and energy sources are finite and precious; consequently their use must be governed by stringent criteria of sustainability. In the same way, sustainable development is not possible without assessing hazards, minimizing risks and maximizing awareness. Earth's scientists must play a fundamental role in the building of a sustainable world because they constitute the largest living database of information about the past and the present of planet Earth.

Loss of soil due to factors such as contamination, sealing, compaction, loss of organic matter or erosion impair; the fertility of land; the function of recharging essential groundwater resources; its buffer role in flood prone areas. Coastal erosion threatens tourist areas; landslides in mountains and floods in plains endanger people, infrastructure and property; over-exploitation of natural resources, including water, jeopardize future generations. To manage these problems, planning authorities need reliable information on geological settings, on subsurface resources and on natural hazards. This need is likely to continue to rise in the coming years.

The role of Geological Surveys is therefore to acquire the necessary quality-controlled data, to turn it into information and knowledge and to disseminate it to support policy makers and other components of society (academia and research, engineering and consultancy firms, industry, insurance companies, investors, NGOs, the general public...); to fill the gaps in knowledge, to refine data and improve their availability in interactive and harmonized formats. At the same time, there is an increasing demand for information from the public. European citizens ask to have more immediate access to the information they need for a better understanding of the environment in which they live, the hazards they are potentially exposed to, the importance of preventing such hazards and the necessity of a sustainable use of precious natural resources.

The development of an integrated and multidisciplinary approach to applied Earth Sciences, as well as the development of interactive and harmonized geoscientific data layers are necessary to support:

- existing or forthcoming European policies, regulations and initiatives that involve the knowledge, the use and the management of the Earth's subsurface resources as well as the threats generated by our living Earth
- national as well as regional or local policies and regulations addressing natural resources, geological hazards or the development and management of subsurface space
- the provision of the above-mentioned users with data, information and knowledge related to the mentioned themes.



Effect of a sea-storm along the Emilia-Romagna coastal system.

Fifth European Congress

The fifth session of the "European Congress on Regional Geoscientific Cartography and Information Systems" should represent an outstanding opportunity to

progress towards these goals. The Congress, with the subheading "Earth and Water", will be held in Barcelona on 13-16 June 2006 (for details visit the website www.icc.es/econgeo2006/home.html). The Congress will be structured in sessions and in workshops dealing with the following themes:

- Quality and quantity of water in the future
- Soil conservation
- Mineral resources and geothermal energy
- Climate change
- Geological risk assessment and security policies
- Coastal system management
- Geology of urban areas
- Popularization of geology
- Remote sensing applications
- Mapping, information systems and new technologies
- Ground movements using interferometry techniques
- Geotourism and Heritage

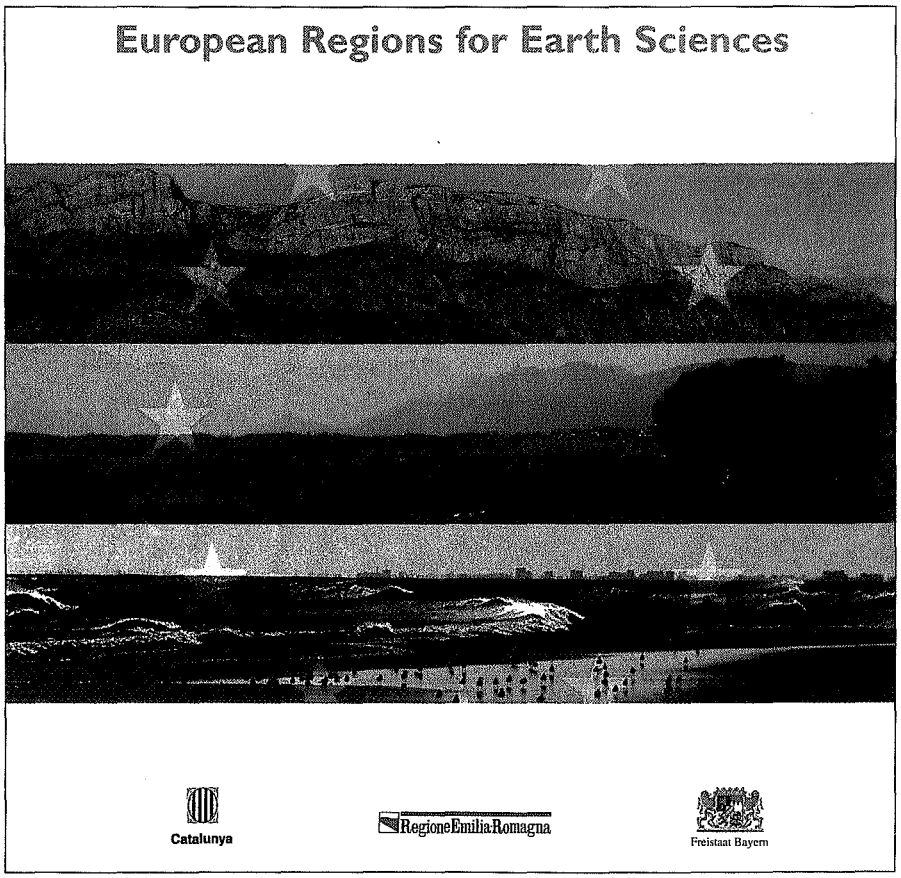
The contents of the next session of the Congress are of the highest significance for Europe's growth and sustainable development. They are strongly related to many European, or EU-supported, policies, (existing Directives, legislative initiatives and programmes). The Congress wants to offer to the participants an opportunity to assess how the European Geoscientific Community can best support:

- the implementation of the UN Implementation Plan decided in 2002, at the Johannesburg World Summit on Sustainable Development
- the Global Earth Observation System of Systems 10-years implementation plan
- the EU Sustainable Development Policy
- the Global Monitoring for Environment and Security (GMES) programme
- the Water Framework Directive and the draft Directive on the Protection of Groundwater against pollution
- the forthcoming Thematic Strategies on Soils, on the Sustainable Use of Natural Resources, on the Protection of the Marine Environment, on Urban Environment
- the EU energy policy
- the European *e*Content plus programme and the European Research and Technology Development Programme
- the European needs for energy and mineral resources.

Representatives of the European Commission and of other European institutions, as well as from National and Regional authorities are invited to participate in the Congress.

The aim of the Congress is to stimulate discussion between the geoscientific community and its stakeholders on the future data and services that it is required to provide, at all scales from local to European, in support of Europe's Sustainable Development, to support policy making, regulatory developments and implementation/ evaluation and sustainable growth.

See first circular, page 37



Cover of the brochure "European Regions for Earth Sciences" presented at the 32nd IGC (Florence, 2004). From the top to the bottom: typical landscapes of Catalonia, Bavaria and Emilia-Romagna.

Ground movement and vulnerability mapping from 800 km

by Prof. Mustafa Aktar[1]

Radar satellites, in orbits 800km above the Earth, have been collecting data through the European Space Agency (ESA) since 1992, and have been providing information on ground movements at the centimeter scale. Just 5 years ago, a new processing technique (PSI) developed by TRE in Italy, allowed a ten-fold improvement in capability so that movements of less than 1 millimeter per year can now be measured. Applied to the earthquake - threatened city of Istanbul, this leading edge technology heralds the prospect of vulnerability mapping over large areas, at low cost, with improved risk assessment and the focusing of resources for remedial action. Ground vulnerability is the parameter in the risk equation which has been least understood and quantifiable.

Les satellites Radar, en orbites de 800 kilomètres au-dessus de la terre, recueillent des données depuis 1992 par l'intermédiaire de l'Agence Européenne de l'Espace (ESA) et ont fourni des informations sur les mouvements du sol terrestre, à l'échelle du centimètre. Il y a juste 5 ans, une nouvelle technique de traitement des données (PSI), mise en oeuvre par TRE en Italie, a permis d'améliorer le système dans un rapport de 10 de telle sorte que des mouvements d'amplitude inférieure à 1 millimètre peuvent être perçus aujourd'hui. Appliquée au tremblement de terre - les risques encourus par la ville d'Istanbul, par exemple- cette technique d'avant-garde ouvre la possibilité de cartes régionales de vulnérabilité, à coût réduit, avec une meilleure evaluation des risques et une convergence des moyens à titre curatif. La vulnérabilité du sol est le paramètre qui, dans l'équation du risque, a été le moins compris et quantifié.

Desde 1992 los satélites radar, en órbita a 800 km de la Tierra, han estado recogiendo datos para la Agencia Europea del Espacio (ESA) y han estado proporcionando información sobre los movimientos del terreno a escala centimétrica. Hace tan sólo 5 años, una nueva técnica de tratamiento (PSI) desarrollada por TRE en Italia, permitió una mejora de su resolución de diez veces, de modo que ahora se pueden medir movimientos de menos de 1 mm al año. Aplicada a la ciudad de Estabul, amenazada por los terremotos, esta tecnología punta, anuncia la posibilidad de mapas de vulnerabilidad de grandes áreas a un bajo coste, con una mejor valoración del riesgo y la orientación de los recursos hacia acciones paliativas. La vulnerabilidad del terreno es el parámetro de la ecuación de riesgo que ha sido peor comprendido y cuantificable.

Since 2003, radar satellite data for 16 cities from Dublin to Haifa and Moscow to Sofia have been used to map their ground movements, exploiting the 13-year archive of raw information now held by the European Space Agency. Under the project title of GMES Terrafirma, partners have been established across the European-Mediterranean region to extend scientific and practical applications in the service of citizens, Governments, industry and commerce.

Within this project, a particular focus has been Istanbul with its great heritage of buildings, its 10 million population and its vulnerability to large earthquakes.

The threat to Istanbul

The city has a long historical record of earthquake damage related to the well known North Anatolian Fault that passes only a few tens of kilometres away beneath the Sea of Marmara. During the last 5 centuries, at least 8 earthquakes with magnitudes greater than 7.0 (M>7.0), have occurred close to Istanbul, causing high casualties and damage. In 1912 (M=7.2, Ganos) and 1999 (M=7.4, Izmit), two earthquakes ruptured both ends of the Marmara Sea, leaving the central submarine section as the most likely one to slip within coming decades (Fig. 1). Recent studies show that the probability of an earthquake of magnitude greater than 7.0 affecting Istanbul within the next 30 years is now 53%, taking into account stress transfer from the Izmit earthquake.

Rapid growth of the population (a ten-fold increase in the last 50 years) has resulted in the production of a large volume of building stock within a limited time period, often not compliant with the required quality standard. It is estimated that about 65% of the total building stock does not satisfy the present earthquake regulation code. The high degree of vulnerability of the city was clearly demonstrated by the considerable damage (and casualties) caused in Istanbul by the 1999 Izmit Earthquake whose epicenter lies at nearly 90 km distance (Fig. 2).

New risk studies

Following this earthquake, intensive studies were initiated both within the scientific community and by the governmental and local authorities, in order to better evaluate the risk and prepare plans for mitigation. Detailed scientific activities have been launched to better understand the earthquake source properties and the active faults in the Sea of Marmara using marine surveys. Ongoing seismic microactivity and crustal deformation are being monitored in real-time by dense arrays of land observation facilities.

In parallel, considerable effort is being devoted to the assessment of the risk in urban areas including the compilation

[1] Professor of Geophysics at the Kandilli Observatory and Earthquake Research Institute in Istanbul.

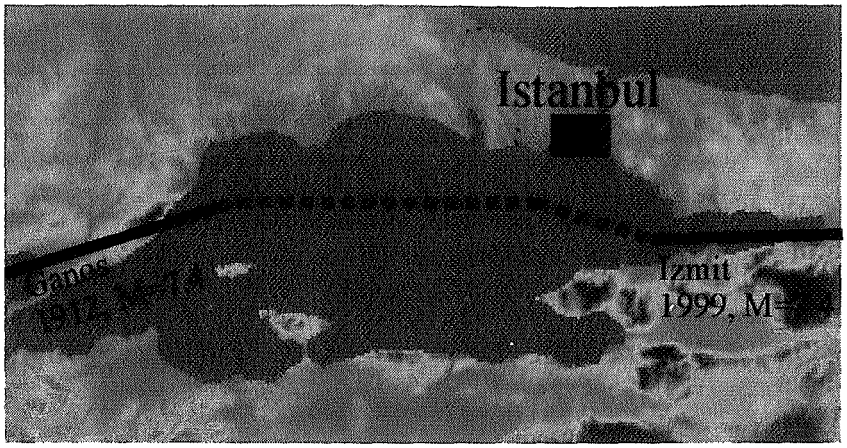


Figure 1. Active faults with recent large earthquakes around Istanbul (black)

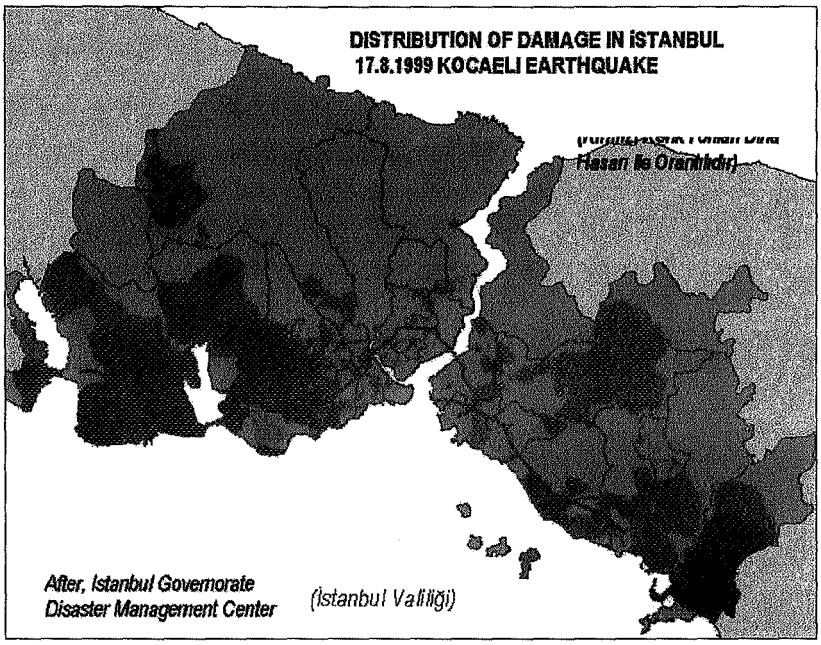
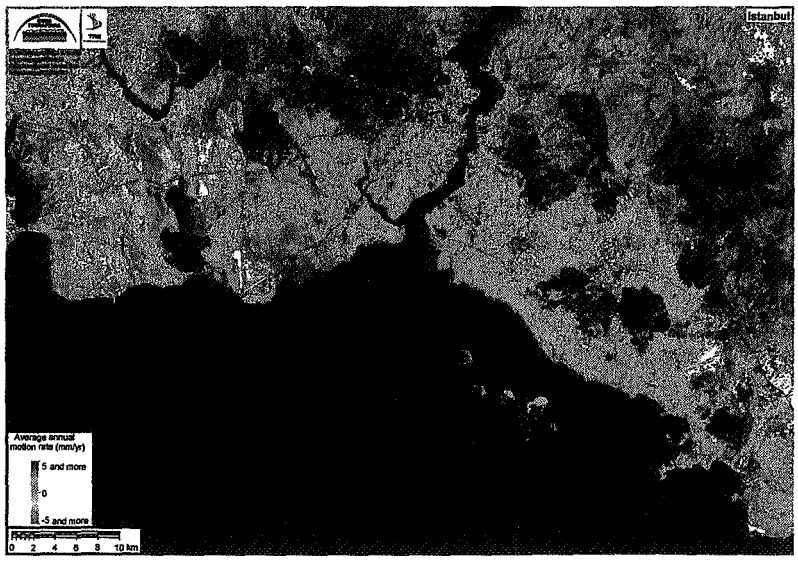


Figure 2. Damage Distribution at Istanbul caused by Izmit Earthquake (1999, M=7.4) (Istanbul Governorate).



of inventories of the built environment. Istanbul Metropolitan Municipality has recently taken the initiative for an extensive microzonation project, which will eventually cover the entire metropolitan area. Modern techniques, such as GPS, GIS and satellite imagery, will be supported by borehole investigations to 30 m depth.

Vulnerability from satellite mapping

The new results obtained using radar satellite PSI studies have produced a subsidence map (Fig. 3) giving first-hand evidence of the high degree of spatial variability of the ground conditions throughout the urban area of Istanbul. The data from 13 years of observations not only show the general trends that correlate well with the local geology but also help to reveal other characteristics at a smaller scale which would otherwise remain undetected.

This subsidence map covers a large area of 50x30 km, and shows a striking pattern that supports the existence of a widespread subsidence on the western part of the city (red coloured area in contrast to the green ones that are stable). This corresponds to the areas that were rapidly urbanized during the last two decades on the smooth topography of young sedimentary ground cover. In contrast, the eastern part of the city, which includes the historical part, is located mostly on solid rock, and is generally stable. Within it, however, there are critical localized zones revealed by the PSI study (see below and Fig. 4).The high average subsidence of 2-3 mm/year detected in the western part, is probably due to consolidation and compaction triggered by extensive water pumping activites, that are well documented by local municipalities. This subsidence is a clear sign of the presence of unconsolidated soft sediments which cause high amplification factors for seismic ground motion. In fact, as clearly seen in the damage map (Fig. 2), much of the destruction (brighter colours) caused by the Izmit earthquake, was concentrated in the western part of the city, even though the earthquake was well to the East. This emphasizes the importance

Figure 3. Subsidence map of Istanbul from satellite PSI, with green showing stability, through yellow to high subsidence areas in red (courtesy TRE and Terrafirma).

Figure 4. Detail of PSI subsidence data over Istanbul (red) which reveals vulnerable soft foundation geology in the ancient river channels and coastal embayments of Istanbul.

of understanding ground conditions and vulnerability for earthquake loss mitigation and risk assessment.

The eastern part of Istanbul, including the ancient city, is located mostly on hard rock and the PSI study shows subsidence only on a very local scale. It picks out ancient riverbeds and coastal fills (Fig. 4). Ancient riverbeds are abundant since the region has experienced sequences of rapid uplift and inundations during the recent geological past, leaving behind deep and narrow gorges filled alternately with coarse gravel and sand. These narrow riverbeds are barely reflected in the actual topography, and in most cases are completely hidden below the modern city development. A similar situation exists for coastal formations such as the ancient estuaries and bays that were filled with sediments over time, both naturally and artificially. In fact, the coastline of the ancient city was not at all a linear one as it appears today but a rugged one with small ports and harbours, as can clearly be seen in XVI century engravings.

The radar satellite PSI technique has proved to be an efficient and most effective tool for detecting these narrow strips of vulnerable soft sediments at a level of detail almost impossible to achieve on the ground. These are the areas most vulnerable to earthquake shaking.

visit www.terrafirma.eu.com

The TERRAFIRMA PROJECT

by David Norbury[1]

Mustafa Aktar's article on Ground Movement and Vulnerability Mapping describes an application of ground movement data to real practical problems in monitoring and mitigating natural hazards, and possibly even in their prediction. The data referred to here is that collected by the ERS and ENVISAT platforms since 1991. Many readers of this magazine might well be aware of this data and its applicability to the whole topic of Natural Hazards, as many national Geological Surveys are partners in the Terrafirma Project. The second stage of this project Terrafirma 2 is about to kick off, and the EFG are also now partners in this latest activity.

So, what is Terrafirma? The project is a pan-European ground motion information service in support of National and European policies aimed at protecting the citizen against natural and anthropogenic ground motion hazards. Funding is by the European Space Agency.

Stage 1 of the project saw the successful consolidation of product suppliers and users and was supported by cautions enthusiasm of the users for the products. The products referred to are ground motion records showing historic and ongoing movements down to sub-centimetric levels of accuracy. This enables assessment of movements arising from landslides, subsidence, and other ground movements from whatever source. One example of this output is described by Mustafa Aktar.

The aims of the Stage 2 project are to build on the results of the first work to develop confidence in and to broaden the appeal and application of the products. Thus, for example, the first stage has shown the possible use of ground motion records in planning. However, the causes of the movements may not be clear. Stage 2 will combine the simple records with geological ground truth information, as held by geological surveys. This will greatly enhance the usefulness of the product.

What is the EFG Involvement in this project? The Board have agreed that EFG should become partners with a view to actively promoting the technology and products in the mitigation of natural hazards. This promotion would be to and through the National Association members of the Federation, as well as taking every opportunity for promotion within European and National governments. The project fits closely with the aims of the EFG Expert Panel on Natural Hazards, and other Expert Panels, in demonstrating the role that geology has to play in the safety of the citizen in an everyday and real sense.

This note is an Introduction, and we will be taking every opportunity over the three year life of the project to explain more about this project to you.

[1]Secretary General, EFG

The Applied Petrography Group

by EurGeol. Richard Fox

There has been a growing concern in recent years that petrographic investigations have not provided the reliable findings that could give confidence in assessing problems. The lack of consistency in the recognition of common rock types, the use of imprecise nomenclature containing too many ambiguous or poorly defined terms, as well as problems in applying some of the statistical aspects of 'standard,' have all added to the confusion.

Ces dernières années, le fait que les recherches pétrographiques n'ont pas fourni les résultats fiables qui auraient donné confiance dans l'évaluation des problèmes est devenu un souci croissant. Le manque de logique dans l'identification des différentes catégories de roches communes, l'utilisation d'une nomenclature approximative incluant trop de termes ambigus ou imprécis et les problèmes liés à l'application de règles statistiques définissant un *standard* ont tous ajouté à la confusion.

En los últimos años ha habido una preocupación cada vez mayor sobre que las investigaciones petrográficas no han proporcionado descubrimientos relevantes que podrían haber dado confianza en la valoración de problemas. La falta de consistencia en el reconocimiento de los tipos de rocas más corrientes, el empleo de una nomenclatura imprecisa que contiene términos muy ambiguos o con falta de definición así como los problemas de aplicación de algunos de los aspectos estadísticos de "nomalizado" han afianzado la confusión.

In 2000 several industrial and academic scientists set up a committee to consider the problems, under the name of the Proficiency Scheme for Aggregate Petrographers (PSAP), and some useful trials were conducted by the laboratories linked to PSAP to assess the capabilities of petrographers in identifying rock types. Unfortunately the limited number of suitable laboratories in the UK to participate in the aggregate trials was a cause for concern and resulted in the PSAP deciding to widen the scope of the investigations to include concrete, building stone and related materials.

The new investigations team was renamed the Applied Petrography Group (APG) to reflect the wider interests and a better over-view of construction materials.

Constitution of the Group

The APG is affiliated to the Engineering Group of the Geological Society with an independent Chairman appointed by the Engineering Group Committee. Currently the Chairman is EurGeol. Richard Fox, and the Secretary is Dr Alan Poole with the Group having a wide membership from practicing petrographers representing various organizations and institutions in the UK.

Objectives

Members of the Group are currently working towards addressing the following five objectives:

- reviewing and recommending amendments to relevant standards
- preparing Guidelines and Codes of Practice for the petrographic investigation of concrete and other constructional materials
- reviewing the qualifications appropriate for a title of 'competent petrographers'
- developing and organizing appropriate training and CPD programmes
- publicizing and promoting the usefulness of applied petrography to a wide professional audience.

The APG is initially concentrating on achieving its objectives within the UK. However, the intention is to extend links and contacts with applied Petrographers from Europe, America and the rest of the world in order to draw on the wider experience available and to seek information and comment. This will enable the Group to insure that their work is compatible with systems already in place elsewhere.

Competence in Applied Petrography.

In trying to assess standards of competence various enquiries were made to colleagues in Canada and the USA, which suggest that a reasonable approach to a petrographic qualification would require at least 'Appropriate Academic Qualifications' (or an equivalent experience) together with 'on the job' supervised training. Some form of practical test of competence covering microscopical observation and the preparation of a report could provide an objective assessment.

From initial investigations it would seem that any scheme to measure competence will need to provide for standards indicating precisely the kinds of competence that are to be judged, together with the appropriate objective verification procedures. Implementation then requires a Community of trained assessors with agreed methods of interpretation.

Currently the Geological Society, together with the Institution of Civil Engineers and the Institute of Materials, Minerals and Mining (on behalf of the Ground Forum), are considering a voluntary scheme whereby individuals who are Chartered with an appropriate professional body and have reached an appropriate level of competence can apply to be 'registered' as 'ground engineering professionals.'

It may be that a similar 'register' could be established for competent petrographers and these are matters being considered by the APG in the coming months.

Conclusion

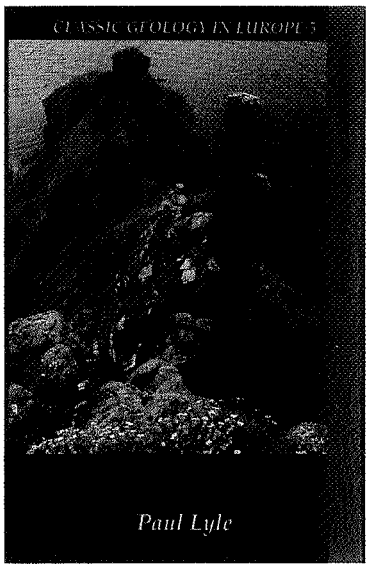
The Applied Petrography Group welcomes the opportunity to widen the discussions throughout Europe through the European Federation of Geologists. Further information and contact can be obtained by liasing with the Group Secretary:

Dr Alan Poole,
Tel: +44(0) 1865 558188
Fax: +44(0) 1865 316221
abhmpoole@lineone.net

(Affiliated to the Geological Society Engineering Group)

The North Rocks!

Book review by David Harper[1]



The north of Ireland by Paul Lyle
Classic Geology in Europe 5

Published by Terra Publishing [www.terrapublishing.co.uk]
ISBN: 1-903544-08-4 paperback
Date: 2003, pp 214
Price: £13.95 (€21)

The north of Ireland displays a near unrivalled diversity of scenery contained within the relatively limited area of the six counties of Northern Ireland together with Donegal and parts of Cavan, Leitrim, Louth, Monaghan and Sligo. The jagged peaks of Dalradian Donegal contrast with the limestone terrains of Fermanagh and Sligo and the cubist simplicity of the columnar basalts of the Giant's Causeway. This diversity of surface sculpture reflects a long and varied geological history, stretching back some 1500 million years to the late Precambrian. Paul Lyle has tracked the history of this part of the European margin through a remarkable catalogue of geological environments and processes. This journey takes us from the Precambrian basement rocks of Inishtrahull and the Ox Mountains through the changing environments of the developing Iapetus Ocean (that geographically split the north and south of Ireland) and its subsequent closure marked by the Caledonian Mountains and terrestrial Devonian sediments of their intermontane basins. During the subsequent part of the Palaeozoic and the succeeding Mesozoic era, more quiescent environments dominated by marine deposition during the Carboniferous and Jurassic-Cretaceous were interrupted by the deserts of the Permian and Triassic and crowned by the spectacular tertiary Antrim plateau basalts.

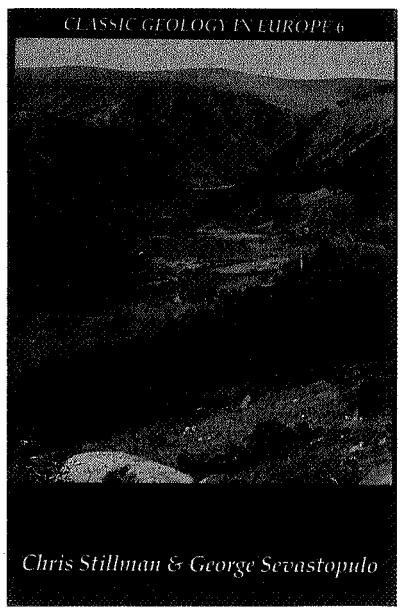
But there are already a number of good books on the geology of Ireland, with excellent chapters on the north. Lyle, however, develops the story further with a series of well-illustrated itineraries including 'The West', 'Fermanagh and Tyrone', 'Down' and 'Antrim'. Colour photographs of many of the critical exposures are provided, keyed into maps and stratigraphical columns from the Geological Surveys of Northern Ireland and the Republic of Ireland publications. Errors are few; for example, the spectacular Carboniferous coral at Streedagh Point is *Caninia*.

Field geology may be temporarily out of fashion in many universities and colleges; nevertheless the extraordinary range of rocks and structures in the north of Ireland, exhibited here by Paul Lyle, provides an unequalled training ground for potential geologists, sadly in a region without a geology department.

[1]EurGeol. David Harper is Professor of palaeontology, Natural History Museum of Denmark, University of Copenhagen

Leinster exposed

Book review by David Harper[1]



Leinster by Chris Stillman and George Sevastopulo
Classic Geology in Europe 6

Published by Terra Publishing [www.terrapublishing.co.uk]
ISBN: 1-903544-13-0 paperback
Date: 2005, pp 192
Price: £13.95 (€21)

Although Dublin is the point of entry for most tourists to the island of Ireland, many are immediately seduced by the wild scenery of the west and southwest coasts or the heaving nightlife of the cities of Cork, Dublin and Galway, neglecting the more subtle scenery of Leinster, itself. The subdued landscapes of the province, however, mask a remarkably diverse geological and human history that began at least 1000 million years ago in the rocks of the Precambrian Rosslare Complex and ended in the heart of the Celtic tiger. This clearly-narrated and well-illustrated guide to the geology of Leinster, written by two of Geology's elder statesmen, brings alive the vivid history of the province. A brief introduction reprises an eventful geological history, highlighting the spectacular Ordovician volcanics of the Waterford coast (formed when the northern and southern parts of Ireland were separated by the Iapetus Ocean), the Caledonian Leinster granites (associated with the closure of the ocean and continental collision) and the fossiliferous limestones of the Carboniferous; the more recent history of the region involved Quaternary glaciations and a variety of associated landforms. Detailed excursion guides follow; North Leinster (diverse Ordovician-Silurian, Carboniferous strata and tertiary intrusives and volcanics together with the archaeology of the Boyne valley); Dublin Region (mainly the Leinster granites and Carboniferous strata: some localities accessible by the DART light-rail system); County Wicklow (Lower Palaeozoic rocks and Leinster granites) together with South Wexford and Waterford (Precambrian basement, Ordovician volcanics and sediments together with Devonian-Carboniferous strata). All are illustrated with readable maps and good-quality photographs together with didactic explanations. There is a useful glossary and index. This informative and readable guide should do much to place Leinster on the tourist trail, at least for hammer-carrying visitors.

News and events 2005

News from Serbia and Montenegro

Karst 2005

On September 13 to 19, the International Conference **«KARST 2005 – Water resources and environmental problems in karst»** was held in Belgrade (Serbia) and Kotor (Montenegro). The Conference was organized by the IAH National Committee of Serbia and Montenegro (International Association of Hydrogeologists, with approx. 5,000 members), IAH Karst Commission and UNESCO. The main topic of the event was karst, for which Serbia and Montenegro are world famous. Another topic was the historical role and the significance of world-famous Serbian karstologist and founder of karst hydrogeology Jovan Cvijic – the Conference was a tribute to mark the 110th anniversary of the publication of the seminal work «Karst».

The co-organizers of the Conference were: ISU (International Union of Speleologists), IAEG (International Association of Engineering Geologists) and IAHS (International Asociation of Hydrological Sciences). Other co-organizers were: Serbian Academy of Sciences and Arts, Serbian Geological Society, Union of Geological Societies of SMG, Faculty of Mining and Geology, as well as Geological Bureaus of Serbia and Montenegro. The Conference was held under the patronage of the Ministry of Science and Environmental Protection of Serbia, and the main sponsors were NIS-Naftagas (Oil & Gas Industry of Serbia) and EAGE (European Association of Geoscientists and Engineers).

Various regional conferences, symposia, congresses and meetings have been organized in many countries with dominating karst problems, in order to exchange experience and discuss new scientific and engineering information. The KARST 2005 Conference represents a continuity of international meetings for scientists and engineers whose primary interest is focused on the different aspects of karstology.

During the Conference, the Annual Meeting of the IAH Council was held, as well as the General Assembly. In addition, a two-day Workshop **«Karst aquifers and related ecosystems»** was organized by UNESCO.

Over 250 participants (150 from overseas) attended the event, field excursions and social events. In total, there were 132 papers (written by 304 authors from 32 countries from six continents) under five main topics:

- Vulnerability of the karst environment and ecological problems
- Management and sustainable use of karstic water resources
- Hydrogeology and multidisciplinary research of karst
- Impact of man-made structures on karst eco-systems
- Vulnerability of Geo- and Bio- diversities in karst and their protection, legal aspects and environmental education.

These were published in the 930-page Book of Papers, and also burned onto CD. Of this number, 49 papers were presented during the six working sessions, held in Belgrade and Kotor, while 83 papers were discussed at the special poster session in Kotor.

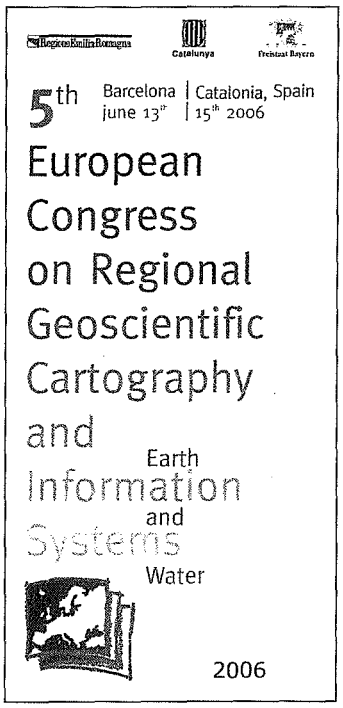
KARST 2005 is the most important international conference treating groundwater resources ever held in Serbia and Montenegro. It was an outstanding opportunity for professionals to exchange experiences, discuss problems and their solutions, and to propose measures to improve management of the karst environment. Several excursions and field seminars (before, during and after the Conference) provided an opportunity to visit some of the most impressive terrains and localities in the classic karst of Serbia, Montenegro and Hertzogevina.

All additional information is available at: www.cvijic-karst2005.org.yu

Dr Snežana Komatina-Petrović, secretary of the IAH National Committee and Secretary of the KARST 2005 Conference

News from Spain

First circular



News and events 2005

News from France

The UFG 40th anniversary

Under the presidency of Alain Perrodon, Honorary President and one of the founding fathers of the UFG, (June 1965), and Jacques Marie, the current President, the Union Française des Géologues celebrated its 40th anniversary at the Ministry of Ecology and Sustainable Development on May 19 2005.

More than 200 geologists, aged between 25 and 85, attended the meeting where Earth Science professionals were freely debating the actual and future situation of the geosciences.

The EFG was represented by Isabel Fernandez, Director of the Brussels EFG Office, Carlo Enrico Bravi, Treasurer and David Norbury, General Secretary.

The objectives of this meeting were three-fold:

- bringing together all those practising geosciences in France, professionals from public and private sectors
- verifying through technical oral papers the mandatory place of the geologist in both natural resources exploration and environmental risk assessment
- provoking a discussion between professionals from industry and academia (students, professors and researchers) about education in the geosciences, the geo-job market in France and Europe and the future of the Earth Sciences.

During the morning, representatives of TOTAL, AREVA, ANGLO-AMERICAN, BRGM, Marseille University and EFG (Carlo Enrico Bravi) presented impressive papers with topics ranging from natural resources (oil, uranium, sulphides, water) to natural hazards, particularly in Italy and France (volcanoes, earthquakes, landslides, flooding, subsidence and clays swelling). An ambitious national plan is necessary to mitigate the effects of natural and man-made disasters because geoscientists are the key planners in creating a sustainable future.

The Roubault Prize, which rewards geological works according to both their innovative and applied perspectives, was awarded to Jean-Laurent Mallet, Professor at the *Institut National Polytechnique de Lorraine* and *Directeur du Laboratoire Informatique et Analyse des données de l'Ecole Nationale Supérieure de Géology de Nancy.*

Professor Mallet invented a new method of data interpolation named *Discrete Smooth Interpolation* which has led to the GOCAD research Project. (*Geomodelling,* 600 pp, edited by Oxford University Press details the GOCAD research Project). This proposes an original method of geometric modelling, involving a new CAO form dedicated to natural objects. His current work deals with a future tool which will enhance the study of sedimentary rocks

After a nice lunch, allowing some thirty students to meet their elders, feedback, discussion and collaboration were the order of the afternoon.

Presentations and round tables about the future of geologists, mainly in the domains of natural resources and risks in land-use planning, acknowledged the need for a formal education enhancing field observations, the development of foreign languages and a solid training.

David Norbury and Isabel Fernandez (EFG) stressed the need for the mobility of geologists, the harmonization of Earth Sciences curricula and the recognition of expertise through the EurGeol. title.

UFG will resume its active role at the EFG and French geologists are encouraged to look more towards Europe and apply for the EurGeol. title.

What is the future for professional geologists in France?

Jean Dercourt, from the Academy of Sciences closed the meeting by proposing a few recommendations for strengthening the UFG and the geological community:

- geology through its techniques and applications has been internationalized and there is an urgent need to federate the existing associations in geosciences, starting with the three main bodies: SGF (academic), UFG and CNFG (international representation of French geology)
- a Federation with a common publication will ease the geo-job market and increase the impact of geologists
- this initiative will raise the awareness of the contribution to, and role of the earth sciences in, society in the minds of decision-makers, the media and the general public.

Pierre Andrieux and Antoine Bouvier

News from Italy

AEGS in Turin triumph

The Association of European Geological Societies, which has recently held a week-long international conference on Natural hazards related to recent tectonic processes and regional evolution is in the ascendant.

The AEGS, the only body to link together all the national geological societies in the wider Europe, held its 14th biennial conference (MAEGS-14) in Turin, Italy from 19-23 September. Sponsored generously by ARPA Piemonte and the Province of Torino, this highly successful conference attracted over 180 delegates from 25 countries, including some as far away as Bangladesh, Egypt and Japan. This made MAEGS-14 the most successful conference in terms of attendance in the history of AEGS.

Dr Jens Wiegand (Deutsche Geologische Gesellschaft, AEGS Secretary) said: "With its three days of high quality presentations and its two-day field excursion, this conference was an inspiration to future organizers. I want to express my thanks to Prof. Carlo Bartolini, Prof. Francesco Carraro, and especially Dr Marco Giardino, for all their efforts."

Some years ago at an extraordinary meeting of the AEGS Executive Committee at Burlington House, London, it was decided to take the AEGS back to its roots and choose topics for biennial conferences that were highly applied, of international significance and above all, relevant to societal needs. This decision has since been vindicated with subsequent meetings showing a continual improvement in attendance, from the Hannover meeting two years ago on the European Water Directive, to the current highly topical conference on hazards. The next meeting, to be held in 2007 in Tallinn (Estonia), will concentrate on *Georesources and public policy: research, management, environment.*

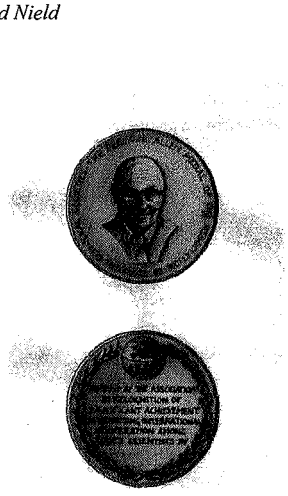
The AEGS developed out of an initiative first taken in 1975 by Prof. Percival Allen FRS of Reading University. In those days the imperatives were slightly different, the main aim being to develop an inclusive international congress on applied aspects of geology, which reach through the Iron Curtain and bring geoscientists from the Eastern Bloc into contact with Western thinking – and *vice versa*. Today, the need to maintain contacts with other European societies remains strong; but in

the aftermath of the fall of communism the need is to support societies in the emergent and EU accession nations that are now struggling to develop or re-establish their own identity after decades of decline, and whose currencies may be too weak to allow their geoscientists to attend more costly congresses.

As one of those rare European initiatives that started in Britain, one decision taken by the AEGS Executive (when it met during the Turin conference) was particularly significant for the UK. Dr Ted Nield, who represents the GSL on the Executive, had offered one year ago to bring forward a proposal as to how the AEGS could mark its unofficial 40th birthday by founding an award. He contacted AEGS founder Prof. Allen and received his permission to propose the establishment of a Biennial Percival Allen Medal of the AEGS (see picture below) to honour those who have done most to foster international cooperation among Earth scientists. The fully costed proposal, with design mock-up of the medal was accepted, and the three-inch bronze medal will be struck by the Society's medal makers, Spink (1666).

A call for nominations for this medal will go up on the AEGS Web Site during the AEGS's next Executive meeting, to be held in Tallinn on 7 July 2006. Ted Nield said after the meeting: "This medal will achieve three things – it will honour a great British geoscientist, remind the Association of how it came into being and why, and help to tie member societies together by generating interest in the AEGS's activities."

Dr. Ted Nield



News from Portugal

IV International Symposium ProGEO on the Conservation of the Geological Heritage, 13-16 September 2005 University of Minho, Braga

The IV International Symposium ProGEO on the Conservation of the Geological Heritage was held between 13-16 September 2005 at the University of Minho (Braga, Portugal), organized by ProGEO (European Association for the Conservation of the Geological Heritage) and by the Earth Sciences Department of the University of Minho.

Nationals of more than 30 countries from four continents contributed to the symposium's activity and products. Several international and national institutions were represented at the Opening Ceremony, namely: IUGS; IUCN -The World Conservation Union; the European Federation of Geologists; the Portuguese Nature Conservation Institute; the National Institute of Engineering, Technology and Innovation - Portuguese Geological Survey; the National Natural History Museum; the Portuguese Geologists Association; the National Association of Portuguese Municipalities. In all, 160 participants presented about 150 oral and poster contributions. These contributions were devoted to the following themes:

- Methodologies to characterize geological heritage
- Management of geological heritage
- Integrating geoconservation in nature conservation policies
- Geoconservation and education for sustainable development
- Portuguese frameworks of international relevance.

During the Closing Ceremony, a Final Declaration was approved, and its seven points summarize the most significant remarks of the Symposium and its agreement on future collaboration.

Final Declaration

The final congregation of the Braga Symposium is in accord in agreeing as follows:

- we congratulate the organizing committee on achieving the presence of participants from more than 30 countries, from different continents, and in their promotion of the sharing of experiences and good practice, allowing us to learn from each other
- we urge, as at the last International Geoconservation Symposium, that, due to the fact that many geosites of paramount importance continue to be at risk in numerous countries, national authorities should pursue strategies in order to implement *Recommendation Rec(2004)3 on Conservation of the Geological Heritage and Areas of Special Geological Interest* of the Council of Europe
- we stress the importance of the integration of geoconservation issues in school curricula, as a contribution for the United Nations Decade of Education for Sustainable Development (2005-2014)
- we endorse all local, national and wider development of Geoparks, which must be based on sound and sustainable protection of the geosite resource
- we fully endorse and support the recent developments undertaken in Portugal by the national ProGEO Group with the collaboration of other national institutions, those efforts resulting in the definition of geological frameworks of international and national relevance
- we recommend that both Portuguese and Spanish specialists should renew efforts to achieve the definition of geosite frameworks of Iberian relevance; ultimately linking this work with that in other south European countries
- we recommend the Portuguese Official Authorities, namely the Nature Conservation Institute, to urgently integrate geoconservation into national strategies. Also it is an essential requirement that this Institute increases the geological expertise of its technical staff, in order to better assure the conservation of the Portuguese geological heritage inside and outside protected areas.

University of Minho, 16 September 2005

Submission of articles to European Geologist Magazine

The EFG calls for quality articles for future issues of European Geologist. Submissions should be in English and between 1000 and 3000 words, although longer articles may be considered. An abstract of between 100 and 120 words should be included in English, French and Spanish. Articles should be sent via e-mail to the Editor at Harper-mccorry@tele2adsl.dk or on disc to Vordingborgvej 63, 4600 Køge, Denmark. Photographs or graphics are very welcome and should be sent to the Editor as tif or jpg files in CYMG colour. Further details may be found on the EFG website: www.eurogeologists.de

Deadline for submission 30 March and 30 September.

Advertisements

Prices for advertisements

	One Insertion	Two Insertions
Full page (colour)	820 Euro	1320 Euro
Half page (colour)	420 Euro	670 Euro
Quarter page (colour)	220 Euro	350 Euro
Full page (black and white)	420 Euro	670 Euro
Half page (black and white)	220 Euro	350 Euro
Quarter page (black and white)	120 Euro	200 Euro
Business card size	90 Euro	150 Euro
Preferential location	25% plus	
Price for special pages:		
Outside back cover (colour)	1200 Euro	1900 Euro
Second page (colour)	1000 Euro	1600 Euro
Second last page (colour)	1000 Euro	1600 Euro

Data for European Geologist Magazine	
Number of issues printed:	6500
Periodicity:	2 times a year
Print mode:	Offset
Size:	A4 (210 mm x 297 mm)
Deadline:	30 March, 30 September.
Published:	30 May, 30 November
Advertisement delivered as computer file:	EPS, TIFF
For graphics remember to include fonts.	

6500 issues of European Geologist are distributed among professional geologists all over Europe. They are sent to the European countries National Federations of Geologists, and these national organisations distribute them to their members. These include geologists working in companies as well as at universities.

Layout of the magazine is made in Adobe Indesign CS for PC.

Method of payment:

Invoice after publication

Subscription Rates: Annual subscription to the Magazine: 13 Euro

Contact:

Dr. Maureen Mc Corry

e-mail: Harper-mccorry@tele2adsl.dk

Tel: +45 45831970

European Federation of Geologists (EFG)

The European Federation of Geologists was established in Paris in 1980 during the 26th International Congress of Geology. In the same year the Statutes were presented to the European Economic Community in Brussels.

The Council of the EFG is composed of the representatives of the national associations of geologists of Belgium-Luxembourg (UBLG), Czech Republic (CAEG), Finland (YKL), France (UFG), Germany (BDG), Hungary (MFT), Iceland (GSI), Ireland (IGI), Italy (CNG and ANGI), Netherlands (KNGMG), Poland (PTG), Portugal (APG), Slovakia (SGS), Slovenia (SGD), Spain (ICOG), Sweden (N), Switzerland (CHGEOL), United Kingdom (GS), whilst the American Institute of Professional Geologists (AIPG) is an Associate Member. The EFG currently represents about 40,000 geologists across Europe.

Mission

To promote the profession and practice of geology and its relevance.

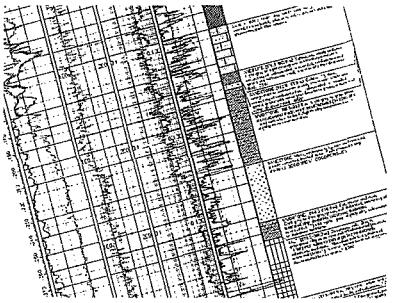
Objectives

1. To promote and facilitate the establishment and implementation of national arrangements for recognizing geologists who, through academic training and appropriate periods of relevant experience in the profession and practice of geology, are qualified to be designated as EurGeol.
2. To organize meetings and conferences to discuss issues related to the profession and practice of geology.
3. To co-ordinate the activities of member national organisations in preparing briefing papers on geological issues and presenting these to European bodies, national governments and other relevant organisations.
4. To maintain contact with the European Commission and respond in timely manner to requests for information.
5. To communicate, through meetings and other means, the relevance of geology to the resolution of issues of concern to society.
6. To promote the establishment of best practice for training of geologists.
7. To safeguard and promote the present and future interests of the geological profession in Europe, including:

- to guarantee the free movement of geologists in Europe, with the mutual recognition of their academic and professional qualifications by the adoption of the title of European Geologist (EurGeol.).
- to promote the harmonisation of education and training.
- to define and protect the title of geologist and related professional titles.
- to promote the code of professional ethics of the EFG.
- to provide advice and assistance to constituent member National Associations.

Impressive

$599

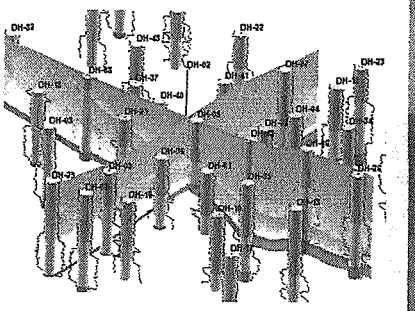


LogPlot

Powerful. Flexible. Affordable.

Display geotechnical, geophysical, mud logging, and oil/gas data as a graphic strip log. Plot single page logs for shallow borings, or multi-page/ continuous logs for deep wells.

$1,499

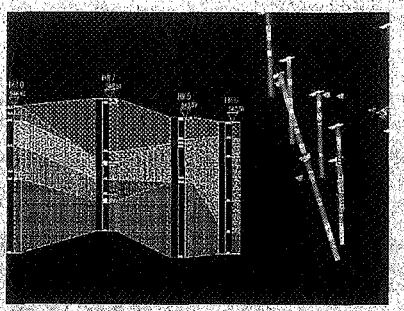


RockWorks

3D Subsurface Data Management, Analysis, and Visualization

All-in-one tool that allows you to visualize, interpret and present your surface and sub-surface data. Now with Access Database for powerful queries, data verification, relational integrity, built-in import/export tools for LogPlot data, and LAS import for geophysical data.

$1,499

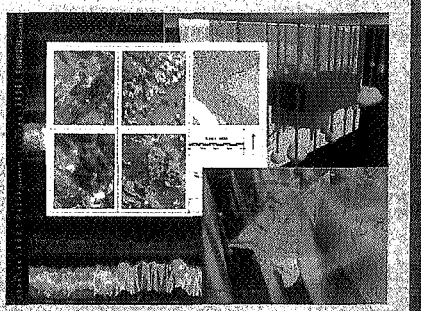


Drill&Log

Strip Logs for AutoCAD

State-of-the-art borehole logging system. Based on a powerful database engine, Drill&Log provides efficient input, manipulation, storage, exchange and output of drilling as well as pile driving data. 2D and 3D boring logs are output in standard .dwg (AutoCAD) format.

$2,200 (base price)



Profile Analyst

Integrate, Analyze and Visualize Geophysics, Geochemistry and Geology Data from Various Sources

Integrate the fields of geophysics, geology and geochemistry into a single cohesive view. An integration environment for Encom Discover for MapInfo Professional, Encom ModelVision Pro, Encom QuickMag Pro and EM Flow.

RockWare®

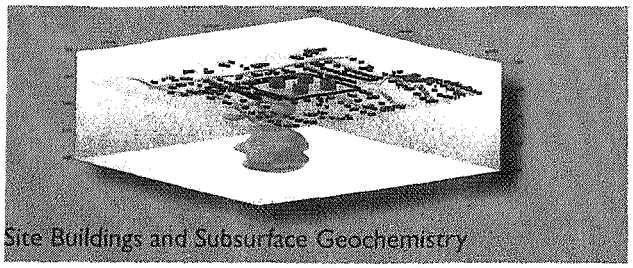
Since 1983

Earth Science Software • GIS Software • Training • Consulting

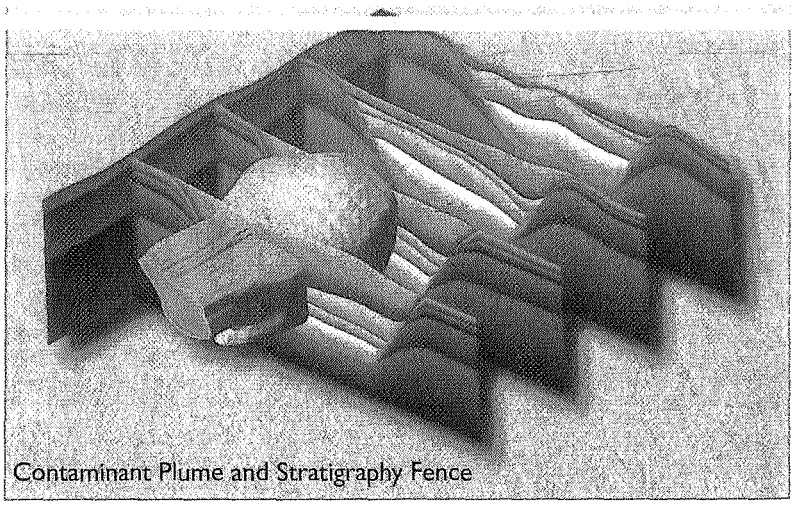
www.rockware.com

303.278.3534 • F: 303.278.4099

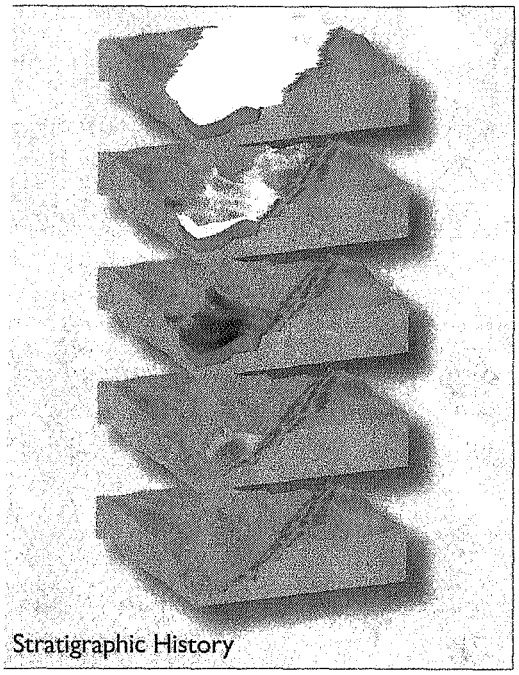
RockWorks™ v.2004



Site Buildings and Subsurface Geochemistry



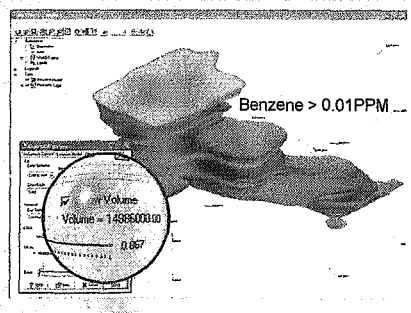
Contaminant Plume and Stratigraphy Fence



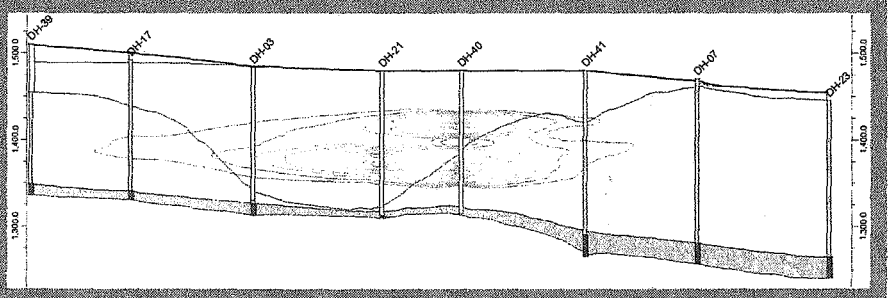
Stratigraphic History

3-Dimensional Subsurface Data Management, Analysis, and Visualization

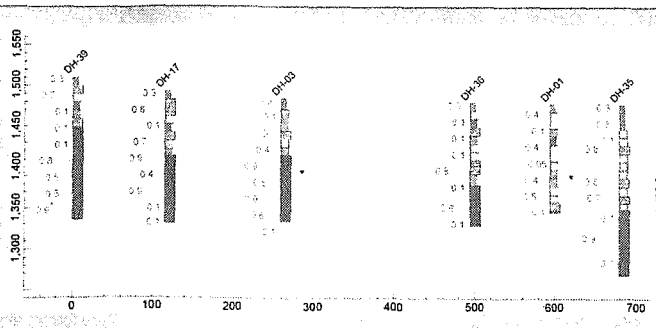
RockWorks2004 is an affordable, all-in-one tool that allows you to visualize, interpret and present your surface and sub-surface data. Whether you are a petroleum engineer, an environmental scientist, a geologist or other earth scientist, RockWorks contains tools that will save you and your clients time and money. Increase your profitability and competitive edge with high quality graphics, models and plots... all for just $1199.00. Download a trial version at www.rockware.com. Contact us for training and consulting services at 303.278.3534.



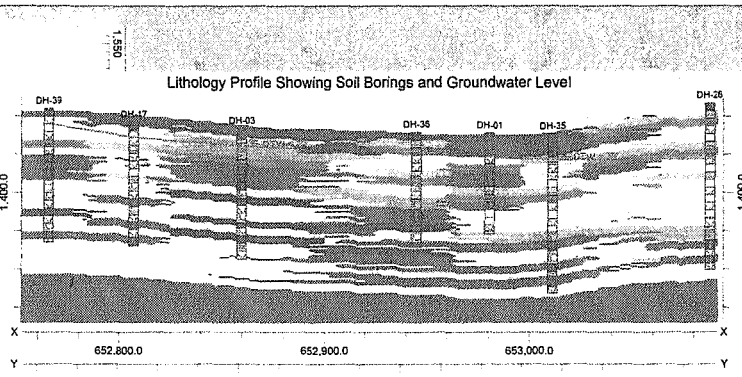
Interpolated Lithology Model with Volumetric Display



Hydrostratigraphy and Geochemical Contours



Lithology Logs



Interpolated Lithology Cross Section

RockWare®
2221 East St. Golden, CO 80401 303.278.3534 F: 303.278.4099 www.rockware.com
RockWare Europe —Vicolo dei Saroli 1 6944 Cureglia, Switzerland +41 91 967 52 53 F:41 91 967 55 50