1997

European Geologist

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

MAPPING OF GROUND WATER RADON POTENTIAL

GEOTHERMAL ENERGY IN EUROPE

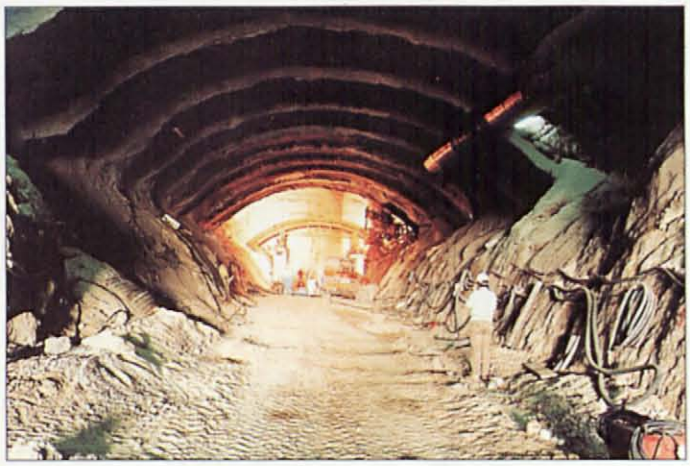
SWEDEN A MINING COUNTRY WITHIN THE EUROPEAN COMMUNITY

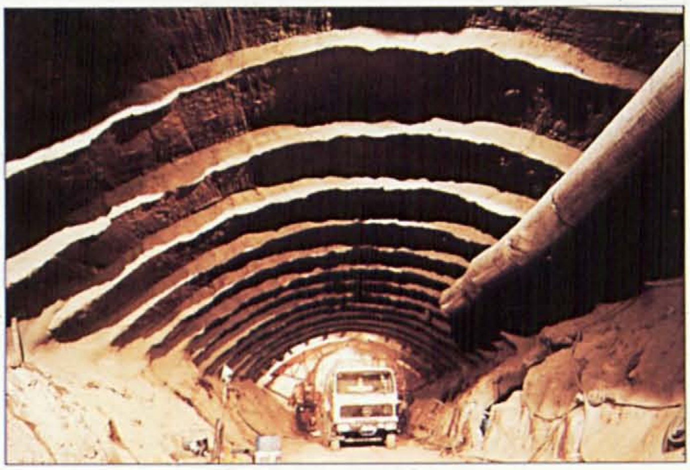
SPANISH RAILWAY BALLAST STANDARD

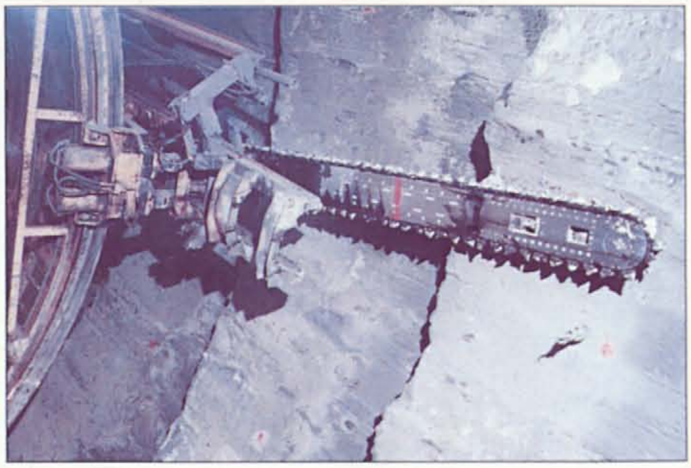
EFG - GEOCALENDAR - BOOKS

TUNELES BAJO EL MONTE DE EL PARDO

EJECUCION DE LA PREBOVEDA (METODO PREMILL)







EUROPEAN GEOLOGIST

is published by the
European Federation of Geologists
«Maison de la Géologie»
77-79 Rue Claude-Bernard
75005 PARIS (France)
Tel: 33 (1) 47079195. Fax: 33 (1) 47079193
E-mail: efgparis@hol.fr

Officers
PRESIDENT
EurGeol Manuel Regueiro y González-Barros
Instituto Tecnológico Geominero de España
Dirección de Recursos Minerales
Ríos Rosas, 23. Planta Baja
28003 Madrid (Spain)
Tel: 34 1 3495778. Fax: 34 1 4426216
E-mail: mregueir@santandersupernet.com

VICE PRESIDENT
EurGeol Gareth Jones
Conodate International Ltd
Parkview House Beech Hill
O.C. Clonskeagh. Dublin (Ireland)
Tel: 353 12698464. Fax: 353 12601635
E-mail: comodate@iol.ie

SECRETARY-TREASURER
Jukka Marmo
Geological Survey of Finland
P.O. Box 96
FIN-02151 Espoo (Finland)
Tel: 358 2055011. Fax: 358 2055012
E-mail: jukka.marmo@gsf.fi

PRESIDENT CGUE WG
Vittorio Illicetto
Consiglio Nazionale dei Geologi
Via Vittorio Colonna 40
I-00186 Rome (Italy)
Tel: 39 6 68807736. Fax: 39 6 68807742

EDITORS
Manuel Regueiro
Gareth Jones

ASSISTANT EDITOR
Natalia García Corrales

EDITORIAL BOARD
Antoine Bouvier
CGC
1 Rue Léon Migaux
F-91341 Massy cedex (France)
Tel: 33 1 64473672. Fax: 33 1 64473986
E-mail: abouvier@cgg.com

Richard Selley
Department of Geology
Royal School of Mines. Imperial College
Prince Consort Rd.
London SW7 2BP (UK)
Tel: 44 1 715946425. Fax: 44 1 715946464
E-mail: r.selley@ic.ac.uk

Advertising & Subscriptions
Jean Claude Vidal
Assistant Secretary
EFG Headquarters
Paris

Printed by
Gráficas Summa, S. A.
Polígono Ind. de Silvota
Llanera. Asturias. Spain
ISSN: pending
Depósito Legal: AS. 1.184-1995

Cover Pictures:
Manuel Regueiro
M. Lombardero
J. P. Calvo Sorando

Europe can be divided in terms of professional practise of geology (and many other professions) by a very sharp line: countries with laws regulating the profession (Italy and Spain) and countries with no legal protection for professional geological practise (the rest). These last can also be subdivided in countries were practise is liberal (any one can practise geology, the client or contractor decides if the professional is competent) such as Denmark, Sweden, Finland, Germany and Norway, and countries were practise is under the patronage of private professional associations, such as Great Britain, France, Greece, Portugal, Belgium, Ireland, but with no legal way to impede illegal practising.

It might appear from the free movement of professionals point of view, that the legal protection of a title framework is designed to hinder the practise of foreign geologists in countries with protection. But in reality the idea behind the legal status of a profession is something the EU is now enforcing: social welfare. Because such protection exists to guarantee the quality of the professional by defining a code of ethics and a minimum level of professionalism.

This is in fact what the trend is in northern European countries: the registration or certification system is a private system (sometimes under a royal umbrella such as the charter status) intended precisely to protect the public, assuring the experience and professional excellence of the applicant.

A similar idea is expanding on the other side of the Atlantic in Canada and the USA, where registration and certification is spreading, as more states are establishing professional quality control systems.

Thus it seems that everywhere there is an increasing need to supply society with better-prepared and more efficient professionals by means of registration. But legal systems do have flaws that can be improved using the ideas of the certification system, although they have the advantage of having a law backing disciplinary actions to fight against unethical behaviour and incompetence.

The European Geologist title is the certification system that serves the citizens of Europe to choose between the best possible geological professionals; it is also the only unified system that might serve to enhance the free movement of geologists in Europe, but it needs two final pushes to achieve its goals: that companies start using the title as their standard of employees quality and that the EU Commission recognises its advantages as a professional passport within the Union.

The EFG will continue to do its best to turn the EurGeol title into the trademark of European professional geology.

Manuel Regueiro
President of the EFG

CONTENTS

Págs.

Professional Geologists
- What on earth is a geologists? - The answer 3
- The geological profession and ethics with particular reference to the UK and continental Europe 5

Environmental Geology
- Geology in land-use planning and environmental protection in Slovakia 9
- Mapping of ground water radon potential 13
- The Grimsel rock laboratory in the Swiss alps. An overview of the research programme 23

Geology
- Explosive, proterozoic volcanism at an archaean continental margin, an example from the Luleå area, northern Sweden 29

Natural Resources
- Geothermal energy in Europe 33
- Sweden - a mining country within the European Community ... 40
- Hydrocarbon occurrence in Portugal 43

Engineering Geology
- Spanish Railway Ballast standards 48

Geological Surveys
- The geological institute of Hungary (Máfi); ready to meet the changing face of Europe 52
- The earth sciences centre at Göteborg University in Sweden 57
- The new geological maps of Belgium 59

European Geologists
- A European geologist's experience in Siberia 61
- William Bowles (1720-1780) eurogeologist 67

EFG
- Member Associations 73
- Eurojeojobs the job service of the European Federation of Geologist 78

Books Review

Geocalendar
- Geocalendar 85

WHAT ON EARTH IS A GEOLOGIST? - THE ANSWER

by Professor Richard C. Selley
Hon. Sec Foreingn & External Affairs the Geological Society, London
Burtington House. Picadilly, London W1V OJU

THE STORY SO FAR: Readers may recall an article in the last issue of the 'European Geologist' posing the question; 'What on earth is a geologist?' The article pointed out the dilemma faced today, whereby universities are being pressured, for reasons of finance and safety, to cut field training, while at the same time important contribution themselves as geologists, nor join any geological societies, learned or professional. If these trends continue we are watching the demise of geology as we know it, and also of its learned and professional bodies.

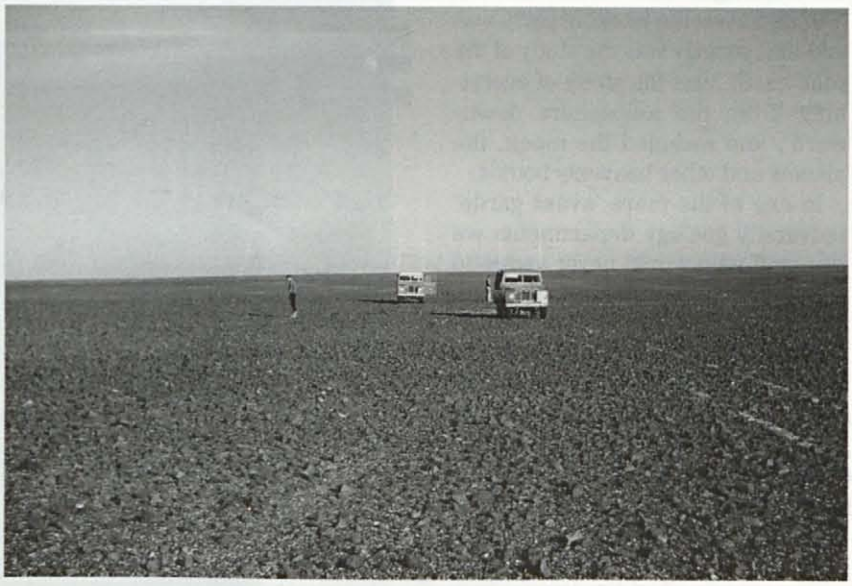
The question 'What on earth is a geologist?' was posed by the author in a paper to the Council of the Geological Society in London in 1995. The then President, Professor Steve Sparks, set up a working party to consider the problem.

The paper drew attention to two disparate but closely related issues:

1. Geology is pursued by a declining number of scientists with a formal field-work based geological training (people that we may, for convenience, term 'ortho-geologists').

2. Major contributions to geology are being made by scientists with no formal geological training (people that we may, for convenience, term 'para-geologists').

The Council of the Geological Society responded to the paper by setting up a working party under the Chairmanship of Professor Murchison of the University of Newcastle. In recent months the working party has visited the geology departments of Southampton, Kingston, Cardiff and Bristol universities, Amerada Hess oil company, the British Geological Survey, and Soil Science Ltd., where it met with engineering geologists from 6 different companies. In total the committee will have taken evidence from geologists in 12 organisations in industry and academe. It has also met several times to deliberate on its own.



Ortho-geologists enjoying a comfort stop during a field survey of the Murzuk basin, southern Libya.

Early on the working party formulated the question: 'Is a geologist defined by their knowledge, their skills or their actions?'. It has concluded that a geologist is characterised by skills rather than knowledge Viz.:

1. By aptitude or training geologists are able to reach decisions on data that is inadequate, comes from many sources, and is of varying degrees of robustness (hence ex-geologists often do well in finance).

These traits are, of course, anathema to pure scientists.

2. By aptitude or training geologists are more 'synergy-consciousí than people trained in a single pure science.

By aptitude or training geologists have well-developed 3D perception.

4. By aptitude or training geologists have well-developed 4D perception.

Is it therefore, the skills listed above, innate, or taught by field work, that differentiate a geologist from an earth scientist or a geoscientist? Though all of these skills may be innate in some people, they are particularly effectively acquired by field work in general, and field mapping in particular.

To the surprise of the working party, it found that the importance of field work is stressed in industry and by theoretical geoscientists, rather than by academic geologists, who took a much more relaxed view of the importance of field-based training.

In its travels the working party was told that geology was the study of the solid earth, was the study of everything 'from the ionosphere downward', and included the moon, the planets and other heavenly bodies.

In one of the more 'avant garde' university geology departments we met staff who would never aspire to call themselves geologists, and who considered that field work was quite unnecessary. They argued that 3D perception could be learnt from crystallography, and 4D perception could be learnt from the study of thermodynamics. Both 3D and 4D perception could be taught from computers. We were not quite sure how much we were fed these views as a joke, but we have a horrible feeling that they were advanced seriously.

Accordingly perhaps we might define a 'geoscientist' as someone who applies science to geology (however defined), an 'earth scientist' as someone who studies the earth, which includes not only geology, but also atmospheric physics, oceanography, and so forth. A 'geologist' is a trained field observer who studies rocks (according to the old dictum of the British Geological Survey, 'if you can hit it with a hammer, then it is geology'.)

Concomitant with the arguments about what on earth is a geologist and geology, the working party constantly found that academics could not see any value in becoming chartered, though they were surprised at the idea that if they were unchartered, then the outside world might not view them as true professionals. Indeed, over the last 18 months the number of Heads of British university geology departments who are chartered has halved from 60 to 31%.

The working party is currently (April '97) drafting its final report to the Council of the Geological Society. It will make depressing reading, pointing out how geology is a microcosm of the wider scientific world, with an explosive fragmentation of the subject, and a loss of whatever public perception of geology the wider world may once have possessed. These conclusions have serious implications for national and international geological societies and professional bodies such as the European Federation of Geologists.

And finally, for readers who really want to know the answer to the question 'What on earth is a geologist?' I direct you to the words of Humpty Dumpty in 'Through the Looking Glass' by Lewis Caroll: 'When I use a word it means just what I choose it to mean - neither more, nor less'.

THE GEOLOGICAL PROFESSION AND ETHICS WITH PARTICULAR REFENCE TO THE UK AND CONTINENTAL EUROPE

by Eur Geol Richard Fox
RMC Aggregates (UK) Limited
RMC House High Street, Felham, Middlesex TW13 4HA

Abstract
After a detailed historical review on Geology and geologists, the author studies the origin and evolution of the geological profession in the UK and its links with professional bodies in Europe and outside Europe. In his conclusions, he points out the need of geological professional institutions world-wide ruling his members with unified ethical codes to ensure Society the maximum personal and professional quality.

Resumen
Después de hacer una detallada revisión histórica sobre la geología y los geólogos, el autor pasa a revista a los orígenes y la evolución de la geología profesional en el Reino Unido y sus relaciones con las organizaciones profesionales de Europa y fuera de Europa. En sus conclusiones destaca la necesidad de instituciones profesionales geológicas en todo el mundo regidas por códigos éticos comunes aplicables a sus miembros para garantizar a la sociedad el máximo nivel de calidad personal y profesional.

Résumé
Aprés un historique détaillé de la géologie et des géologues, l'auteur étudie les origines et l'évolution de la profession au Royaume-Uni et ses liens avec les organisations professionnelles en Europe et en dehors de l'Europe. Dans ses conclusions, il attire l'attention sur le besoin dans le Monde entier d'institutions professionnelles géologiques régies par des codes de déontologie unifiés afin d'assurer A la Société le maximum de qualité personnelle et professionnelle.

1. Introduction

The Founding Members of the European Federation (EFG) at its initial meeting in 1978, and endorsed at its inaugural session in 1980 agreed that the main aims of the EFG should be as follows:

- Representation of the profession to the European Community (EC) now the European Union (EU).
- Promotion of the free movement of geologists throughout Europe, both within and outside the Community by mutual recognition of qualifications and harmonisation of educational standards.
- Regulation of degrees, diplomas and titles of geologists.
- Establishment of a common code of professional conduct.
- Long-term promotion of common policies concerning for example, energy and mineral resources, groundwater, and the environment.

High on the agenda at the first Council Meeting was the preparation of The Common Code of Professional Conduct (Deontology or ethical code) and a considerable amount of effort was spent in arriving at a consensus view that was acceptable to those Countries that constituted the Federation at that time. The "Code" was finally published in 1986 and widely circulated throughout the Countries of the Member Associations of the EFG

In considering the need for ethics in the Geological Profession the public or the practising geologist, whether he be an academic, a consultant or in Industry,

might seek to enquire when this need first became apparent.

A prime function of the professional geologist is the discovery, delineation and measurement of reserves, and the exploitation of the natural physical resources of the earth for the benefit of mankind (Ion 1985). In modern time he/she therefore has both the initiating and continuing roles in the energy industries, in the other mineral extractive industries, the water industry, the construction industry, and even in agriculture.

Mankind has had these roles since the dawn of time when circumstances dictated that man should act as a social being. The Stone Age, the Iron Age, the Bronze Age were dependent on the geologists in the tribe, long before the name was invented or it became part of the education system. Those early geologists were extremely able and ingenious, it being suggested that no copper province has been found in Africa that was not known to these ancients.

This pervasive role has continued, and geologistsí knowledge and expertise has widened consistently so that new wealths for society to benefit from have been based on geological findings.

2. A Historical background

Geology as a profession and science has its roots in the late 18th Century, first in the United Kingdom (UE) through the original ideas of William Smith and James Hutton and then more widely in the developing World (Fox et al 1996). Then during the early l9th Century, great advances in Europe were made in geology through such men as Lyell, Murchison, Darwin and Sedgewick in the U.K., as well as Silliman and others in the U.S.A.

The increasing interest in, and awareness of, the importance of geology led to the founding of the Geological Society of London in 1807, the first such Society in the World, Itís purpose being to investigate the mineral structure of the Earth. Other geological societies were formed throughout Europe during the l9th Century, as part of the growing awareness and dawn of understanding by amateurs to pursue exchanges of knowledge in geology and to enhance the learned aspects of the subject.

In the early part of the 19th Century there were small numbers of individuals earning their living through a knowledge of geology in Europe and the U.S.A., but there was sufficient Government interest in the subject for State Geological Surveys in the U.S.A. to be set up (North Carolina 1824) and our National Geological Surveys to be formed in Europe in the middle and latter part of that Century (i.e. British Geological Survey 1835, German Geological Survey 1850 and Portuguese Geological Survey 1858 to name but a few).

The Geological Surveys were originally involved in the systematic regional compilation of information-gathering and monitoring work which has grown and continues today with large numbers of professional geologists employed.

However, until the late 1950's there appeared to be little need for "Codes" or ethics within the geological countries in Europe and the U.S.A. and there was also apparent close links between the geological societies and the national geological surveys which precluded the necessity for geologists to declare their professionalism. A commitment to a "code" was therefore not considered necessary, even though there was increasing interest in geology and a greater awareness in the environment by the public at large.

3. The changing scene in recent years

In the U.K. the time of change for the geological profession appears to be in early 1971 when the publication "Nature" had suggested that the Geological Society had a "dowdy image", and at that time there was a public outcry to a proposal by the R.T.Z. Mining Group to develop an open pit mine in a porphyry copper deposit to the east of the Harlech Dome in North Wales (Knill 1990).

A review body set up by R.T.Z. in an attempt to rationalise the apparent conflicts arising from the growing environmental campaigners heard evidence from a great number of interested bodies including the Geological Society, the Angling Associations and the Ramblers' Association, and it became apparent to the Council of the Geological Society that the Society needed to emphasise a more professional role. Thus, a special committee was formed to consider ways of establishing professional recognition, and after 2 years in 1974, it confirmed that professional bodies carry out important functions but that there were no existing professional outlets which could cope and speak for all geologists in the U.K.

After some considerable debate a separate organisation called the Institution of Geologists was established in 1978 on the basis that legal opinion advised against setting-up a body through the Geological Society because of perceived conflicts relating to its ancient Royal Charter of 1825.

The Institution of Geologists, through the standing Membership and Validation Committee, set about the organisation of various memberships by application, with two of them, Member (M.I.Geol) and Fellow (F.I.Geol), carrying full voting rights. All members were subject to the code of ethics (conduct), and were made aware of their responsibilities to those codes.

Thus, it can be seen that as members of an Institution geologists no longer needed to consider themselves the poor relation in dealings with other professionals such as engineers, surveyors, or lawyers, because of a lack of status (Bristow 1987). In fact, before I.G. existed, some geologists even sought chartered membership of organisations like the Institution of Mining and Metallurgy (IMM) or the Institution of Chartered Engineers (ICE), but these organisations were primarily set-up to cater for engineers and not scientists. Only under very special circumstances can a professional geologist now become a chartered member of the IMM and the ICE.

With the formulating of I.G. geologists were in a stronger position to exercise the important function of lobbying opinion through various channels of government, the media etc. Traditionally a professional institution will do this in a much more restrained way than a Trade Union, whose aims will be overtly aimed at their members' financial interests and conditions of employment, together with political influence. Furthermore, an Institution will exert its influence with both the public and its members interests in mind. Allied to this is the somewhat difficult task of trying to define the concept of "professionalism". However more important issues are the standards of ethics, which are common to most professional institutions in the U.K. and continental Europe and which are embodied in their "Codes of Conduct".

Nearly all of the older and larger professional institutions in the U.K. have a Royal Charter, which enables them to give their members "Chartered" status. This is the established British way of organising the professions and it has served professions and the public alike very well over the years.

When the Institution of Geologists was formed it was always intended that it should seek to achieve a Royal Charter, and it was known that this special recognition by the Privy Council (a body which advises the British Monarch, and is appointed by the Crown) would take some time, bearing in mind the considerable status that a Chartered Institution retains. Eventually it was decided that the best way forward to achieve the Chartered role was for I.G. to merge with the Geological Society. This was completed in 1990 when the previous legal difficulties for granting "professional" chartered status without conflicts with the original 1825 Charter were resolved.

The revised By-laws of the Geological Society now provide for a code of ethics (conduct) which is applicable to all the membership and is overseen by the Membership and Validation Committee which reports to the Council of the Society.

4. Professionalism in geology outside the U.K.

Although the professional institution is, in many ways, a particularly British phenomenon, it was always one of the Institution of Geologists' prime aims that it should link-up with parallel developments of professional organisations in Continental Europe. Thus, the Institution was a founder member of the European Federation of Geologists (EFG) in 1980, and through its membership of the Council of EFG the Institution, and more recently the Geological Society have encouraged the interest and growth in geological professionalism in the European Community (now European Union) which now continues to include those countries outside the Community.

A further encouraging sign of harmonisation beyond the shores of Europe has been the exchange of experiences between the American Institute of Professional Geologists (A.I.P.G.) and the European Federation of Geologists. This has enhanced the World-wide development of professionalism to give comfort and assurance to the public that geologists are part of a greater international movement to raise standards and ensure that codes of ethics prevail.

It is encouraging to know that the Australian Institute of Geologists is currently trying to lobby support for the title of "Registered Professional Geologists" it being recognised that Registration within the geological profession provides stature in the community, ensures the highest standards of practice, and will also enhance the accreditation of the professional's right to work as a geologist within specialisation. The outcome of their proposals are awaited with interest.

5. Links with other Scientific and Engineering Professional Organisations in Europe

The European Federation of Geologists Council and Board have pursued strengthening links with other scientific and engineering groups such as the European Federation of National Engineering Associations (FEANI) the European Communities Biologists Association (ECBA), and the European Communities Chemistry Council, it being appreciated that professional geologists often participate in multi-functional teams when investigating projects.

Although codes of ethics which apply to national bodies take priority, all the European organisations accept that professionals should abide by a pan-European code. Thus, the FEANI states that all persons listed in the FEANI Register have the obligation to be conscious of the importance of science and technology for mankind and of their own social responsibilities when engaged in their professional activities (FEANI 1993). The ìcode of ethics" specifies personal ethics7 professional ethics and social responsibility, as well as distinguishing between them.

6. The future role for professional geologists and the importance of ethics.

With the growth of the European Union the wider implications of professionalism and ethics will be emphasised as the European Single Market encourages the ìmutual recognition of professional qualifications" to enhance the free movement of geologists from one State to another. This policy is now enshrined in the Directive on mutual recognition (89/48/EEC OJ Reference L19/16) which puts the emphasis on Competent Authorities (i.e. professional bodies like the Geological Society) to consider applications from outside national boundaries as a way of regulating professional activity.

It follows that National Governments do not intend to regulate professional activities, since it will be the responsibility of the designated authorities for the appropriate professions to implement the Directive and act as the regulating body.

Some professions in the U.K. are regulated by Law or by public authority such as Solicitors, Mine Managers etc., but most of the other Competent Authorities are regulated by professional bodies incorporated by Royal Charter

In other parts of Europe, as in Italy and Spain, the regulation of professional bodies is by legal "Orders" which are licensed to control professional activities.

Thus, the role of the professional institution is a proper role in society and should not be confused with the role of a learned society (Bristow 1987).

In the public eye true professionalism must be linked to how the geologist respects the code of ethics, both at the personal and professional level.

References:

Bristow, C.M. 1987 Presidents page. Does the geological profession need an Institution? British Geologist Vol.13.No.4. London, U.K.

European Federation of National Engineering Associations (FEANI) 1993 . Its Aims, Organisations and Achievements. Paris, France.

Fox R.A., Knight,W.V~ and Williams J.H. 1996. Professional Geology and regulation. Episodes Vol.l9. No.3. pp. 74-76.clO British Geological Survey, Nottingham, U.K.

Knill, J.L. 1990 Formative years of I.G. - A personal view. British Geologist Vo.16. No.4. London, U.K.

Ion D. 1985. Who are the Wealth Creating Scientists? Presidential address to the 1985 A.G.M., British Geologist, Vol.ll. No.2. London, U.K.

GEOLOGY IN LAND-USE PLANNING AND ENVIRONMENTAL PROTECTION IN SLOVAKIA

by Miroslav Hrasna & Rudolf Ondrasik
Department of Engineering Geology, Comenius University, Bratislava, Slovakia

Abstract

Geology has been accepted in land-use planning in Slovakia through accessible regional geological data. A geological map of Slovakia at a scale of 1:200,000 was completed in 1964 and three quarters of the area is covered by geological maps at 1:25,000 and 1:50,000. A hydrogeological map of Slovakia at a scale of 1:200,000 was completed in 1989.

Resumen

La geología ha sido aceptada en la planificación del territorio de Eslovaquia gracias a la disponibilidad de datos geológicos regionales. En 1964 se determinó el mapa geológico de Eslovaquia a escala 1:200.000 y las tres cuartas partes del país disponen de cartografía geológica a escala 1:50.000. En 1989 se terminó el mapa hidrogeológico de Eslovaquia a escala 1:200.000.

Résumé

La géologie a été acceptée dans l'aménagement du territoire grE2ce A la disponibilité des données géologiques régionales. Une carte géologique de Slovaquie au 1:200 000 a été terminée en 1964 et les trois quarts de la surface du pays sont couverts par des cartes géologiques au 1:25 000 et au 1: 50 000. Une carte hydrogéologique de Slovaquie au 1:200 000 a été terminée en 1989.

Maps of engineering geological condition and zoning

Engineering geological map development with environmental aspects, related to regionally oriented research, started in Slovakia in 1969. At that time an Engineering Geological map of Slovakia at a scale of 1:500,000 was issued, with precisely defined hierarchical taxonomic units of zonation accepted for land-use planning (Matula, 1969). A year later a systematic compilation of engineering geological maps was started at a scale of 1:25,000 for selected vulnerable urban areas. Consequently, a general engineering geological map of Slovakia for land-use planning, at a scale of 1:200,000 was compiled (Matula, Hrasna and Ondrasik, 1989), creating a unifying skeleton for a mosaic of maps at a scale of 1:25,000 and including more detailed urban areas with their background. It resulted in a comprehensive information system on engineering geological conditions for the whole of Slovakian territory, with more detailed data for its economically charged regions. The maps also involve data of geopotentials and geobarriers in the delineated zoning units.

Landslide inventory and vulnerability maps

Parallel to the systematic regional engineering geological research in the 60s, a systematic research of hazardous geological phenomena (landslides, suffusion, erosion, loess, structure collapse, etc.) was developed. During the winter of 1960-61, a landslide disaster in the mining district of Handlová destroyed more than 200 buildings. This triggered a systematic landslide inventory for the whole territory of the previous Czecho-Slovakia. During the years 1962-63 as much as 123,594 slope deformations were registered in Slovakia covering a total area of 1,615km² (3.3% of the total state territory). However, slope deformations represent locally up to 20 to 30% of the area. Since that time

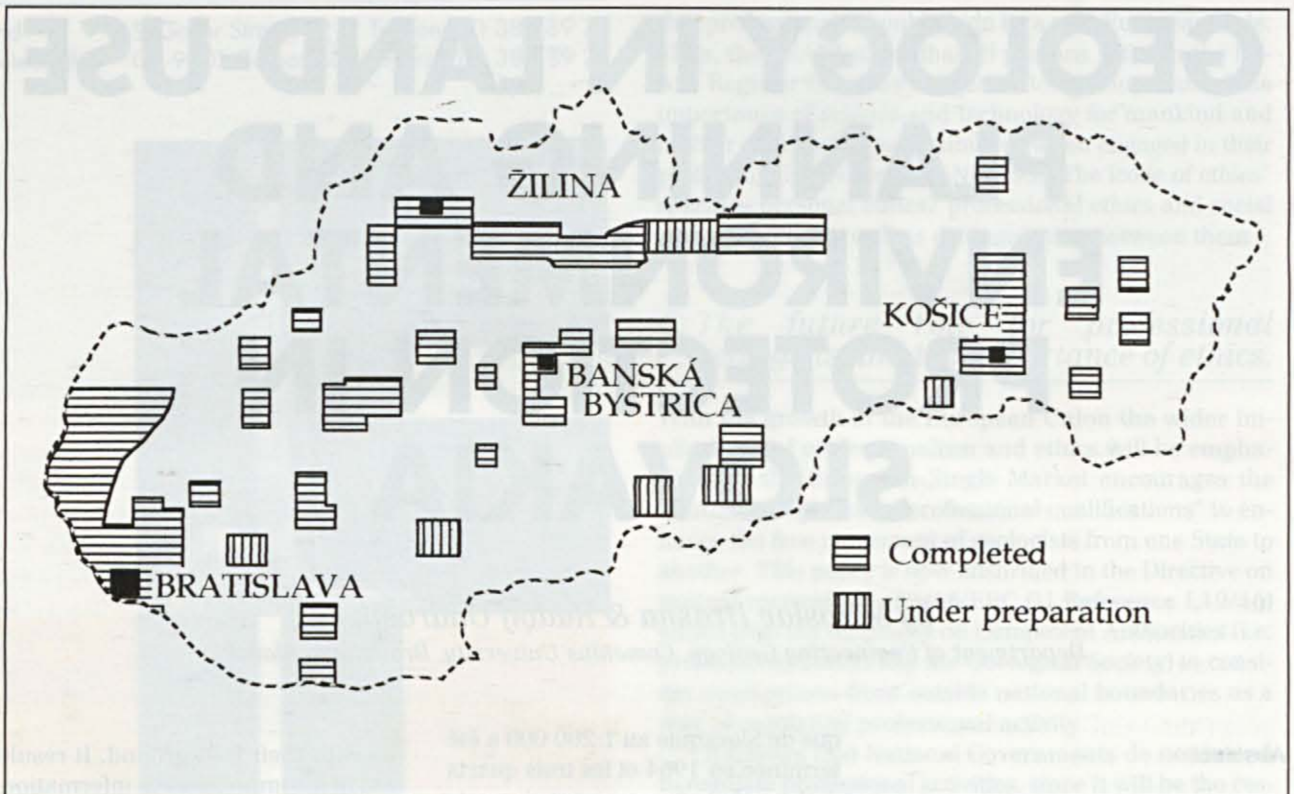


Figure 1. Medium scale engineering geological maps from the territory of Slovakia, 1 - completed, 2 - under preparation.

maps of landslide hazards of various types and scales have been systematically prepared for vulnerable portions of the country (Malgot and Baliak, 1993). Consequently, some landslides, endangering civil engineering structures or urban areas, have been reclaimed.

Engineering geological valoration maps

While the compilation of multipurpose maps of engineering geological conditions and zoning prevailed in the last two decades in Slovakia, special purpose zoning maps or so-called valorisation maps requested by customers have predominated recently (Hrasna and Vlcko, 1994). These suitability maps may be prepared for a specific land-use purpose, as optimisation maps (compiled by multicriterial analysis) or as prognostic maps expressing expected changes in the geological environment due to civil engineering interference.

Compilation of suitability maps for waste disposal location for the whole territory of Slovakia at 1:200,000 (1990-92) and at 1:50,000 (1992-93) was the more extensive project of this type (Hrasna, 1993). The danger of groundwater pollution and geological hazard's impact are the main criteria of geological suitability aspects in these maps. Apart from that, protected areas of various kinds (including mineral resources and aquifers) as well as other phenomena (floodlands, protective forests, etc.) affecting land-use for the given purpose are depicted in the maps.

Optimisation maps are set up for land-use planning with the aim to decide the most suitable use of various parts of particular areas (Matula, Hrasna and Vlcko, 1986) or with the aim to select the most suitable site for particular investment decision (Hrasna, 1994). The last ones are compiled especially for the siting of complex or ecologically risky constructions. A specific programme, within the waste disposal industry, deals with research for the selection of suitable geological structures for toxic and radioactive wastes, as well as for suitable waste disposal site selection for large urban agglomerations.

The character and intensity of man's interference classification, as well as the classification of expected changes in geological environment and their consequent impact on technosphere and landscape are needed for the compiling of prognostic maps of changes in geological environment caused by engineering interference (Hrasna and Vlcko, 1994).

Hydrogeological and geochemical maps

A hydrogeological map of Slovakia at a scale of 1:200,000 was compiled in 1989. Compiling of hydrogeological maps at a 1:50,000 has started and will continue by using geoinformation systems well as the programme for the optimisation of the groundwater utilisation. Preparation of groundwater vulnerability maps is also under consideration.

A geochemical atlas at a scale of

1:50,000 and of risk components in rock, soils and river deposits as well as in river water is proceeding in industrialised zones and urban agglomerations. Particular attention is being paid to the revitalisation of areas in which old mines have been closed.

Monitoring of environmental geofactors and environmental impact assessment

The other significant programme is the monitoring of environmental geofactors, carried out at the request of the Geological Division of the Ministry of Environment of the Slovak Republic, in the same manner as the above mentioned maps. The programme involves monitoring of the following phenomena: recent tectonic movements, landslides, erosion, sagging of loess, subsidence of undermined surfaces and groundwater pollution.

The State Geological Service in co-operation with the Department of Engineering Geology of the Faculty of Natural Sciences of the Comenius University, in Bratislava, has carried out elaborate investigation and the compilation of special purpose maps for urban development (in accordance with the new urbanisation programme in the Slovak Republic and anticipated innovation of the law for land-use planning).

Slovak engineering geology and hydrogeology have realised significantly in environmental protection in accordance with recently (1994) adopted law for environmental impact assessment (EIA). The law specified all kinds of environmental interference at which the EIA method is to be accepted and gives a rough succession of particular steps. The related and acute task of geology is to specify methods of geological environment assessment from the point of view of stability failure or pollution, and, to quantify the extent and cost of the expected preventive and/or remedial measures.

References

HRASNA, M. 1993. Evaluation of geoenvironmental suitability for waste disposal siting. Proc. Int. Symp. Geology and Confinement of Toxic Wastes (Montpellier). Balkema, Rotterdam, 81-85.

HRASNA, M. 1994. Quantitative evaluation of engineering geological conditions for the site selection of a nuclear power plant in northern Slovakia. Acta Geologica Universitatis Comenianæ, 50, 5-9.

HRASNA, M. & Vlcko, J. 1994. Development in engineering geological mapping in Slovakia. Proc. 7th Int. Congr. IAEG (Lisboa). Blakema, Rotterdam, 2513-2516.

MALGOT. J. & Baliak, F. 1993. Engineering geological maps with respect to slope stability in Slovakia. Proc. 7th Int. Conf. on Landslides (Bratislava). Balkema, Rotterdam, 62-101.

MATULA, M. HRASNA, M. & Ondrasik, T. 1989. Vyuzitie a ochrana geologickeho prostreia Slovenskej republiky. Explanation to the Engineering Geological map of Slovakia 1:200,000. SGU, GUDS, PRIF, UK Bratsilava, 48.

MATULA, M. HRASNA, M. & Vlcko, J. 1986. Engineering geological maps for landuse planning documents. Proc. 5th Int. Congr. IAEG (Buenos Aires), 1821-1823.

1,200 words.

MAPPING OF GROUND WATER RADON POTENTIAL

by Gustav ÅKERBLOM
Swedish Radiation Protection Institute
S-171 16 STOCKHOLM Sweden

and Jonas LINDGREN
Geological Survey of Sweden
P.O. Box 670 S-751 28 UPPSALA Sweden

Abstract

The domestic use of water with elevated radon concentration may represent a public health hazard, partly due to the release of radon to the indoor air, but also due to the radiation dose caused by radon and its progeny upon intake. While only a limited number of countries have implemented regulations with respect to radon in water, many more are considering doing so. The compulsory limits proposed by Swedish authorities are 100 Bq/l for public water, while water from private wells is not to exceed 1000 Bq/l. Furthermore, it is recommended that water with a radon content above 500 Bq/l should not be given to children under five years of age. In Sweden, the estimated number of wells with radon levels above 1000 Bq/l exceeds 10,000, with a considerable amount in excess of 10,000 Bq/l. The highest radon concentration in a well supplying drinking water encountered so far is 57,000 Bq/l. Radon levels exceeding 500 Bq/l are almost exclusively found in wells drilled into bedrock and in springs with intramontaneous water. Elevated ground water radon levels require that the water has passed through bedrock with elevated concentration of uranium, or through fractures with coatings of minerals containing elevated concentrations of radium-226. Intramontaneous water from areas with uranium-bearing rock types (e.g. uranium-rich granites, pegmatites and vulcanites) often manifests elevated radon levels. The impending implementation of compulsory radon limits has led to a demand from Society regarding regional information on ground water radon risk. Routines for the establishment of risk maps focusing on water are currently under development. The backbone of the process is the access to high spatial resolution radiometric information together with bedrock and quaternary information on a detailed scale (1:50,000). This information is available from the Geological Survey of Sweden, which is routinely carrying out airborne measurements at an altitude of 30 m and a line spacing of 200 m. While some 60 % of Sweden is covered up to now, 75 % is expected to be covered within the next ten years. Moreover, an increasing part of Sweden is covered by digital geologic information on an appropriate scale. Other available databases utilised in the risk mapping process include radon measurements in wells, geochemical data from ground- and biogeochemical sampling, ground radiometric measurements on outcrops and soils, and the information gathered during the former Swedish programme for uranium resource evaluation.

Resumen

El uso doméstico de agua con elevados contenidos de radón puede presentar peligro para la salud pública, en parte debido al desprendimiento del radón en el aire en el interior de las casas, pero también debido a la dosis de radiación causada por el radón y su progenie al beberla. Aunque sólo un número reducido de países han desarrollado legislación con respecto al radón en el agua, muchos más están estudiando hacerlo. Los límites obligatorios propuestos por las autoridades suecas son 100 Bq/l para aguas públicas, mientras que para aguas de pozos privados no deberá exceder los 1000 Bq/l. Además, se recomienda que el agua con un contenido en radón por encima de 500 Bq/l no se debería suministrar a niños menores de 5 años. En Suecia, el número estimado de pozos con niveles de radón por encima de 1000 Bq/l, supera los 10.000, con un número considerable que supera los 10.000 Bq/l. La concentración de radón más elevada de un pozo para suministro de agua potable registrada hasta la fecha fue de 57.000 Bq/l. Los niveles de radón que superan los 500 Bq/l se encuentran casi exclusivamente en pozos perforados en roca y en manatiales de aguas de montaña. Para que los niveles de ra-

dón sean elevados es preciso que el agua haya pasado por sustrato rocoso con elevadas concentraciones de uranio o a través de fracturas con recubrimientos de minerales que contengan elevadas concentraciones de radio-226. Las aguas montañosas procedentes de áreas con tipos rocosas que contienen uranio (p.ej. granitos ricos en uranio, pegmatitas y vulcanitas) a menudo presentan elevados niveles de radón. La pendiente implantación de límites de radón obligatorios, ha dado lugar a la demanda de la sociedad de información regional sobre el riesgo por radón de las aguas subterráneas En la actualidad se están desarrollando metodologías para el desarrollo de mapas de riesgos enfocados al agua. El fundamento del proceso es el acceso a información radiométrica de alta resolución espacial, junto con información del sustrato rocoso y del Cuaternario a escalas detalladas (1:50 000). Esta información está disponible en el Servicio Geológico Sueco que, de manera rutinaria, realiza mediciones aerométricas a una altitud de 30 m y con un espaciado entre líneas de 200 m. Aunque hasta la fecha el 60% de la superficie de Suecia está cubierta, se espera tener cubierto hasta un 75% en los próximos diez años. Además una parte cada vez mayor de Suecia dispone de información geológica digitalizada a una escala adecuada. Otra de las bases de datos disponibles son las medidas de radón en pozos, geoquímica de muestras de suelos y biogeoquímica, medidas terrestres radiométricas en afloramientos y suelos y la información obtenida durante el anterior proyectos de evaluación de los recursos de uranio.

Résumé

L'usage domestique d'eau a concentration élevée en radon peut représenter un risque pour la santé publique, dFB en partie a la libération de radon dans l'air des habitations, mais aussi a la dose de radiation produite par le radon et sa progéniture lors de la consommation. Alors que seuls quelques pays ont établi des réglements concernant la teneur de radon dans l'eau, beaucoup d'autres ont l'intention de le faire. La limite obligatoire proposées par les autorités suédoises est de 100Bq/l pour la distribution publique, alors que dans les puits privés elle ne doit pas dépasser 1000 Bq/l. De plus, il est recommandé que l'eau contenant du radon A plus de 500 Bq/l ne soit pas donnée aux enfants en dessous de 5 ans. En Suéde, le nombre estimé de puits ayant un niveau de radon supérieur A 1000 Bq/l dépasse 10 000, avec un nombre considérable dépassant 10 000 Bq/l. La plus haute concentration en radon rencontrée dans un puits d'eau potable est de 57 000 Bq/l. Des niveaux de radon dépassant 500 Bq/l sont presque exclusivement rencontrés dans des puits forés dans le substratum rocheux et dans des sources d'eau provenant de reliefs Pour que les eaux souterraines atteignent de forts niveaux de radon il faut qu'elles soient passée a travers un substratum ayant des concentrations élevées en uranium ou dans des fractures enduites de minéraux contenant des concentrations élevées en radium 226. Les eaux provenant de reliefs de roches contenant de l'uranium (granites riches en uranium, pegmatites et vulcanites) montrent souvent des niveaux élevés en radon. L'application imminente de limites obligatoires du niveau de radon est a l'origine d'une demande publique pour une information régionale sur le risque "radon" des eaux souterraines. Des procédures pour l'établissement de cartes de risque centrées sur l'eau sont actuellement encours de mise en place. Elles sont basées sur l'accés a l'information radiométrique a haute résolution spatiale jointe a l'information sur le quaternaire et le substratum a une échelle détaillée (1:50 000). Cette information est disponible au Service Géologique de Suéde qui fait des mesures aéroportées systématiques a une altitude de 30 m avec des lignes espacées de 200 m. Jusqu'a maintenant, 60% de la Suéde a été couverte et on pense en couvrir 75 % dans les 10 ans a venir. De plus, les données géologiques digitalisées a une échelle appropriée couvrent une part croissante de la Suéde. D'autres banques de données sont utilisées pour la cartographie du risque, elles sont disponibles et comprennent les mesures de radon dans les puits, les données géochimiques du sol, y compris l'échantillonnage biogéochimique, les mesures radiométriques au sol sur les affleurements et les sols, et les informations recueillies pendant le précédent programme suédois pour l'évaluation des ressources en uranium.

1. Introduction

Radon in water may be a cause of cancer. Given the radon concentrations normally found in ground water, health risks are small. However, the radon dose may be important if ground water containing a high concentration of radon is consumed by infants and young children regularly as drinking water or if radon gas is released into an indoor environment. Elevated radon concentrations in ground water are most common in areas where the crystalline bedrock contains elevated concentrations of uranium. Geological, geophysical and geochemical data from uranium exploration and other surveys of natural radiation are used to indicate and delimit areas of varying risk of elevated radon concentration in ground water in Sweden. This information is utilised by local authorities in an effort to discover which wells may have unsuitably high radon concentrations.

2. Radon in water - A health risk

Radon in water may constitute a health risk, partly due to inhalation of the radon gas released from water and partly due to ingestion of the water. When water containing radon is used, 10-90 % of the radon is released into the air. The release is greater the more the water is atomised, processed or heated. For example, showering causes the release of 50-70 % of the radon in water [1]. If the release occurs indoors and the water radon concentration is elevated, the radon concentration in the indoor air could be high. How high depends upon the water's radon concentration, how much water is used and how the water is used. In Sweden, a very rough rule of thumb is used to estimate the concentration which a household is subjected to: residential radon concentration is 2(10^{-4} of the water radon concentration (e.g. if the concentration of radon in the water is 1000 Bq/l, then the concentration of radon in the indoor air of the home will be 200 Bq/m^3). In air, radon gas decays into its progeny which are inhaled along with air and whose radiation may cause lung cancer.

When water containing radon is ingested, a dose of radiation is imparted to the digestive system by the radon gas and its progeny. The greater portion of the radon is absorbed through the intestinal walls, transported throughout the body and, for the most part, released upon exhalation. The radon which decays in the body and the continued decay of radon's short- and long-lived progeny impart radiation to the various organs of the body. Because radon is quite soluble in fat, the radon progeny may concentrate in organs rich in fat. The greatest risk associated with the ingestion of water containing radon and radon progeny is considered to be that the radiation could cause stomach-colon cancer [2] and other organ cancers. Radon as a cause of leukaemia has also been discussed [3].

Earlier, it was calculated that the greatest radiation dose from radon in water would be derived from the contribution of radon to the air and that the ingestion of water containing radon would give a considerably lower radiation dose. That calculation is still accurate for adults. However, in recent years, it has been shown that young children, especially infants, receive a greater dose of radiation from ingesting water containing radon than do adults [4, 5]. This is because the ingestion of water is great in comparison to body weight and because young children drink more unprocessed water than do adults. Table I shows radiation doses calculated for Swedish adults, children and infants for various radon concentrations in water [6]. The calculation of the radiation dose received from indoor air assumed that an average person in a household used 200 l of water per day. The calculation of the radiation dose due to ingestion of water is based upon the assumption that adults ingest 50 l of unheated or otherwise unprocessed water per year, children 75 l/y and infants 100 l/y [7]. In comparison, consider that the highest radiation dose allowed for persons exposed to radiation in the workplace is 50 millisievert per year (mSv/y) during one year and at most 20 mSv/y as an average for five consecutive years. Individuals within the most exposed group of the general public, but who do not work with radiation, must not be exposed to a dose in excess of 5 mSv/y resulting from human activity involving radiation. This is according to the European Union suggestion for Directive on basic safety standards (BSS) for the protection of the health of workers and the general public against the dangers arising from ionising radiation [8].

Radiation doses from radon in water can be very high. In Sweden, households have been discovered in which the children daily ingest water with radon concentrations of 55,000 Bq/l. Every day approximately 60,000 Swedes (population of Sweden 8.8 million) consume water having radon concentrations higher than 1000 Bq/l.

Radon gas released from household water into the indoor air is calculated to cause approximately 50 cases of lung cancer per year. Ingestion of water containing radon is calculated to cause 13-20 cases of cancer per year [9].

Table I: Typical values for effective radiation doses via inhalation and ingestion of radon from household water for adults, children and infants calculated for the limits proposed by the Swedish National Food Administration for radon concentrations in public and private drinking water, 100 and 1000 Bq/l, respectively. Individual doses may vary greatly [6].

Radon in water (Bq/l)	*Inhalation* Approximate effective dose (mSv/y)	*Ingestion* Approximate effective dose (mSv/y)	*Rounded Sum* Approximate effective dose (mSv/y)
100	0.4	0.05	0.45
		(0.15)[a]	0.55
		(0.7)[b]	1.1
1000	4	0.5	4.5
		(1.5)[a]	5.5
		(7)[b]	11

[a] Children aged 10 years [b] Infants aged 1 year

After consultation with the Swedish Radiation Protection Institute and the Swedish National Board of Health & Welfare, the Swedish National Food Administration proposed limits for radon in drinking water in 1995 (Table II) [10]. These will be compulsory limits. None of Sweden's large public water works deliver water with radon concentrations

Table II: Proposed Swedish limits for radon concentrations in drinking water.

Concentration	*Subject to limits*	*Comments*
100 Bq/l	Public water supply	Compulsory limit. Concerns concentrations in water delivered by public water works.
500 Bq/l	Private water supply	Recommended limit. Concerns the maximum concentration in water given to children under 5 years of age.
1000 Bq/l	All drinking water	Unfit for human consumption.

above 100 Bq/m³. On the other hand, Sweden has 20,000-30,000 drilled wells in which the water contains radon concentrations above 500 Bq/l, and approximately 10,000 drilled wells with more than 10,000 Bq/l. In total, there are approximately 200,000 drilled wells in Sweden which are utilised year round by permanent residents and 200,000-300,000 drilled wells which are utilised irregularly by non-permanent recreation residents. The latter will not be subject to the proposed limits for radon in water.

Finland since 1993 has a compulsory limit of 300 Bq/l for public water supplies [11]; the Czech Republic has a compulsory limit of 50 Bq/l for public water supplies and a compulsory limit of 1000 Bq/l for all water supplied to dwellings [12].

3. *Radon in water – Why and where*

Radon in water is primarily a problem for water supplies which extract water from drill holes in rock or from springs flowing through areas with crystalline rocks, which have somewhat higher uranium concentrations than the average bedrock. Examples of rock types which often have enhanced uranium concentrations, > 5 ppm U (approx. 60 Bq/kg), include the following: granites, syenites, pegmatites, acid volcanic rocks, and acid gneisses. Wells in areas with these rock types commonly contain intramontaneous ground water with radon concentrations of 50-500 Bq/l or considerably higher. Intramontaneous waters from sedimentary rocks such as limestone, sandstone, and shales, as well as igneous, volcanic intermediate and basic rocks usually have radon concentrations of 5-70 Bq/l, which is to be expected since these rock types generally have low uranium concentrations. Exceptions do exist, however rare. Well waters with elevated radon concentrations from wells in bedrock with low uranium concentrations are known. In such instances, the water has been in contact with uranium mineralizations, e.g. in sandstone and basic rocks, or the ground water has passed through sedimentary layers of bedrock with high uranium concentrations and then travelled long distances, e.g. artesian water in contact with underlying granites. In the latter case, the reason for the high radon concentration in the well water or spring is that uranium and radium have leached from the underlying bedrock, been transported by water and precipitated out along the path of transportation, but relatively near the well or spring.

Ground water in soil layers has considerably lower radon concentrations, as a rule, than does water occurring in cracks in the bedrock. Normal radon concentrations are 5-100 Bq/l in water from dug wells, which receive water from the surrounding soil layers. Factors which determine the radon concentration in the ground water of soil layers are as follows: radon concentration in the soil, the emanation coefficient of the soil (how much of the radon formed is released from the mineral grains into the water in the soil pores), and the soil porosity. Radon concentration in pore water in soil is governed by Formula 1:

$$A_{w\max,\,pore} = A_{ra} \cdot e \cdot \delta \cdot \frac{1-p}{p}, \quad (1)$$

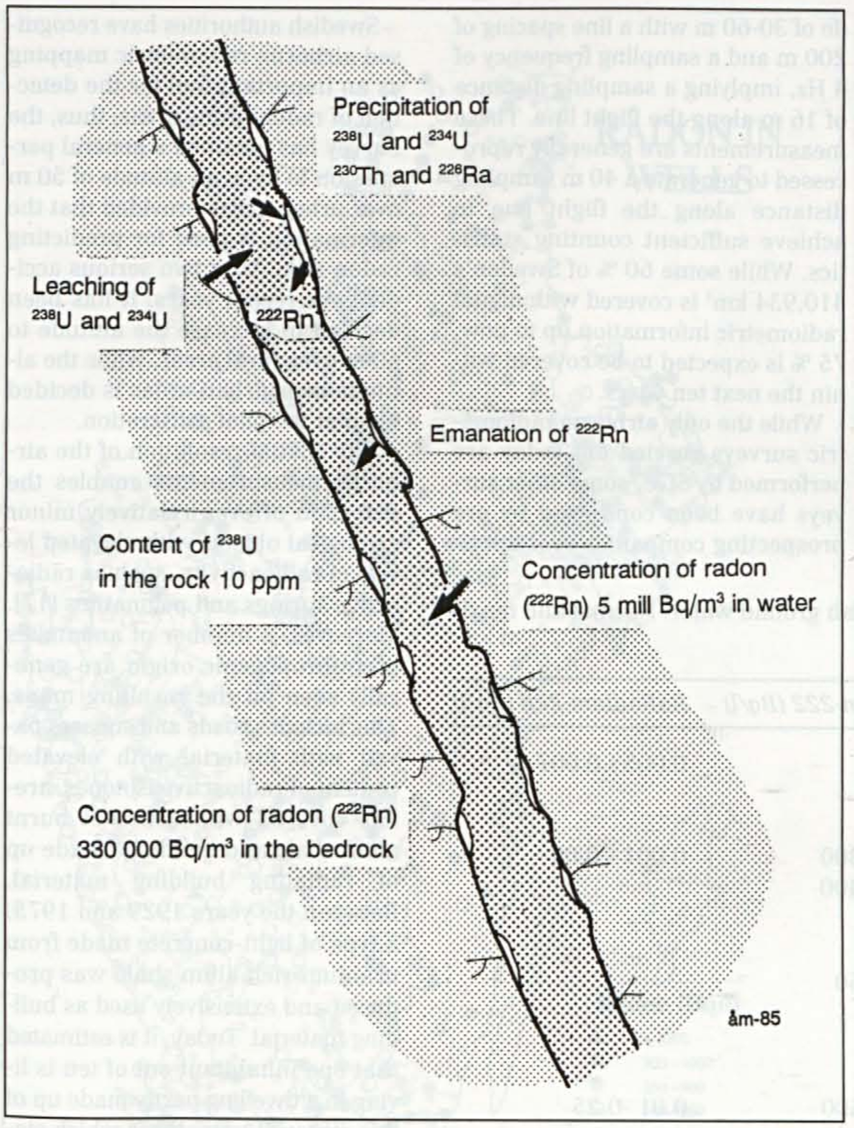
$A_{w\max,\,pore}$ = radon concentration in the pore space water
A_{ra} = activity of radium-226 (Bq/kg)[a]
e = emanation coefficient (emitted radon / formed radon)
δ = compact density (kg/m³), normal rock material 2700 kg/m³
p = porosity (pore volume / total volume)

[a] 1 ppm uranium is equivalent to 12.3 Bq/kg Ra-226 assuming equilibrium in the decay series

Normal emanation, *e*, for soils is 0.2-0.4, and may for certain clays reach 0.6. Porosity, *p*, is normally 0.25-0.45. The radium concentration, A_{ra}, is 5-25 Bq/kg for silts, sands and soils with origins in rocks with low uranium concentrations, e.g. limestone. Soils originating from rocks with normal uranium concentrations have radium concentrations of 10-50 Bq/kg. These values correspond to radon concentrations of 5-50 Bq/l for ground water in soils with low uranium concentrations, and 10-100 Bq/l in soils with normal uranium concentrations.

In water from surface water reserves, the radon concentration is low, < 2 Bq/l, mainly because the radon has had time to decay during the long holding period in the surface reserve, among other reasons.

Radon concentrations in intramontaneous water are normally considerably higher and often much higher than in ground water in soil layers. Water arising from uranium-rich rocks, e.g. uranium-rich granites and pegmatites, commonly have radon concentrations in excess of 500 Bq/l, with maximum concentrations of 20,000-60,000 Bq/l. This concentration is 2-100 times



Formation of radon gas in a water-filled crack [13].

higher than the radon concentration of the surrounding bedrock, calculated per kg rock. One explanation for the elevated radon concentration in intramontaneous ground water is that 6-valence uranium is relatively easily dissolvable and is leached out of the rocks by the ground water. Dissolved uranium and its decay products precipitate onto the surface of fractures, partly because they react chemically with fracture minerals on the surfaces of the cracks, and partly because the decay products are sparingly soluble, thus precipitating out [13]. Landström and Tullborg [14] found that uranium concentrations in fracture coatings are often 3-20 times higher than in the surrounding rock. Consequently, a coating of radium-rich material builds up on the surfaces of cracks and fissures, from which radon emanates directly into the water in the crack. Figure 1 illustrates the process. Another possible reason for increased radon in ground water is that in any particular grain of uranium, the radon concentration is many times greater than that of the surrounding rock and water, thus it diffuses from the grain of uranium into the water phase. Since the rock porosity is very low, conditions exist for the water radon concentration to be 10-100 times greater than the rock matrix radon concentration (Formula 1).

4. Radon in water in Sweden

Radon in water is a relatively great problem in Sweden. As discussed earlier, many Swedes drink water containing high concentrations of radon, and approximately 20 % of the population obtain their water from drilled wells. The reason for the pervading relatively high radon concentrations is that a major portion of the bedrock in Sweden is made up of Precambrian rocks, which consist mainly of granites, acid gneisses, and acid volcanics. In regions of gneiss, pegmatites and aplites are abundant. Table III presents normal concentration variations for radon, as well as radon concentrations for various types of water reserves and bedrock in Sweden. Figure 2 shows the distribution of water radon concentrations of some 1200 drilled wells in Southern and Central Sweden, and Fig. 3 areas with uranium-rich rock types. The wells were randomly selected for radon analysis during hydrogeological surveys carried out by the Geological Survey of Sweden and a national survey of water radon concentration performed by the Swedish Radiation Protection Institute [15]. It is evident from the map that there is a cluster of wells with enhanced radon concentrations in the central portion of the map, at Bergslagen, where the bedrock consists primarily of acid gneisses, granites, and acid vulcanites containing numerous pegmatites. Another area with numerous radon wells is the northeast coast of Sweden, with geology similar to that of Bergslagen. In Scania, Southern Sweden, where the bedrock mainly consists of non-metamorphic Cambrian-Tertiary sediments, the radon concentration in water is low. These conditions are also applicable to Southwest Sweden which primarily exhibits intermediate and acid gneisses, and intrusives low in uranium.

Bohus granite is generally uranium-rich, 5-40 ppm U, and occurs in a large contiguous area along the northwest coast of Sweden, where wells with high radon concentrations are frequent. The Municipality of Sotenäs lies in that region and 60 % of the drilled wells have radon concentrations in excess of 500 Bq/l and 30 % in excess of 1000 Bq/l. Wells with much higher radon concentrations, > 5000 Bq/l, are primarily located within uranium-rich granite regions. A campaign to measure radon in Sweden's drinking water is currently underway and several wells with more than 20,000 Bq/l have been discovered. So far, the well found with the highest radon concentration, 57,000 Bq/l, was drilled in Blomskogs granite, a uranium-rich granite.

Table III: Radon and radium in Swedish ground water. Normal and maximum concentrations [13].

	Radon-222 (Bq/l)	*RaRadium-226 (Bq/l)*
Lake and sea water	< 2	0.005 - 0.007
Wells dug in soil:		
normal in Sweden	10 - 300	0.001 - 0.09
in granite areas	40 - 400	
Wells bored in sedimentary rocks:		
Eocambrian -Tertiary	10 - 50	
Wells bored in crystalline Precambrian bedrock:		
normal bedrock	50 - 500	0.01 -0.25
uranium-rich granites	300 - 4000, max. 57,000	
uranium-rich pegmatites	max. 30,000	max. 2.5
Uranium ores:		
Lilljuthatten, Stenfjällen	2000 - 100,000	max. 6
Pleutajokk, Arjeplog	18,000 - 55,000	0.1 - 0.17

5. USE OF DATA FROM GEOLOGICAL AND GEOPHYSICAL SURVEYS

5.1 Airborne radiometry

The Geological Survey of Sweden (SGU) is routinely carrying out airborne gamma spectrometric measurements over the Swedish territory since the late 60's. Details on the airborne equipment can be found in [16]. Today, the measurements are carried out at an altitude of 30-60 m with a line spacing of 200 m and a sampling frequency of 4 Hz, implying a sampling distance of 16 m along the flight line. These measurements are generally reprocessed to generate a 40 m sampling distance along the flight line to achieve sufficient counting statistics. While some 60 % of Sweden's 410,934 km² is covered with digital radiometric information up to now, 75 % is expected to be covered within the next ten years.

While the only airborne radiometric surveys carried out today are performed by SGU, some other surveys have been conducted by ore prospecting companies over specific regions in Sweden. Until 1984, when the Swedish programme for uranium exploration was brought to an end, most surveys were carried out for the purpose of uranium exploration. Today, the measurements are conducted within the national airborne geophysical mapping programme. The system used today is based upon a 256-channel Exploranium GR-820 with a 1024 cuin downward looking crystal package and a 256 cuin upward looking detector.

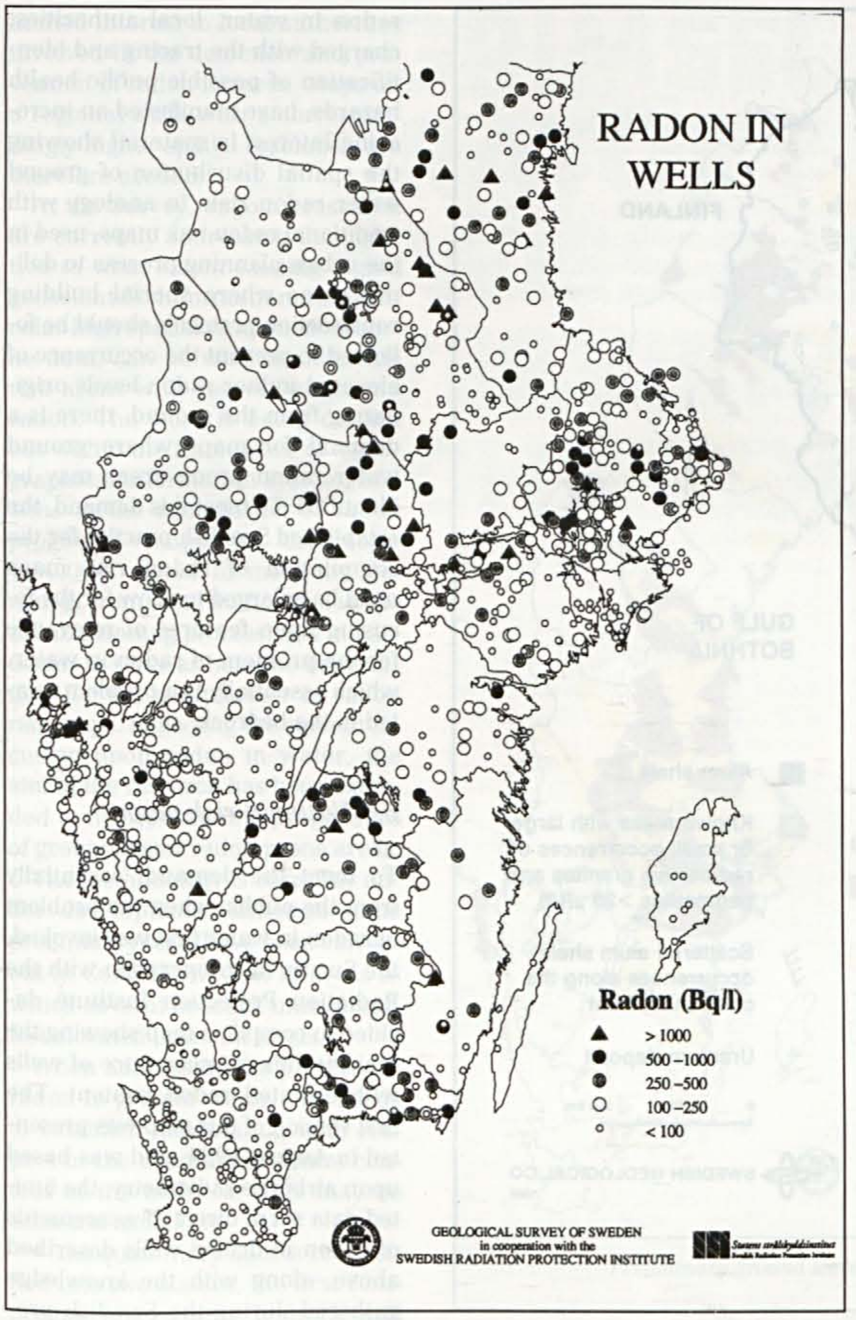
Swedish authorities have recognised airborne radiometric mapping as an important tool for the detection of radon prone areas; thus, the Survey has obtained a general permission to fly at an altitude of 50 m over urban areas provided that the information is used for predicting radon risk. After two serious accidents in recent years, it has been decided to increase the altitude to 60 m over rural areas, while the altitude over urban areas is decided upon at the pilot's discretion.

The spatial resolution of the airborne measurements enables the detection of even relatively minor geological objects with elevated levels of radioactivity, such as radioactive springs and pegmatites [17]. Moreover, a number of anomalies of anthropogenic origin are generally seen on the resulting maps. This includes roads and squares paved with material with elevated content of radioactive isotopes, arenas covered with ashes of burnt alum shale and buildings made up of radiating building material. Between the years 1929 and 1975, a type of light-concrete made from uranium-rich alum shale was produced and extensively used as building material. Today, it is estimated that one inhabitant out of ten is living in a dwelling partly made up of this material, something which significantly has increased the radiation exposure to the Swedish population, both through the direct exposure to gamma radiation emitted from the material and from radon being released to the indoor air.

There is evidence that, under favourable circumstances, even single buildings made up of uranium-rich alum shale-based light concrete may be identified from the airborne radiometric measurements.

5.2 Bedrock and quaternary Geology

The Geological Survey has continuously been mapping the geology of Sweden since 1858. It is, however, not until recently that the Survey has moved to the production



Radon concentrations in randomly selected bedrock wells in Southern Sweden.

of geological information in digital form. The Swedish territory is covered as a whole with digital bedrock and quaternary geologic information, but only in the scale of 1:1,000,000, which is not sufficient for radon prognostics. Quaternary information in the scale 1:50,000 is rapidly becoming available, while the process of converting bedrock information to digital form is still somewhat in its infancy.

5.3 Geochemistry

Within the framework of the programmes for ground geochemical and biogeochemical mapping, samples are being analysed with respect to uranium among other elements. The former programme samples a silt and clay fraction of till from the undisturbed C-horizon, while the latter samples roots from stream plants. Both programmes provide information on uranium concentrations, the former on till and the latter on bioaccessible uranium in streams.

More research is needed to illuminate to what extent the results from geochemistry may be considered to be representative of the uranium/radium content of the underlying bedrock.

5.4 Ground radiometry

During the national uranium prospecting, extensive work were carried out to identify possible sites of interest for uranium mining. A large number of outcrops were visited and radiometrically investigated, although only to a lesser extent with the help of gamma spectrometry. These results are, however, not readily available in digital form.

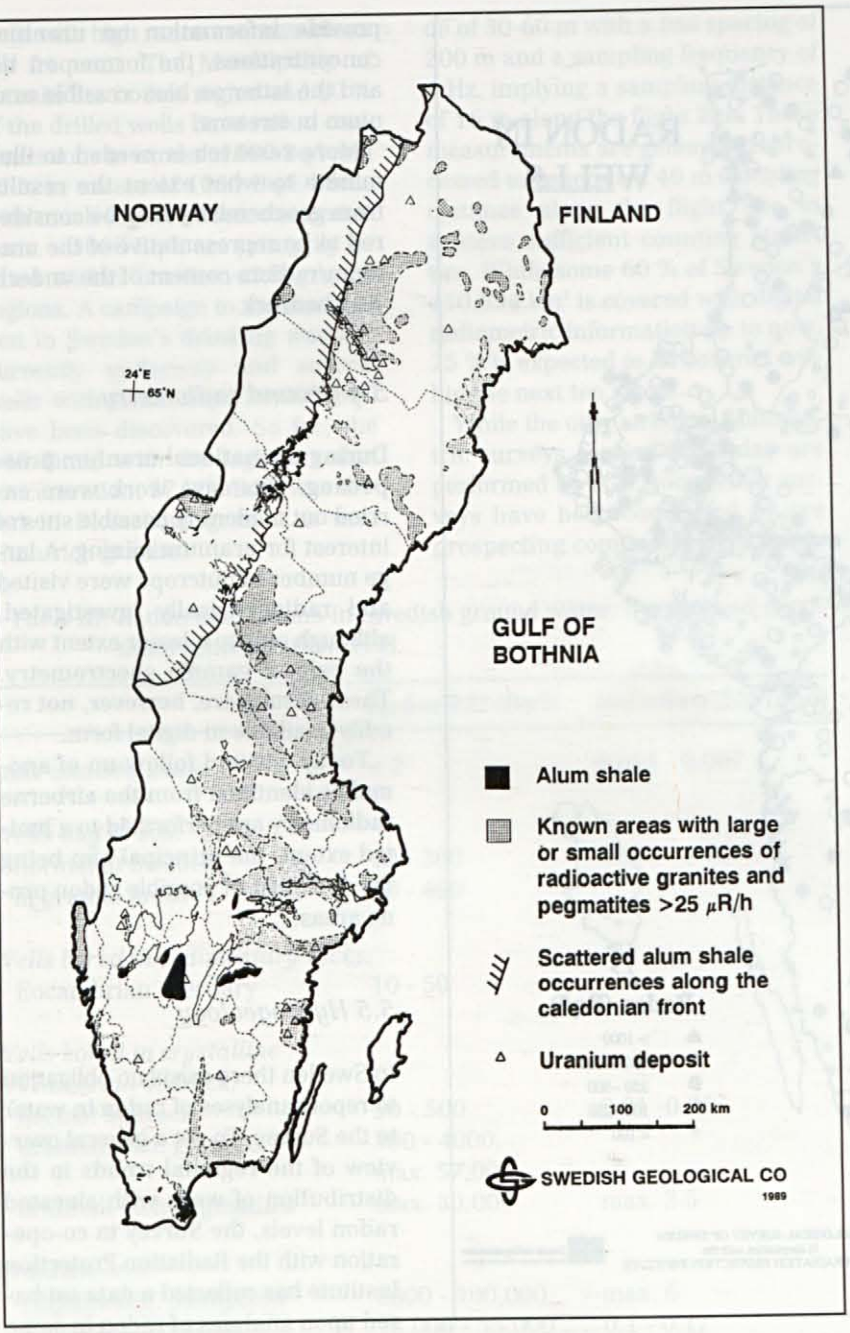
Today, ground follow-up of anomalies identified from the airborne radiometry are performed to a limited extent, the principal aim being the detection of possible radon prone areas.

5.5 Hydrogeology

In Sweden there exists no obligation to report analyses of radon in water to the Survey. To get a general overview of the regional trends in the distribution of wells with elevated radon levels, the Survey in co-operation with the Radiation Protection Institute has collected a data set based upon analyses of radon in some 1200 wells drilled into the bedrock, randomly selected in the south and central part of Sweden as described above. Moreover, within the framework of the regional hydrogeological mapping programme, some selected wells are being analysed with respect to radon among other parameters.

5.6 Other sources of information

It is not until recently that local authorities have initiated ground water radon mapping programmes. The



Distribution of uranium-rich bedrock in Sweden.

major part of analyses of radon in water, however, resides in databases maintained by these authorities. While some municipalities only measure upon request, others have chosen to analyse all known drilled wells within the municipality, thus providing an unbiased material of great value for correlation with geology.

Juridical obstacles have so far hampered the access to this information, since the individual measurements are considered to be the property of the customer and not as information available to the public. It is, however, believed that the measurements in the near future may become accessible to the Survey for the purpose of radon prognostics.

6. Ground water radon prognostics

Following the forthcoming implementation of compulsory limits for radon in water, local authorities, charged with the tracing and identification of possible public health hazards, have manifested an increasing interest in material showing the spatial distribution of ground water radon risk. In analogy with traditional radon risk maps, used in the urban planning process to delimit areas where special building construction protocols should be followed to prevent the occurrence of elevated indoor radon levels originating from the ground, there is a demand for maps where ground water radon prone areas may be identified. To meet this demand, the established Swedish practice for the compilation of radon risk maps must be enlarged to allow for the focusing upon features of relevance for the problem of radon in water, which essentially is a problem related to the bedrock.

6.1 National risk maps

To meet the demand, essentially from the public, when the problem of radon in water first was invoked, the Survey in co-operation with the Radiation Protection Institute decided to compile a map showing the main trends of occurrence of wells with elevated radon content. The first version of this map was presented in August 1994, and was based upon airborne radiometry, the limited data set of direct measurements of radon in drilled wells described above, along with the knowledge gathered during the Swedish programme for uranium exploration. The public debate following the publication of the map, including the possible health hazard that radon in water may represent, put a considerably pressure upon national as well as local authorities to delineate ground water radon prone areas in more detail. A second version of the national map is presented in Fig. 4.

6.1 Regional risk maps

Although of public interest, national overviews as described above are of limited interest to local authorities involved in the detection and prevention of radon hazards. Maps on a regional scale with a correspondingly higher spatial resolution are therefore needed.

At the Survey, ongoing research are currently addressing the question to what extent existing digital geoscientific information, in particular high spatial resolution airborne data, can be used to delineate risk areas with respect to ground radon. The work is being carried out within the framework of a geographical information system, and aims at the compilation of radon prognosis maps in the scale 1:50,000, suited to meet the demands from local authorities in the urban planning process, and in particular to serve as baseline information for the compilation of radon risk maps. Reflecting the current focusing upon radon in water, the aim of the research has been extended to incorporate the prognostics of ground water radon prone areas.

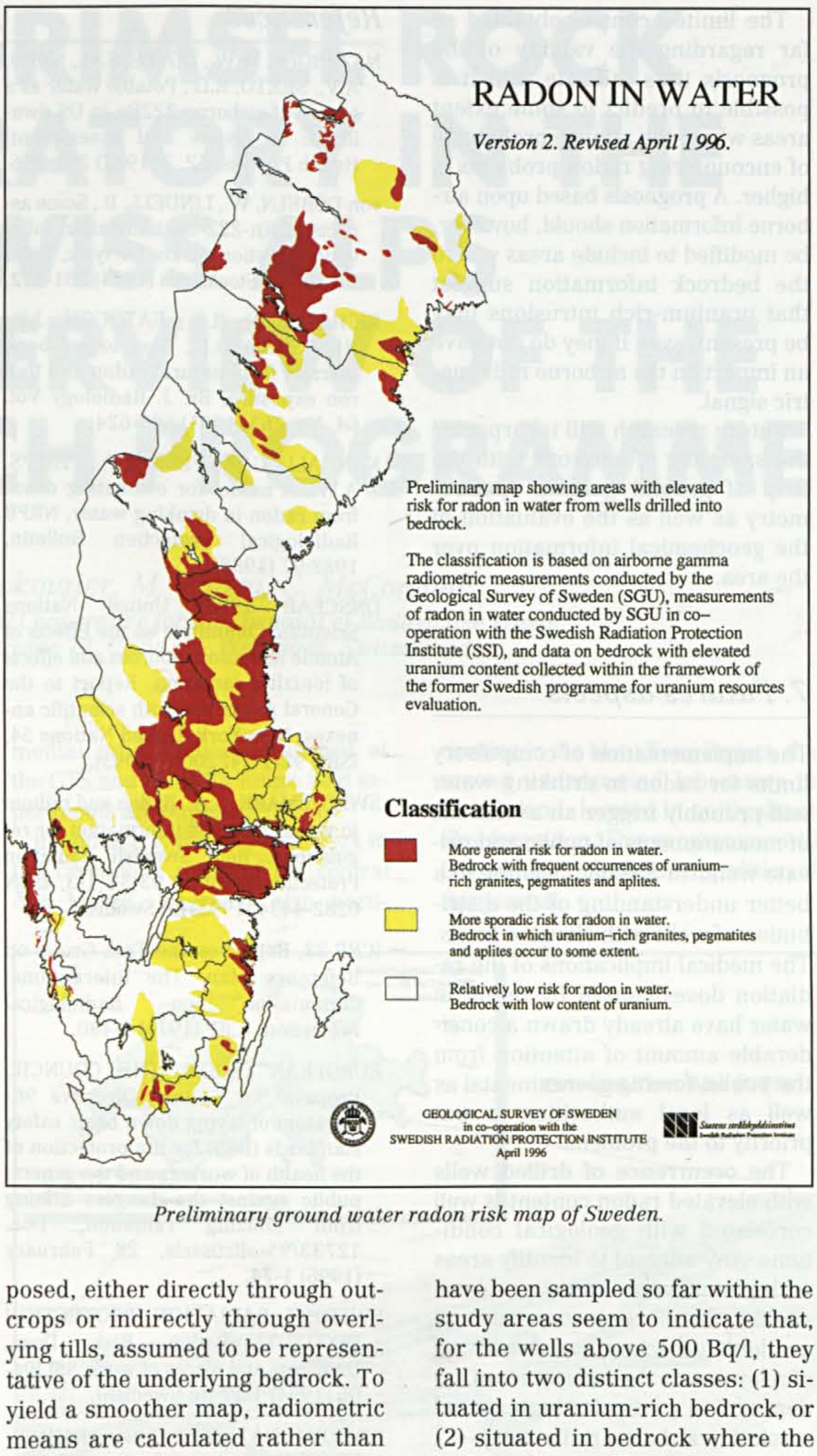
The methodology is currently under development, although some preliminary tests have been carried out in Central Sweden, in areas in which several bedrock units manifest elevated uranium levels.

When addressing the problem of radon in ground water, one needs to establish information with respect to the uranium (radium) content of the bedrock. This may be achieved as follows:

- the quaternary data is reclassified into two classes, the first comprising outcropping bedrock and till, and the second containing all other quaternary units
- the reclassified quaternary data is applied as a logical mask to the uranium component of the airborne radiometric data, retaining measurements over outcrops and till only, thus rejecting all other data
- the remaining radiometric data are processed together with the bedrock data to yield estimates of the mean radiometric signal over the individual bedrock units

In such a way, a uranium map of the bedrock is compiled, bearing information on all units that are exposed, either directly through outcrops or indirectly through overlying tills, assumed to be representative of the underlying bedrock. To yield a smoother map, radiometric means are calculated rather than cell-by-cell values. This approach also allows the information to be extrapolated beneath the quaternary cover. The process will allow features and trends to appear which are not readily visible on the raw radiometric map due to signals originating from the quaternary overburden.

The limited number of wells that have been sampled so far within the study areas seem to indicate that, for the wells above 500 Bq/l, they fall into two distinct classes: (1) situated in uranium-rich bedrock, or (2) situated in bedrock where the bulk rock manifests no elevated uranium content, but where there is an abundance of pegmatitic intrusions. These pegmatites are known often to be fairly radioactive, but they seem not to appear to a sufficient extent to have any major influence on the airborne radiometric measurements and/or not to be enough exposed as outcrops.



Preliminary ground water radon risk map of Sweden.

The limited control obtained so far regarding the validity of the prognosis thus indicate that it is possible to predict to some extent areas where the relative probability of encountering radon problems is higher. A prognosis based upon airborne information should, however, be modified to include areas where the bedrock information suggest that uranium-rich intrusions may be present, even if they do not have an impact on the airborne radiometric signal.

Future research will incorporate the sampling of outcrops with the help of ground gamma spectrometry as well as the evaluation of the geochemical information over the area.

7. Futures aspects

The implementation of compulsory limits for radon in drinking water will probably trigger an avalanche of measurements of public and private water in Sweden, leading to a better understanding of the distribution of wells with elevated levels. The medical implications of the radiation doses caused by radon in water have already drawn a considerable amount of attention from the public, forcing governmental as well as local authorities to put priority to the problem.

The occurrence of drilled wells with elevated radon content is well correlated with geological conditions. Any attempt to identify areas with ground water radon problems should therefore incorporate all available geoscientific information of relevance to the occurrence of radon, and in particular high spatial resolution airborne radiometry.

It is the definite conviction of the authors that ground water radon prognostics, based upon available geological, geophysical and geochemical information in connection with ground water radon mapping programmes will play an increasingly important role in the regional and municipal planning process with respect to radon risk.

References

NAZAROFF, W.W., DOYLE, S.M., NERO, A.V., SEXTO, R.G., Potable water as a source of airborne 222Rn in US dwellings: A review and assessment, Health Physics, 52, 3 (1987) 281-296.

von DÖBELN, W., LINDELL, B., Some aspects of Rn-222 contamination following ingestion, Arkiv för fysik, Band 27 No. 32, Stockholm (1964) 531-572.

RICHARDSON, R.B., EATOUGH, J.P., HENSSHAW D.L., Dose to red bone marrow from natural radon and thoron exposure, Br. J. Radiology Vol. 64, No. 763 (1991) 608-624.

KENDALL, G.M., FELL, T.P., PHIPPS, A.W., A model for evaluating doses from radon in drinking water, NRPB Radiological Protection Bulletin, 1988:97 (1988).

UNSCEAR 1993, United Nations Scientific Committee on the Effects of Atomic Radiation. Sources and effects of ionizing radiation. Report to the General Assembly, with scientific annexes, New York, United Nations 54, ISBN 92-1-142200-0 (1993).

SWEDJEMARK, G.A., Radon and radium in water. Baseline information for regulations, Rep. Swedish Radiation Protection Institute 93-34 1-3, ISSN 0282-4434 (1993) (In Swedish).

ICRP 23, Report on the Task Group on Reference Man, The International Commission on Radiological Protection, ICRP (1974) 1-480.

EUROPEAN UNION, THE COUNCIL, Proposal for Council Directive 96/ Euratom of laying down basic safety standards (BSS) for the protection of the health of workers and the general public against the dangers arising from ionizing radiation, Doc. 12733/95 Brussels, 28 February (1996) 1-74.

SWEDISH RADIATION PROTECTION INSTITUTE, Radon - Risk - Dose. Dwellings and places of work, SSI i94-06 (1994) 1-17 (In Swedish).

SWEDISH NATIONAL FOOD ADMINISTRATION, Proposal for limits for radon in drinking water. Letter to the Swedish Ministry of Agriculture, National Food Administration, Dnr 4049/95 (December 1995) (In Swedish).

FINNISH CENTER FOR RADIATION AND NUCLEAR SAFETY, Radioactivity of Household Water, ST Guide 12.3, 1-8, ISBN 951-47-8651-3 (9 August 1993).

THE MINISTRY OF HEALTH OF THE CZECH REPUBLIC, Decree 76 on requirements for limiting radiation exposure due to radon and other natural radionuclides, Acts Collection, Part 16, February 12 (1991) 365-366.

ÅKERBLOM, G., PETTERSSON, B., ROSÉN, B., Radon from the ground - Handbook on investigation of the radon situation in areas before building, The Swedish Council for Building Research and the Swedish National Board for Housing, Building and Planning. Report R88:(1988), New revised edition (1990) 1-159, ISBN 91-540-4937-7 (In Swedish).

LANDSTRÖM, O., TULLBORG, E-L., The influence of fracture mineral/groundwater interaction on the mobility of U, Th, REE and other trace elements, Swedish Nuclear Fuel and Waste Management Company, Technical report 90-37 1-71, ISSN 0284-3757 (1990) 1-71.

KULICH, J., MÖRE, H., SWEDJEMARK, G.A., Radon and radium in household water. Rep. Swedish Radiation Protection Institute 88-11 (1988) 1-74 (In Swedish).

MELLANDER, H., Airborne gamma spectrometric measurements of the fall-out over Sweden after the nuclear reactor accident at Chernobyl, USSR, IAEA/NENF/NM-89-1 (1989).

LINDÉN, A., ÅKERBLOM, G., Method of detecting small or indistinct radioactive sources by airborne gamma ray spectrometry, In: Geology, mining and extractive processing of uranium (JONES, M. J., Ed.) (1976) 111-120.

MAGNUSSON, E., Description to the quaternary map Eskilstuna NV, SGU Ae 18 (1975) (In Swedish with summary in English).

LUNDEGÅRDH, P. H., Description to the map of solid rocks Eskilstuna NV, SGU Af 111 (1974) (In Swedish with summary in English).

Paper presented at the IAEA Technical Committee Meeting to
REVIEW THE ADVANTAGES AND PITFALLS OF USING URANIUM EXPLORATION DATA AND TECHNIQUES AS WELL AS OTHER METHODS FOR THE PREPARATION OF RADIOELEMENT AND RADON MAPS FOR BASELINE INFORMATION IN ENVIRONMENTAL STUDIES AND MONITORING
Vienna, Austria, May 1996

THE GRIMSEL ROCK LABORATORY IN THE SWISS ALPS AN OVERVIEW OF THE RESEARCH PROGRAMME

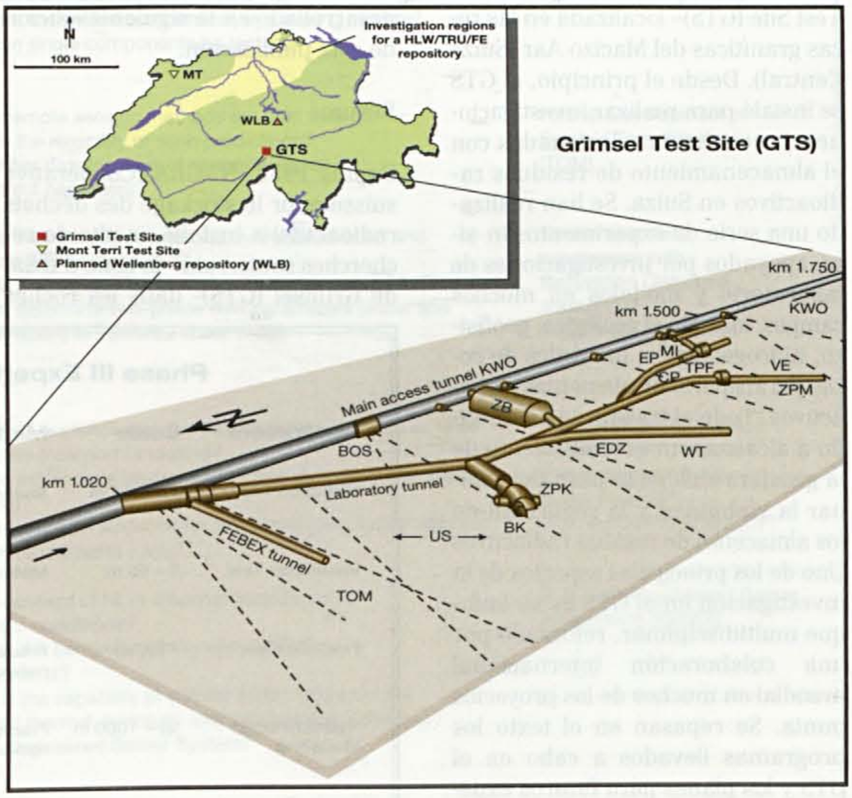
*W. Kickmaier, M. Thury, C. McCombie**
Nagra. National Cooperative for the Disposal of Radioactive Waste
Hardstrasse 73, Ch 5430 - Wettingen. Switzerland

Abstract

Since 1983, NAGRA (the Swiss National Cooperative for the Disposal of Radioactive Waste) has been operating an underground research facility - the Grimsel Test Site (GTS) - in the granitic rocks of the Aar Massif (central Switzerland). From the beginning, the Grimsel Test Site was established to perform research directly related to the disposal of radioactive waste in Switzerland. A series of in-situ experiments supported by laboratory investigations and modelling have been carried out in many fields, including geology, geophysics, hydrogeology, rock mechanics and radionuclide transport. All work is aimed at achieving the understanding of the geosphere required for assessing the feasibility and safety of radioactive waste repositories. A multidisciplinary approach, strengthened by worldwide international collaboration on many projects, is a major aspect of the research at the Grimsel Test Site. A review of past experimental programmes performed at the GTS and plans for future field experiments are outlined.

In addition to the research work in the crystalline rocks of the central Aar Massif, Nagra is also participating in the Mont Terri Project, the second underground laboratory in Switzerland, located in an Opalinus Clay formation. This programme will be outlined in the following edition of this journal.

* Nagra
W. Kickmaier Project Manager GTS
M. Thury Chief Geologist
C. McCombie Director of Science and Technology.



Location and schematic layout of the Grimsel Test Site (GTS)

International Cooperation at Grimsel Test Site

Germany	BMBF	Bundesministerium für Bildung, Wissenschaft, Forschung und Technologie, Bonn
	BGR	Bundesanstalt für Geowissenschaften und Rohstoffe, Hannover
	GRS	Gesellschaft für Anlagen und Reaktorsicherheit, Braunschweig
France	Andra	Agence nationale pour la gestion des déchets radioactifs, Fontenay-aux-Roses
Japan	PNC	Power Reactor and Nuclear Fuel Development Corporation, Tokyo
Sweden	SKB	Svensk Kärnbränslehantering AB, Stockholm
Spain	Enresa	Empresa Nacional de Residuos Radiactivos SA, Madrid
United States of America	US DOE	Department of Energy, Washington D.C.
EU		European Atomic Energy Community

Resumen

Desde 1983, NAGRA (la Cooperativa Nacional Suiza para el Almacenamiento de Residuos Radioactivos) ha estado utilizando una instalación de investigación subterránea –Grimsel Test Site (GTS)– localizada en las rocas graníticas del Macizo Aar (Suiza Central). Desde el principio, el GTS se instaló para realizar investigaciones directamente relacionadas con el almacenamiento de residuos radioactivos en Suiza. Se han realizado una serie de experimentos in situ, apoyados por investigaciones de laboratorio y modelos en muchos campos, incluido el geológico, geofísico, hidrogeológico, mecánica de rocas y transporte de elementos radioactivos. Todo el trabajo se ha dirigido a alcanzar un entendimiento de la geosfera suficiente para determinar la viabilidad y la seguridad de los almacenes de residuo radiactivos Uno de los principales aspectos de la investigación en el GTS es su enfoque multidisciplinar, reforzado por una colaboración internacional mundial en muchos de los proyectos punta. Se repasan en el texto los programas llevados a cabo en el GTS y los planes para futuros experimentos in situ.

Además del trabajo de investigación en las rocas cristalinas de la central Aar Massif, NAGRA también participa en el proyecto Mont Terri, el segundo laboratorio subterráneo suizo, localizado en la formación Opalinus Clay. Este programa será desarrollado en la siguiente edición de esta publicación.

Résumé

Depuis 1983, NAGRA (Coopérative suisse pour le stockage des déchets radioactifs) a installé un site de recherches souterrain - la zone d'essai de Grimsel (GTS)- dans les roches granitiques du massif de l'Aar (Suisse centrale). Dés le début, la zone d'essai de Grimsel était établie pour effectuer des recherches en relation directe avec le stockage des déchets radioactifs en Suisse. On a réalisé une série d'expériences in situ appuyées par des recherches de laboratoire dans plusieurs domaines, entre autres géologie, géophysique, hydrogéologie, mécanique des roches et transport des nucléides. Tous les travaux avaient pour but la connaissance de la géosphére ce qui permettrait d'évaluer la sécurité et la faisabilité des stockages de déchets radioactifs. Un des principaux aspects de la recherche A Grimsel est la multidisciplinarité, renforcée par la collaboration internationale dans de nombreux projets. L'auteur passe en revue le premier programme expérimental du GTS et donne une idée des futures expériences de terrain. En plus des travaux de recherche dans les roches cristallines du massif central de l'Aar, NAGRA, participe aussi au projet Mont Terri, le second laboratoire souterrain suisse, situé dans la formation argileuse Opalinus. Les grandes lignes de ce programme seront envisagées dans les prochains numéros de cette revue.Explosive, Proterozoic volcanism at an archean continental margin, anexample from the Lulea area, northern SwlenRésuméLes auteurs décrivent les caractéristiques d'un volcanisme explosif d'·ge protérozoÏque, dont l'origine probable est la subduction de croéte océanique sous une marge continentale archéenne.

Phase III Experiments (1990-1993)

Experiment	Scale	Medium	Focal point
Migration Test	1.7 – 17 m	Shear zone	• In Situ Radionuclide transport • Transport modelling • Laboratory sorption tests
Ventilation Test	0 – 50 m	Matrix	• Macropermeability of the rock • Evaporation at the tunnel surface • Unsaturated zone in the rock
Fracture Flow	~100 m	Fracture network	• Hydraulic parameters in complex fracture networks • Advective transport in fractures
Hydrodynamic Modelling	10 – 1000 m	Fractured rocks	• Disturbance to normal groundwater flow in fractured rock included by the presence of underground tunnels

Introduction

The Grimsel Test Site (GTS) located approximately 450 metres beneath the east flank of the Juchlistock mountain in the granitic rocks of the Aar Massif. The tunnel system of the GTS has a total length of around one kilometre and was excavated in 1983 using a full-face tunnel boring machine (TBM) with a diameter of 3.5 metres. The conditions for performing experiments at the GTS are particularly favourable because it contains areas of relatively undisturbed low-permeability rock, as well as water-bearing zones (shear zones, fractures and lamprophyre dykes). The GTS is a "first generation" rock laboratory, not chosen as a potential repository site but instead has been established to operate purely as an underground research facility generating data. The aims are:

- Building up know-how in various scientific and technical disciplines.
- Acquiring practical experience in site exploration methodologies.
- Investigating physical and chemical processes relevant for the safety of a repository.
- Further development and testing (verification) of models used to describe the long term evolution of a repository.

It should be noted that these objectives are pursued against a background of international collaboration. At the GTS, Nagra works closely together with research groups from 7 countries. This not only greatly increases the cost/benefit ratio of the work but also allows for wider exchange of expertise and cross-comparison of results and models.

Research Programmes 1983 - 1993

The research and development programmes performed at the Grimsel Test Site allow development of site characterisation methodologies which will be implemented in the characterisation of potential repository host rock formations. The GTS provides direct access to the deep geological environment where in situ experiments can be performed to improve the understanding of processes which may influence the long-term evolution of a repository.

During the first years of operation (Phases I and II, 1983 -1989), a comprehensive investigation pro-

GTS Experiments Phase IV 1994-1996

Strategy of programme planning

Key areas of interest	Related Questions	Experiment
Demonstration of sealing technologies	How can boreholes be best sealed? What are the critical components of a sealing system? How can single components be tested?	Borehole Sealing (BOS)
Determination the geometry of major fracture zones	Which remote sensing methods are best suited? What is the reliability of such predictions? Is a further development of methodology or equipment necessary?	Further Development of Seismic Tomography (TOM)
Influence of repository construction, operation and post closure processes on repository safety Properties of the excavation disturbed zone around a gallery	How is the hydrology perturbed by the excavation and how can this be measured? What is the extent of deformation at the tunnel wall? How to determine two-phase flow parameters (water and gas transport) in fracture / shear zones	Tunnel near-field programme with Excavation Disturbed zone (EDZ) Two Phase Flow (TPF)
Radionuclide transport though the geosphere. Modelling and Validation of assumed transport processes	Does field evidence support the processes included in predictive transport modelling? How to extrapolate laboratory sorption data to flow systems (scaling)? Is there any field evidence for diffusional pore space adjacent to preferential parth ways?	Radionuclide Retardation Project (RRP) Excavation of the MI-shear zone (EP) Connected Porosities (CP)
Emplacement Technologies for High Level Waste Disposal and behaviour of Engineered Barrier Systems (EBS)	Is the concept of HLW-disposal feasible under 'realistic' conditions? What is the behaviour of the various EBS components? What is the capability of current codes to predict the coupled thermal, hydraulic and geochemical behaviour of the Engineered Barrier System?	Full-scale Engineered Barrier Experiment (FEBEX)

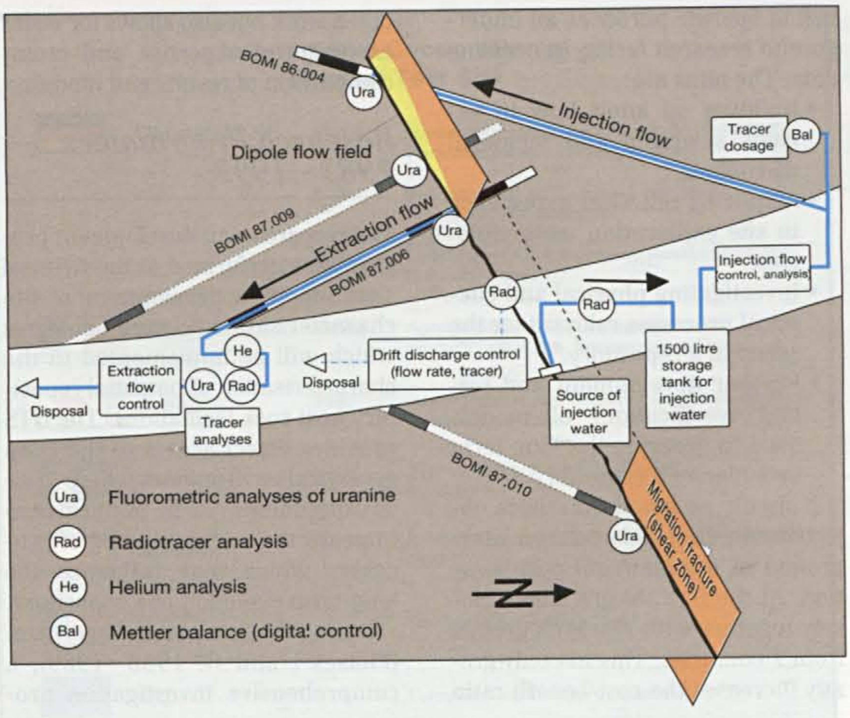


Figure 1. Overview of the test layout for the migration experiment. The example shown is of a dipole field over 4.9 meteres flow distance.

works (advective transport) and the determination of matrix parameters (macropermea-bility) and processes in the unsaturated zone. Using an integrated approach to synthesise the results in the hydrodynamic modelling project, the Phase III experiments focused on the main geological features relevant for the disposal of radioactive waste in granite; the matrix as a potential host rock, the fracture network as preferential transport pathways and the near-field as a direct contact between the engineered barriers and the geosphere. With the migration experiments, the role of associated modelling studies became increasingly important. Models initially used to interpret simple field observations were subsequently used to predict the results of later, more complex, experiments and these predictions were compared with measured output.

gramme was carried out consisting of 16 main experimental programmes. In addition to providing detailed information on the hydrogeological conditions, which is required for planning, per-forming and interpreting later tests, a range of seismic and radar methods were used to identify important inhomogeneities, such as fault zones and lamprophyres, in the surrounding rock. An improved understanding of the interaction between modelling exercises, laboratory experiments and in situ studies was also a major achievement of the first phases of research at the GTS.

With time, the focus of the research changed from obtaining generic data and development of site characterisation methodologies to model testing and 'validation'. Finally, the issue of public acceptance is coming increasingly to the fore and this is also reflected in the GTS programmes. Drawing on a more detailed understanding of the hydrogeological and the experience gained to date, investigations in phase III (1990 - 1993) focused on the determination of hydraulic parameters in complex fracture net-

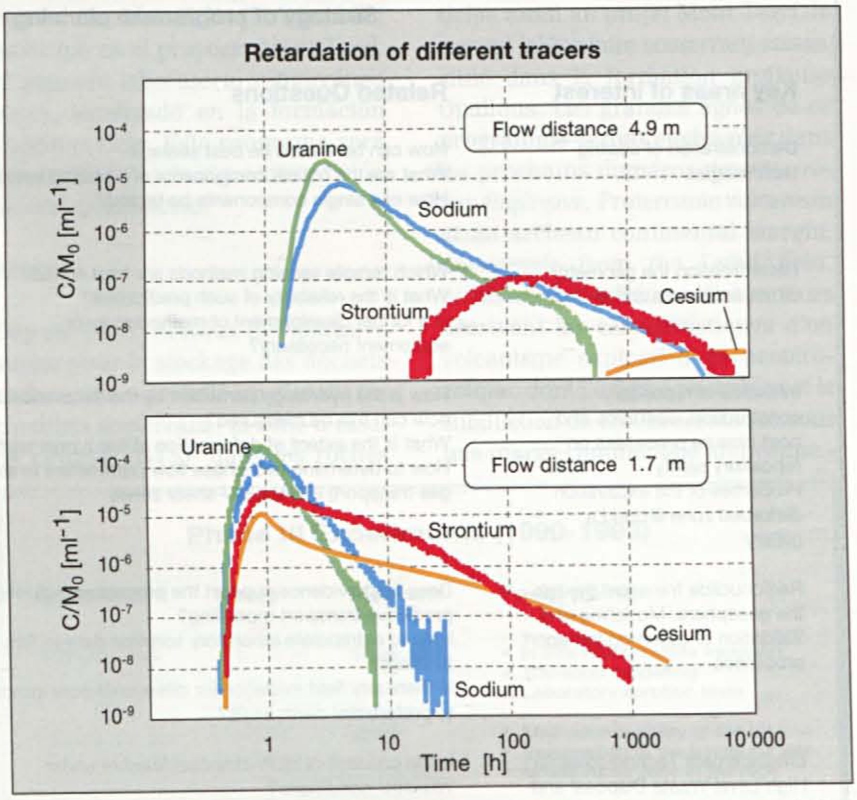


Figure 2. Retardation for different test conditions and a range of tracers with the same injection and extraction rates over flow distances of 1.7 and 4.9 meters. With high flow rates over the short distances, Non-sorbing anions show similar peak times, less enhanced peak concentrations and rapidly decaying breakthrough curves when compared to cations which display various degrees of sorption. For weakly to moderately sorbing tracers with breakthrough over the flow distance of 4.9 meters, there is a clear retardation coupled with marked dilution.

View to the migration test tunnel

Research Programme (Phase IV, 1994 - 1996)

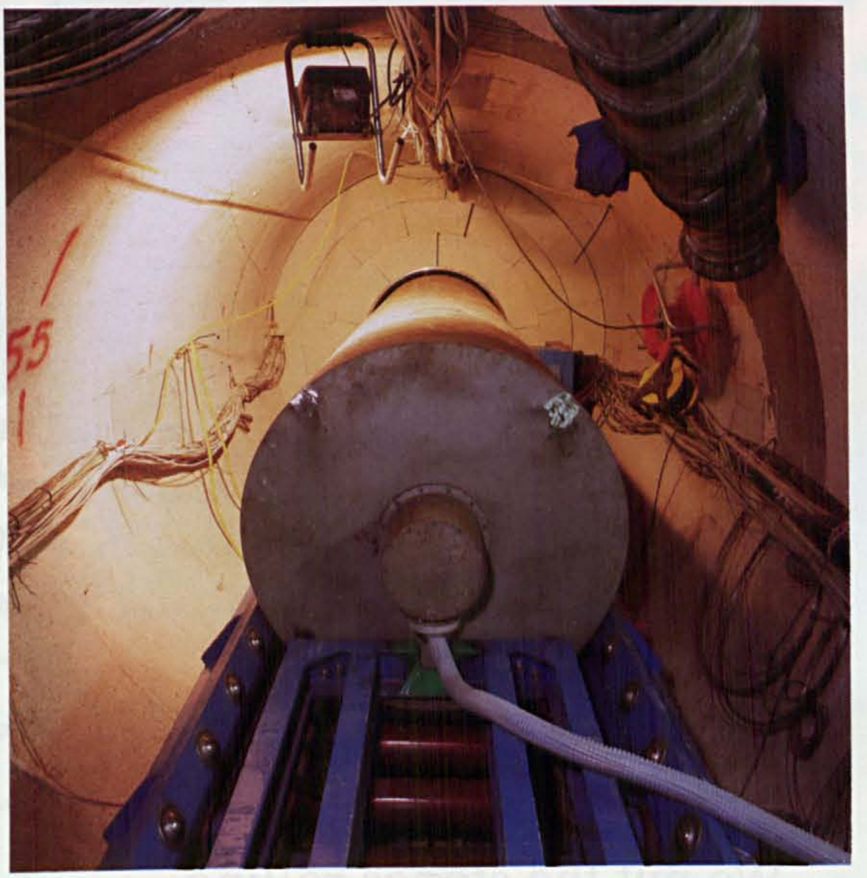
In 1993, much progress had been made towards fulfilling the objective of gaining experience and knowhow in site characterisation and the generation of generic data. The subsequent GTS programmes no longer focus entirely on isolated technical questions, but rather on multidisciplinary projects which can be clearly related to the final goal of construction of safe repositories. For planning the Phase IV experimental programme (1994-1996), a systematic approach, best described as a top-down approach, has been applied. Starting from a list of key areas of interest identified in ongoing repository projects and associated performance assessments, open questions were defined and finally experimental proposals elaborated. For the selection of the experiments, the following ranking criteria were applied:

- relevance to repository safety
- suitability of the GTS for the project
- cost/benefit ratio
- chance of success
- specific relevance for the Swiss waste disposal programme
- international interest
- novelty; scientific interest

One highlight during recent years of research at the GTS has been the Migration Experiment. Tracer experiments were performed in a hydrologically well defined, transmissive shear zone and were supported by laboratory sorption experiments and intensive modelling. The general test layout is illustrated in Figure 1. A series of short-lived radioactive tracers with different sorption characteristics were utilised, with the aim of rigorous testing of radionuclide transport models, testing conceptual models of in-situ retardation and determining the relevance of applying laboratory sorption data to radionuclide retardation in situ. An example of the retardation of different tracers is shown in Figure 2. After successfully performing a ^{137}Cs tracer test, it was decided to terminate the experiment by excavating the shear zone (Excavation Project). To investigate retardation processes directly, a 'tracer cocktail' of strongly retarded radionuclides was injected, followed by resin injection to fix the shear -zone; excavation of the flowfield has been carried out by large diameter boreholes. The distribution of radionuclides will be analysed using radiochemical and surface analytical techniques.

Future research (Phase V, 1997 - 2002)

In view of the positive outcome of the programmes performed to date, it was decided at the end of Phase IV to continue the work at the Grimsel Test Site to the year 2002. Some new experiments in Phase V are directed specifically towards solving problems arising in connection with construction and operation of planned repositories. A good example, already began in Phase IV, is the FEBEX-Project a 1:1 scale demonstration of the engineered barrier system for of high level waste disposal. On an international level, partner organisations are actively involved in all Phase V programme planning. The test concepts and objectives of joint and complementary experiments are being formulated in multidisciplinary and multinational working groups. One focus of interest defi-



The FEBEX Project:
A 1:1 demonstration test for the disposal of high-level waste / spent fuel. Electrical heaters simulating the waste are horizontal emplaced in a bentonite backfilled tunnel section.

ned so far is the possibility of carrying out in situ experiments with a range of radionuclides over long timescales in the radiation controlled zone (IAEA type B) at the GTS; these experiments are currently in a planning stage. It is hoped to start the first field experiments during late 1997.

The organisation of Phase V ensures a degree of flexibility regarding the level of participation of different partner organisations or complementary research by universities. The stepwise procedure foreseen for initiating individual experiments will enable the requirements of partner organisations to be taken into account. Exchange of information and know-how between partners will take place via participation in the experiments and through a special technical-scientific committee.

Conclusions

- With the research performed at the GTS, fundamental process understanding and practical experience in carrying out experiments underground have been achieved.
- The multidisciplinary and multinational approach to the research is a key aspect of the programmes.
- The focus of programmes has changed with time from the objective of generating basic information on the deep geological environment to the objective of model verification and validation.
- In-situ experiments in rock laboratories approximating the expected underground conditions at a site can contribute extensively to confidence-building in a wide range of groups ranging from the general public to technical experts.
- Experience gained in underground testing and equipment development is not only relevant for achieving the final goal of constructing safe radioactive waste repositories. There are also general spin-offs in many geotechnical areas. Specifically the know-how is also be applicable in research programmes related to the disposal of chemotoxic wastes.

References:

The results of all experiments performed are published in the Nagra Technical Report series (NTB), which can be ordered at Nagra. Please ask for a complete reference list from Nagra National Cooperative for the Disposal of Radioactive Waste, Hardstrasse 73, Ch 5430-Wettingen).

EXPLOSIVE, PROTEROZOIC VOLCANISM AT AN ARCHAEAN CONTINENTAL MARGIN, AN EXAMPLE FROM THE LULEÅ AREA, NORTHERN SWEDEN

by Anders Wkström

Geological Survey of Sweden, Box 670, SE 751 28 Uppsala, Sweden

and Claes Mellqvist

Division of Applied Geology, Luleå Technical University, SE 971 87 Luleå, Sweden

Abstract

The authors describe the characteristics of explosive volcanic of proterozoic age, interpreted as probably originated from subduction of oceanic crust beneath an archean continental margin.

Resumen

Los autores describen las características de un volcanismo explosivo del proteozoico, interpretado como resultado de subducción de corteza oceánica bajo un margen continental arcaico.

Résumé

Les auteurs décrivent les caractéristiques d'un volcanisme explosif d'·ge protérozoÏque, dont l'origine probable est la subduction de croéte océanique sous une marge continentale archéenne.

The presently known distribution of Archaean (older than 2500 Ma) rocks in northern Sweden and Finland is displayed in Fig. 1. In the Luleå area, the final recognition of these old rocks has a rather young date (Lundqvist et al. 1996). The background for this discovery was an old observation of conglomerates in the Vallen-Alhamn area (Fig. 2) with granitoid pebbles which were described to have been deposited on a granitic basement. As the known Archaean bedrock on the Finnish side of the Bothnian Bay was not so far away , this further motivated radiometric dating in the actual area. Both the basement granitoids and the pebbles were dated and the Archaean ages were discovered. Among the pebbles, also ages of c. 1880 Ma were found and this age has also been received from a locality at Måttsundsberget (Fig. 2).

It was earlier recognized, with a method based on neodymium isotopes, that an old Archaean continental crust had contributed with material to the development of the younger magmatic rocks in parts of Northern Sweden (Öhlander et al. 1993). In the Luleå area this method has been used in more detail (Mellqvist 1996) with the result that

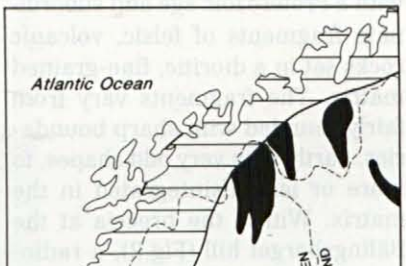


Fig. 1. Sketch map of th distribution of Archaean rocks (black) in a part of the Baltic shield. Ruled area is the Scandinavian Caledonides.

the boundary between magmatic rocks with an Archaean component in the north and juvenile magmatic rocks in the south, rather closely follows the outcropping Archaean rocks. The latter have been traced during the present bedrock mapping of the Luleå map-sheets by the Geological Survey of Sweden.

Within this mapping program, a somewhat different picture of the geological evolution has been developed compared with earlier views. Nowhere has a depositional contact on the Archaean basement with certainty been established. Most contacts towards younger rocks seem to be either intrusive or tectonic in character. The conglomerates have been reinterpreted to be hydraulic, magmatic breccias (Wikström et al. 1996) with transitions into explosive volcanic rocks (although very locally, a sedimentary reworking can be anticipated). In part they are found as dykes in the basement rocks. The so-called Bälinge "conglomerate" which is the most intensively studied member of this rock association, is composed mainly of tonalite fragments with a Proterozoic age and subordinate fragments of felsic, volcanic rocks set in a dioritic, fine-grained matrix. The fragments vary from fairly rounded with sharp boundaries, partly with very odd shapes, to more or less disintegrated in the matrix. Within the breccia at the Bälingsberget hill (Fig.2), a radiometrically dated Archaean block with an approximate size of 75x150 meters in outcrop can be found. At one contact it has been intruded by the Proterozoic tonalite.

As mentioned above, the hydraulic, magmatic breccias were found to be transitional into explosive, volcanic rocks with a somewhat varying character and composition,- generally with a dacitic to andesitic matrix. Geographically these rocks seem to approximately follow the distribution of the Archaean bedrock. With the achieved experience, it has been possible to recognize Archaean fragments in the volcanic rocks, one example can be seen in Fig. 3.

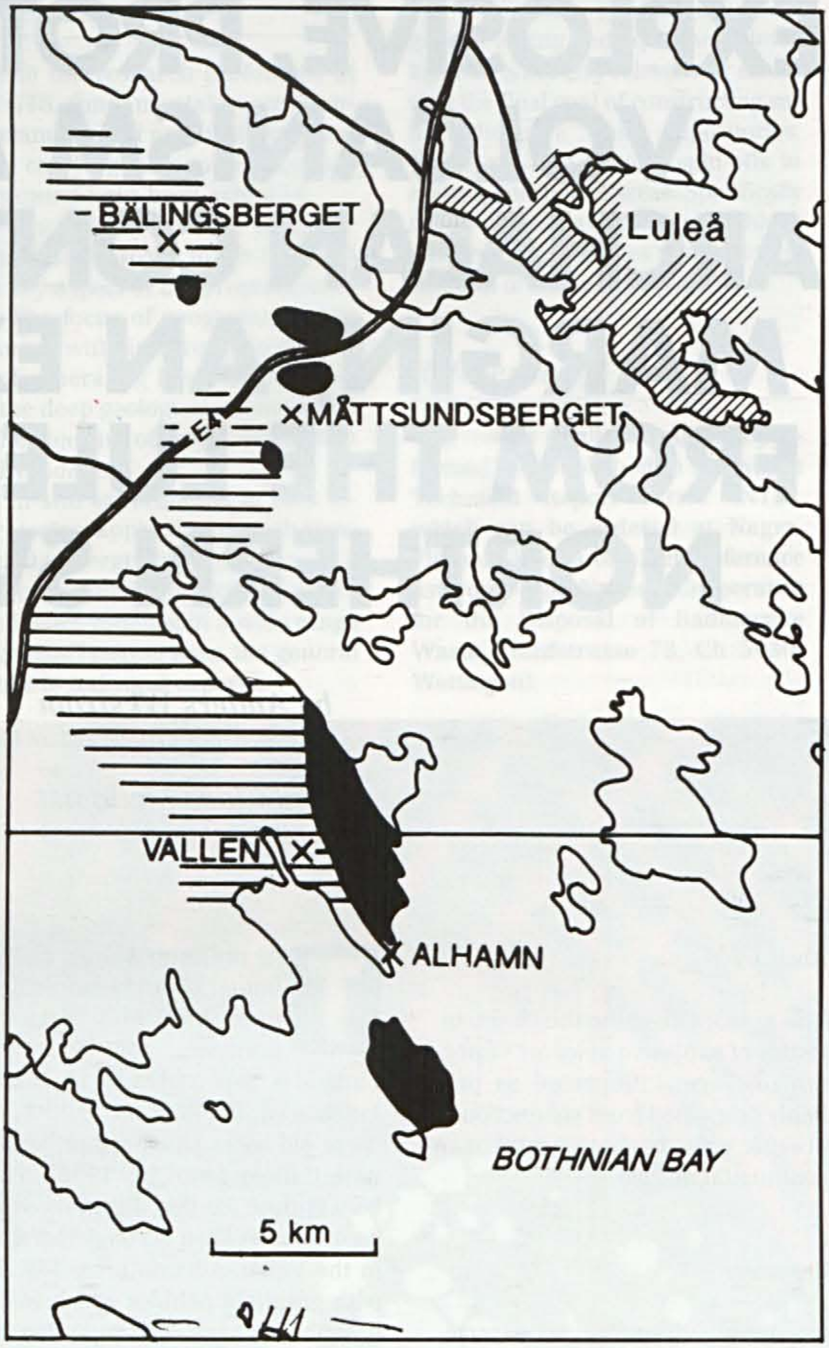


Fig. 2. Sketch map of the distribution of Archaean rocks (black) and explosive magmatic rocks (horisontal ruling) in the Luleå area.

A further characteristic bedrock feature of the area is the presence of large, young gabbro bodies near the exposed Archaean rocks. Judging from the extensively developed magma mixing and mingling relationships with the tonalites, which mainly constitute the fragments in the hydraulic breccias, the gabbros must also be pieces that have to fit when the puzzle is to be be assembled.

A combination of these observations, - blocks of Archaean bedrock exposed along a zone elongated in NW-NNW,- an Archaean crustal contribution to the development of younger magmatic rocks to the NE of this Zone,- explosive, volcanic to subvolcanic magmatic rocks in part with Archaean xenoliths and finally,- some large gabbro bodies which also seem to follow this zone, can be interpreted in the following simplified way: At an Archaean continental margin, mafic magmas were generated under specific conditions, probably related to subduction of oceanic crust beneath the continent. The mafic magmas served as heat sources for explosive magmatism where parts of the old crust was blasted away.

This scenario is different from what has been found further to the north and east where the so-called Karelian development, characterized mainly by vast volumes of basaltic volcanism, related to rifting of the old continent and deposition of continental sandstones, has prevailed. In the Luleå area this development is missing. Here the old continent has been directly involved in Svecokarelian orogenic development.

Fig. 3. An Archaean fragment (at the coin) in a fragment rich, Proterozoic metavolcanic rock.

References:

Lundqvist, Th, Vaasjoki, M. and Skiöld, T. 1996. Preliminary note on the occurrence of Archaean rocks in the Vallen-Alhamn area, northern Sweden. In Th. Lundqvist (ed.): Radiometric dating results 2, 32-33. Sveriges geologiska undersökning C 828

Mellqvist, C. 1996. Using Sm-Nd isotopes and the occurrence of Archaean megaxenoliths as tracers when delineating the Archaean-Proterozoic palaeoboundary in the Luleå area. GFF 118, A20.

Öhlander, B., Skiöld, T., Elming, S.-Å., BABEL Working group, Claesson, S. and Nisca, D.H. 1993. Delineation and character of the Archaean-Proterozoic boundary in northern Sweden. Precambrian Research, 64, 67-84.

Wikström, A., Mellqvist, C. and Barbarin, B. 1996. The Bälinge conglomerate in norhtern Sweden reinterpreted as a magmatic, hydraulic breccia. Terra nova, 8, 166-172.

GEOTHERMAL ENERGY IN EUROPE

by Christian Boissavy
Executive President of Geotherma S.A. (France)
Expert for the General Directorate for Energy (DGXVII - Brussels)

Abstract

Geothermal energy is widely available in Europe, it is an indigenous and sustainable resource with a positive environmental impact. Europe represents 10 % of the installed power for electricity generation and about 50 % of the thermal running power in the world.

Good prospects for important growth in geothermal energy production still exist especially for shallow geothermal reservoir and ground source heat pumps.

However, the largest increase of geothermal development will occur outside Europe, as a result this will create export opportunities for the European geothermal industrial sector.

Resumen

Europa dispone de amplias fuentes de energía geotérmica, es un recurso autóctono y sostenible con un impacto ambiental positivo. Europa representa el 10 % de la potencia instalada para generacion de electricidad y alrededor del 50 % de la potencial termal del mundo.

Existen todavía buenas perspectivas para un importante crecimiento de la producción de energía geotérmica, en especial para depósitos geotérmicos poco profundos y bombas de calor con alimentación subterránea.

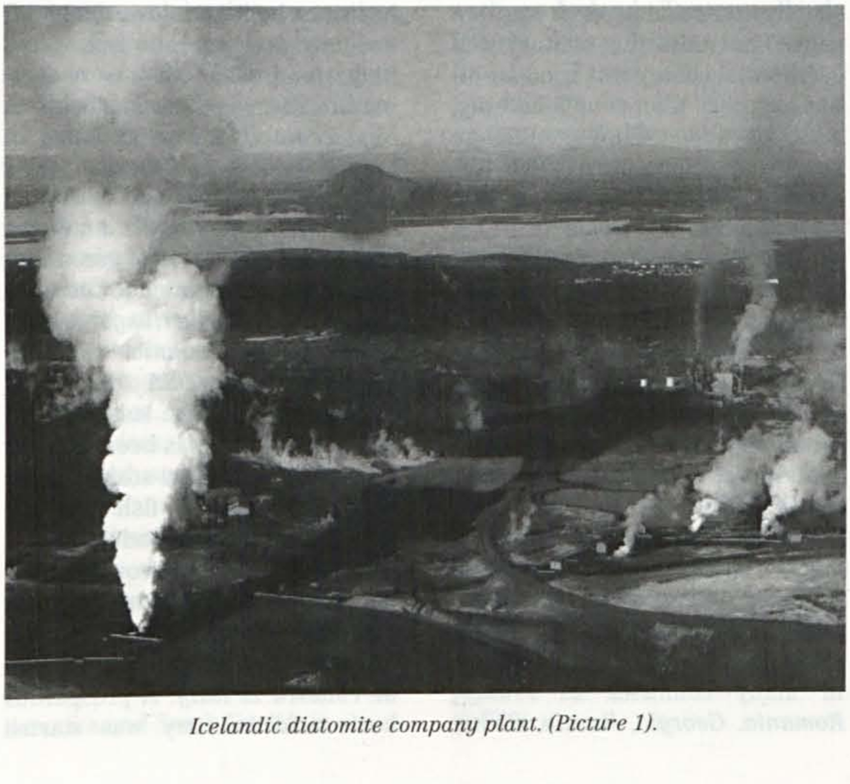
Sin embargo, el mayor aumento de proyectos geotérmicos se producirá fuera de Europa, como resultado de lo cual se crearán grandes oportunidades de exportación para el sector industrial geotérmico europeo.

Résumé

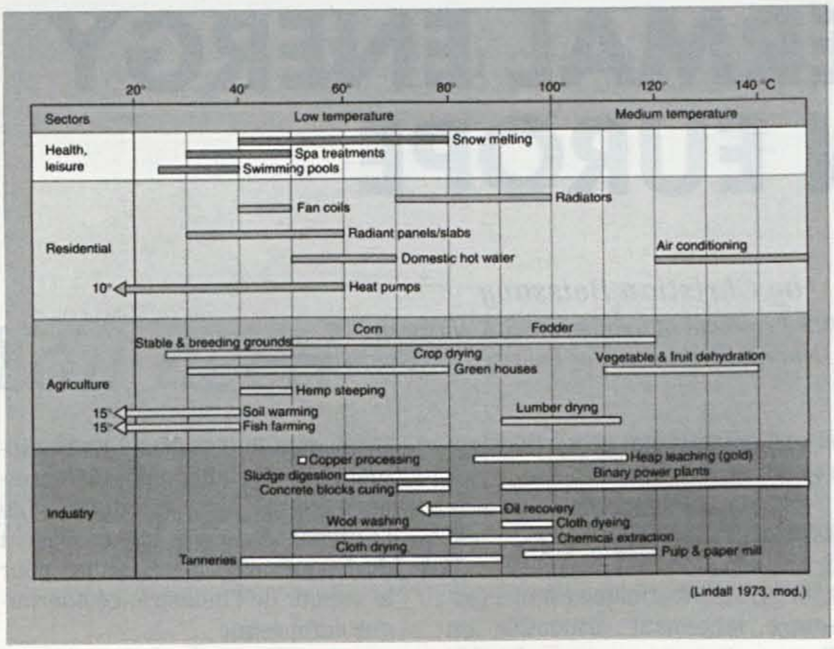
L'énergie géothermique est une ressource largement disponible en Europe, c'est une ressource durable et autochtone a impact environnemental positif. L'Europe représente 10% de la puissance installée pour la production d'électricité et environ 50% de la puissance thermique dans le monde. De bonnes perspectives pour une importante croissance de la production d'énergie géothermique existent encore, spécialement dans les réservoirs géothermiques peu profonds et les pompes a chaleur a alimentation souterraine. Cependant le plus grand accroissement des installations géothermiques aura lieu en dehors de l'Europe, cela créera par conséquent des opportunités d'exportation pour le secteur de l'industrie géothermique européenne.

Introduction

T*Thermal springs* have been used for *bathing, washing* and *cooking* for thousands of years in many countries (figure 1). There are over two thousand year old records of geothermal usage in China, and there are ruins of Roman baths dating for the peak of the Roman empire at numerous localities in



Icelandic diatomite company plant. (Picture 1).



Main applications of geothermal fluids in the low-medium temperature range. (Figura 1).

Europe and reaching as far a field as England and Syria. The ancient peoples of the world, such as the Romans, Greeks, Mexicans, Chinese, Japanese, and Maoris, have in their history been associated with *hot springs* that were alleged to have healing properties. The *balneology* industry developed from the Roman spas and Turkish baths to the present day spas and pools. It was, however, not until this century that geothermal energy was used for other purposes than simple bathing, washing, and cooking. Although primitive pipelines were built by the Romans and the Chinese to pipe thermal water and steam for baths, it was only when metal pipes and radiators became common that geothermal energy was used for *space heating* (figure 1). Even in *Iceland*, where hot springs are abundant the mean annual temperature about 4°C, geothermal space heating was first installed in a house in 1909.

The earliest residential heating in the world by geothermal water was at Boise, Idaho (USA) in 1892. *District heating* systems using geothermal water have been built now in many countries as *France, Romania, Georgia, Russia, China, and USA.* The first light bulb was lit with electricity generated by geothermal steam in 1904 in *Larderello* in *Italy*, and the first geothermal power station was built there a decade later. By 1940, a geothermal power station with a capacity of 140 MW_e was feeding the Italian railway system. This was destroyed during the latter part of war, but has since built up to over 500 MW_e not only at Larderello but across Italy. Hundreds of MWe were commissioned in geothermal fields in *New Zealand, USA* and *Japan* in the 1960's. Using geothermal water for greenhouse farming was started in Iceland in the 1920's, and later hundreds of hectares of greenhouses have been operated for decades in countries such as *Hungary*, Italy, *Macedonia, Romania, Russia, China, Japan, USA and New Zealand.* During the last decades, geothermal heat has been used on an increasingly large scale also for animal husbandry, fish farming, soil heating and air conditioning.

Mineral extraction from geothermal fluids started already in Etruscan time when *boric acid* was extracted from boiling springs south of Volterra in *Italy*. A prosperous boric acid industry was started again in Larderello in the early 19th century. The first large industial application of geothermal steam was initiated in the 1950's in a pulp and paper mill in *Kawerau* in *New Zealand.* In 1967, a factory started operation in Iceland using geothermal steam to dry *diatomaceous slurry* (see picture 1) pumped from the bottom of nearby lake. Wool washing factories have operated in *Iceland* since the 1960's, and in *China* geothermal water has been used for washing but also used for its chemical properties for dyeing in large scale carpet factories for several decades.

General overview

Geothermal energy is commonly listed in the literature with unconventional energy resources.

Geothermal energy is the natural heat of the earth which can be produced by the means of a fluid which absorbs the heat underground and yields it on the surface. The fluid is generally water contained in underground reservoir which can be either in liquid or, less frequently, in gaseous state. There exist two main classifications of geothermal fields, a classification according to the reservoir temperature and a classification according to their geological nature.

The former divides geothermal fields into high and low enthalpy fields, the borderline usually defined between 150°C and 200°C. The second classification is into sedimentary and fractured reservoirs. In sedimentary reservoirs, aquifers are connected to widespread sedimentary layers, usually sub-horizontal. In fractured reservoirs, aquifers are usually in steeply dipping fractures and usually connected to the tectonic and volcanic zones. Sedimentary reservoirs are usually low enthalpy resources while fractured reservoirs can be either low or high enthalpy.

Prospecting for geothermal resources involves the uncertainties which are typical of mining ventures. Geothermal resources are, for most practical purposes, renewable within the limits of equilibrium between extraction of fluid and natural or artificial recharge.

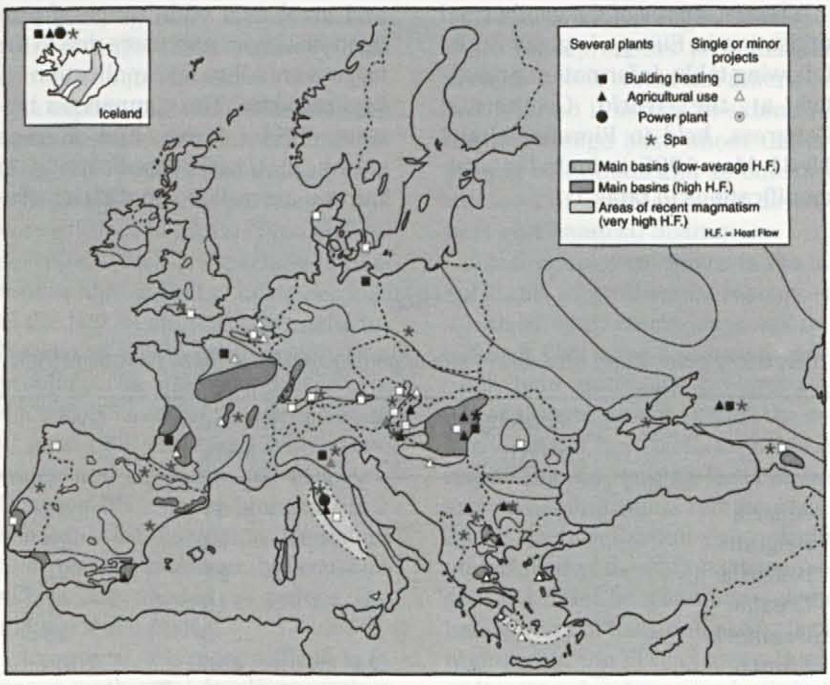
World wide exploitation of geothermal energy is growing rapidly. In 1994, the electricity produced in Europe from geothermal was 37.3 TWh/y compared with 1.7 and 0.5 TWh/y from wind energy, solar energy and tidal energy respectively (WEC 1995) (see table 1). In addition, direct use of geothermal energy amounts 33.5 GWh/y. Thus geothermal energy is at present the far most important of these four renewable energy resources. It is, moreover, a firm source, exploitable 24 hours per day, 365 days per year. There is at present rapid development of geothermal utilization in many countries, especially in developing ones.

Although geothermal energy is so widely used, its usage is mostly on a modest scale of tens and hundreds of MW per country. About 3.6 x 10^{21} Joules of geothermal energy are estimated to be convertible by existing technology for the generation of electric power (WEC, 1978). For comparison, this is equivalent to 1.2 x 10^6 MW of electric generating capacity for 100 years. The recoverable thermal energy theoretically suitable for direct applications has been estimed at 2.9 x 10^{24} Joules, which is about 10,000 times the present annual world consumption of primary energy without regard to grade (Armstead, 1983).

The geothermal potential of Europe is shown on the figure 2. Three main types of systems can be individualized.

Low enthalpy areas (in pink) in foredeep and intracratonic basins with large sedimentary multi-aquifer systems such as these in France (Aquitaine and Paris Basin), Italy (Po Valley), United Kingdom (Wessex, East Yorkshire), Germany (North German Basin, Molasse alpine foredeep basin), the Nederlands, Denmark, Romania (Carpathian foredeep), Spain (Ebro valley), etc...

Low and intermediate enthalpy areas (in dark blue) of continental drift and rift valleys e.g. Limagne, Rhone Valley, Rhine Graben, deep parts of sedimentary basins and marginal and back arc basins with reduced continental crust (Pannonian Basin).



Main geothermal areas and uses. (Figure 2).

High enthalpy reservoir (in light blue) in the Mediteranean areas chiefly the tectonic system of Tuscany, the Pliocene quaternary volcanism of northern Latium and Campania, subduction magnatism of the Eolian Arc complex plate boundaries cross (Turkey) and active volcanic islands on ridge rift zone (Iceland / Azores).

The consumption of geothermal energy within the European Union has been irregular. Electricty production has started in some remote regions (Azores, Guadeloupe) has increased at a moderate rate in Italy, while the development of low enthalpy resources has continued at a slow pace. As a result of low energy prices, the European geothermal industry has made important investments to increase efficiency in order to remain competitive and is actively pursuing new business opportunities both in the internal market and mostly in external markets of Eastern Europe, Middle East, Central and South America and South East Asia.

There is also a very large growth, not adequately recorded in the statistics, in the use of heat pumps to upgrade the (usually low temperature) heat energy in the shallow sub-surface.

Following these good resources, the geothermal industry plays a very important role in the economics of several regions of Europe such as Iceland, Tuscany, Ile de France, Azores, Eastern Germany, Bavaria, Pannonian Basin and Guadeloupe, by supplying an indigenous, renewable resource at competitive prices.

European countries have an excellent technological position in most areas of geothermal activities and are well positioned to compete with the USA, which is the most active competitor. The USA government through its Department of Energy funds research, development and demonstration at a rate of US $ 30 x 10^6 per year, well ahead of the EU funding and actively supports the exporting efforts of its geothermal sector.

Europeans are leaders in district heating schemes, sea water desalination, HDR research and at the forefront in other sectors such as corrosion, scaling abatement and modelling.

A recent survey of the geothermal utilisation in Europe is given in the following table. Information presented at the World Geothermal Congress, held in Florence (Italy) 18-31 May 1995 is included with modifications in table 1.

TABLE 1

Electricty generation and direct use of geothermal energy in Europe (1995)

	Electricity MWe	GWh	Direct use MWt	GWh
Austria			41	56
Belgium			4	28
Bulgaria			21	77
Croatia			15	17
Denmark			3	13
France	4	24	456	2006
Georgia			245	2136
Germany			323	330
Greece	2	0	23	38
Hungary			638	2795
Iceland	49	265	1443	5878
Italy	625	3417	308	1008
Fyrom			70	142
Netherlands			2	
Poland			63	206
Portugal (Azores)	8	40.5		
Romania	2		137	765
Russia	11	25	210	673
Serbia			80	660
Slovakia			100	502
Slovenia			37	212
Spain				40
Sweden			137	581
Switzerland			110	243
United Kingdom			2	9
TOTAL	701	3771.5	4466	18415

The table shows that geothermal energy is at present used in 25 European countries and that direct use of geothermal energy in Europe represents about 18,4 TWh (thermal) per year, 8 TWht in 1984, whereas electricity generated from geothermal resources is about 3,8 TWh (electrical) per year, 1,5 Twhe in 1983. The direct use of geothermal energy is thus at a relatively more advanced stage in European countries than in other parts of the world and involves a wide range of production sectors and users due to the large versatility of application of said resource. The comparison between USA, Japan and Europe shows that main applications in Europe are related to district heating and that other uses such as agricultural and heat pumps, could be strongly developed.

Direct use load factor can be estimated at 50 % because climate conditions do not usually allow summer exploitation of fully installed capacity. On the other hand, electricity generation assumes load factor and availability of more than 85 % on average and sometimes 95 % which is better compared to conventional sources and other renewables.

Present market situation

For new technologies near cost competitiveness with conventional energy sources, success stories in various EU countries have proved that where a stable and favourable framework has been set up, new markets and related industries can be established with related benefits for energy security, environment and economic development.

The geothermal market in France (direct use) experienced relatively slow growth rate after the large reduction in energy prices in 1986.

In electricity production, only Italy has a large power generating capacity with 625 MWe in 1995. This corresponds to the fourth position in the world market, the first three being USA (2817 MWe), Philippines (1227 MWe) and Mexico (750 MWe).

Non-electrical applications in European countries, have been developed mainly in Hungary, former USSR; Iceland (which is the world leader), Italy, France and Eastern Germany.

Geothermal energy supply is of considerable local importance in certain regions of Europe. Due to the fairly abundant supply of conventional energy sources at very competitive prices, prevailing economic conditions and competitiveness of geothermal energy have deteriorated within the last few years, especially regarding thermal applications.

Electricity generation, however, still remains competitive, especially in isolated regions. Geothermal energy costs are of the order of magnitude of 0.04-0.08 ECU/KWh$_{(th)}$ for direct heat applications and 0.05-0.10 ECU/KW$_{(e)}$ for electricity generation.

For the geo-electricity market, no specific problems arise because of the high density of the electrical grid in most parts of the EC. Development limitation can occur when the geothermal resource is located on isolated islands (Greece, Canaries, Azores), when the export of surplus production would need undersea transmission lines.

Problems are rather different in the non electrical sector. If the situation remains unchanged, the main use will be district heating which is very dependant on the development of distribution networks and directly subject to the competition of other energy sources. Expansion of such networks is difficult, especially where an efficient gas distribution system exists, or if preference for individual heating system persists in collective housing.

If the geothermal field is located in the vicinity of an urban area, then an accessible nearby heat market is available for district heating or industrial applications. Otherwise, as is often the case, the heat market must be developed prior to the exploitation of the geothermal energy for greenhouse heating, fish farming or agricultural/industrial purposes.

Under all circumstances the exploitation scheme is characterised by high front-end investments, while integration by cascading or combining seasonal or complementary uses helps in improving overall economics of the geothermal projects.

It should be mentioned that, apart from current low fuel prices and other constraints described above, the slow market penetration of geothermal energy can also be attributed to insufficient dissemination actions within EU Member States and other European countries. Despite many efforts, the public profile of geothermal energy remains low and it stay an almost unknown option.

However, as the use of geothermal energy is widely possible in Europe dissemination actions should be local. On the other hand, general actions for dissemination referring to successful geothermal applications appear to be useful.

A number of problems currently limit the development of the geothermal EU potential to only the most easily accessible and exploitable resources. Development of geothermal fields has followed the normal mining trend of taking first the best part of the share without full exploitation of extracted energy, before tackling more adverse reservoir settings, heat recovery and conversion processes.

In exploration and production, the main obstacles are linked to the mining uncertainties and the aggressiveness of brines. In particular, it is very difficult to locate fractured reservoirs, which is especially important in high enthalpy fields because of the lack of appropriate methodologies and techniques. Exploitation problems can also occur during production because of the composition of geofluids, especially with saline water and the presence of gases. Ongoing R&D has evidenced some solutions for corrosion treatment and scaling abatement, but constant efforts are needed to reduce the maintenance costs.

In general, it is more difficult to finance geothermal development than the development of conventional energy sources. Banks and other financial institutions consider geothermal energy more «risky» than many other energy sources. The main reason for this is lack of information about the nature of geothermal energy, and that anything new is considered more risky than things that are better known. In order to change the attitude of the banks and financial institutions, it is probably best to carry out a number of demonstration projects that clearly prove that geothermal energy is an economical, reliable, and environmentally benign energy resource.

It is considered that at least one successful demonstration project is needed in a region or a country to raise the credibility of geothermal utilisation in the eyes of the decision makers and financial institutions. The widespread use of heat pumps in Switzerland (with very limited conventional geothermal energy resources compared to the neighbouring countries) shows that adequate information to the public can change the energy use in a very noticeable way.

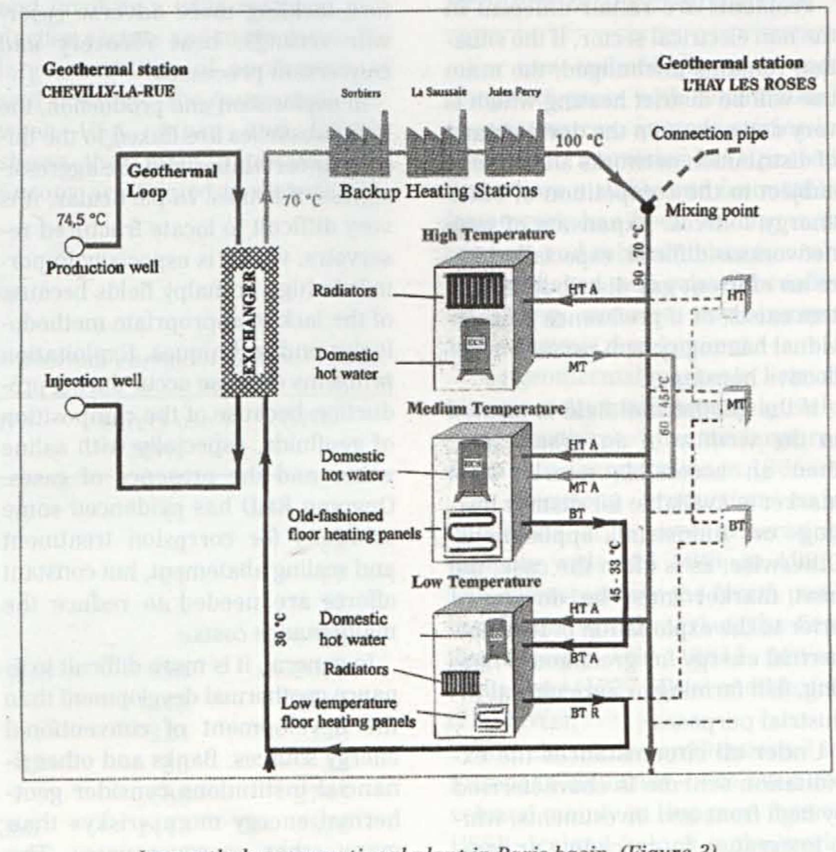
The problem of risk has been addressed in France and Bavaria by the introduction of insurance schemes which help to cover the initial development risk in new boreholes. This has two advantages : it encourages entrepreneurs to undertake projects which would not otherwise be built and it assists in extending the knowledge base about underground conditions and so boosting the level of confidence for developers and financial institutions.

Another relevant factor is the legal status of geothermal resources, which in many countries is still undefined. Financing institutions normally lend money for the later stages of a development against the security of the first well, and this is impossible as long as legal status and ownership rights remain undefined. Such definition can only be undertaken at the national level, because it must be done against the background of the pre-existing legal regime, but the EU can assist in coordinating databases and minimizing duplication of effort.

Role of the associations

The International Geothermal Association (IGA) has only been active since 1989. It has already demonstrated its importance and influence by convening the World Geothermal Congress in 1995. This conference turned out to be a major forum of information exchange where almost 1500 professionals gathered to discuss the progress made in the field of research and development of geothermal resources.

The European Branch of IGA has also been of major benefit for the geothermal development in Europe. This is especially true for the needs in Central and Eastern Europe. Most of the countries in this region have substantial low-enthalpy geothermal resources, which up to 1990, were considered of limited importance. Improved information exchange through IGA and the European Branch of IGA has changed considerably the priorities in energy development (Poland, Hungary, Croatia, Slovakia, Romania, etc). The European Branch of IGA (established in 1992) has already held geothermal workshops in Hungary, Poland and Romania with partici-



Low enthalpy conventional plant in Paris basin. (Figure 3).

pants from a large number of European countries.

The role of national Geothermal Associations is very promising. They are active in *Germany, Austria, Switzerland, Poland, Romania, Russia, Georgia, Lithuania, Hungaria, Slovenia* and *Slovakia*. Some associations of geothermal district heating network managers exist in France (Agemo) and Italy. These associations should be encouraged because they can ensure a better dissemination through EU, associated states and candidate countries. Finally, there is a clear need for an *European Geothermal Energy Council* (manufacturers of equipment, software and consultants). Such organisations are very active in Japan and the USA to promote technology and equipment from these countries. It might perhaps be practical to establish one European Council for Renewable Energies which would promote geothemal, hydro, wind, solar, tidal, biomass, etc.

It seems that the consumers are not a strong group in the development and the exploitation of geothermal energy. Furthermore, stronger interaction and dialogue between manufacturers of equipment and the operators of geothermal fields seems to be desirable. An effort should be made to secure closer cooperation between the geothermal manufacturers/consultants and the National/European associations of district heating companies.

Overall development targets in the geothermal sector

In the sector, 3 subsectors can be individualised :

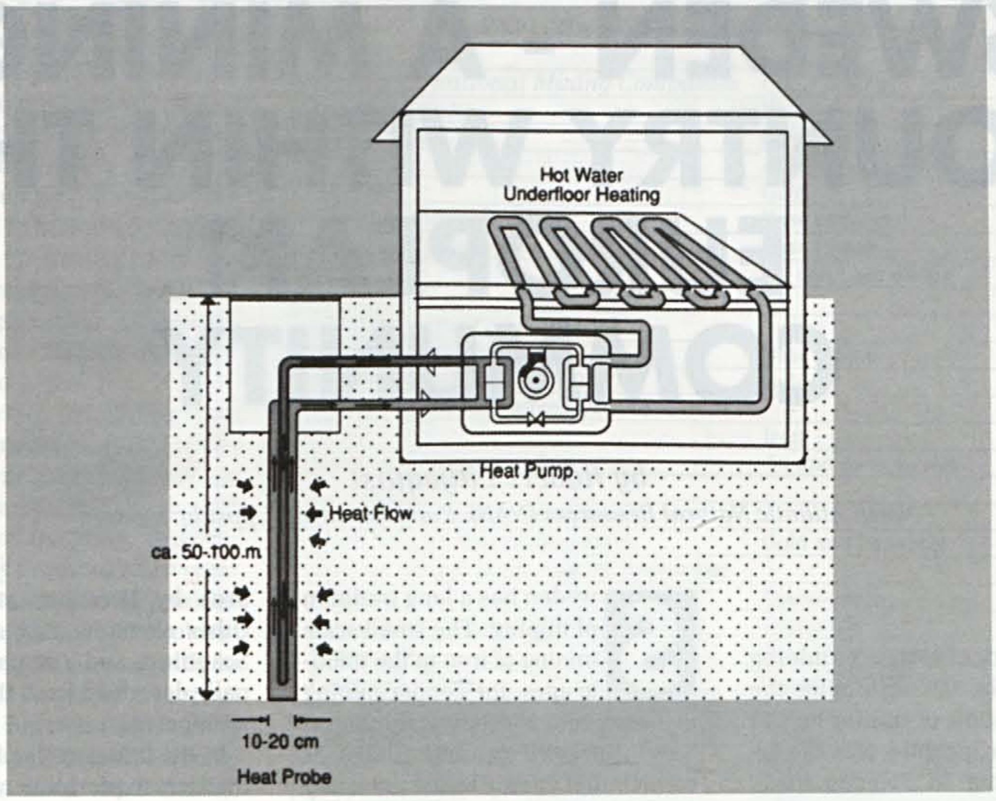
- Electricity generation
- Direct uses applications (see figure 3)
- Geothermal heat pumps.(see figure 4)

Regarding electricity generation, the main target must be to upgrade the efficiency of the various systems (e.g. wider use of Organic-Rankine cycles, completing one HDR project into operation, enhance productivity by injection into existing fields, develop proven steam fields not yet into operation).

For electricity generation purposes, reservoirs exploited at the moment belong to hydrothermal systems less than 4.000 m deep. New technologies for the exploitation of deeper reservoirs, recovery of fluids at temperature over 400°C, heat extraction from magma, geopress reservoirs and hot dry rock are under experimentation. However, some of the technologies used can be perfected in the next 10 to 15 years so as to significantly boost EU development of geothermal energy by 2010.

In the direct use sector, it is of utmost importance to focuse the projects on other applications in addition to district heating and to multiply the existing projects which have replication potential, taking into account that low grade geothermal resources within Europe are connected to deeply buried sedimentary layers of considerable lateral extent. In such cases, the aquifers are widespread and the need for sophisticated methods is limited, but the scope for eventual exploitation is large. The situation in most of the European geothermal high enthalpy fields is different and will require new exploration methods to reduce the number of unproductive wells.

Geothermal heat pumps systems are underdeveloped in EU which install each year between 5.000 to 8.000 units, primarily in Sweden, Switzerland, Austria and Germany. These systems are highly replicable and could be installed throughout the EU for space heating and/or cooling. Unlike conventional geothermal, they do not require fluids at depth or specialized geology. In comparison, the US program of 400.000/year is under way for 2.000 and correlative reduction in greenhouses gas emissions estimated at 1,5 million tons of CO_2 per year. These systems would also provide an opportunity for good European heat pump manufacturers to export their products and consequently allow industry to build confidence in the market and reduce its cost base.



Vertical heat probe (GSHP-ground soure heat pump). (Figura 4).

Conclusions

Geothermal energy is an indigenous and sustainable resource of relative abundance and with a positive environmental impact.

As a result, it has and should greatly contribute to achieve the EU energy policy objectives particularly in the area of increased Renewable Energy production.

World wide consumption of geothermal energy is growing rapidly and European geothermal sectors are well positioned to benefit. Europe is in the forefront in many areas : training (Pisa, Reykjavik), power generation cycles, district heating, hot dry rock, corrosion monitoring and reduction, balneology, etc..

Internally, through research and innovation, it has managed to adapt and grow in a period of low energy prices.

Good possibilities for important growth in geothermal energy production exist for all kinds of geothermal resources, high and low enthalpy resources and shallow geothermal reservoirs (space heating and air conditioning with ground heat pumps). Other applications will have slower growth.

The largest increases of geothermal energy production will occur outside Europe ; as a result this will create export opportunities for the European geothermal industrial sector.

The United States which is our strongest competitor is very active in the promotion of Geothermal Export activities and spends annually US $ 30 x 10^6 in promoting research, development and demonstration.

The European Union should continue to play an important enabling and supporting role commensurate with the greater number of countries participating in the Framework Programme (Iceland, Israël and future participants from Eastern Europe). No single member country has a sufficient large market to warrant the required research development, demonstration and dissemination effort on its own.

It requires an annual effort of around 20 x 10^6 ECU.

Developing countries and candidate countries have completed initial surveys and in some cases have started utilization projects of their geothermal resources. At that stage, EU cooperation through up to date technologies, financing and training will allow a strong and sustainable development.

Bibliography

FAST-OPET (1992). The several uses of low temperature geothermal energy for heating. Commission of the European Communities.

Directorate General for Energy - DG XVII (1995). Thermie Geothermal Energy Technology projects.

F. RUMMEL - O. KAPPELMEYER (1993). Eddwärme. Energieträger der zukunft ? Verlag. C.F. Muller - Karlsruhe.

I. FRIEDLEIFSON - D.H FREESTON (1993). Geothermal Energy research and Development. International Solar Summit - UNESCO - Paris

G.W. HUTTRER (1995). The Status of World Geothermal Power Production 1990 - 1994. International Geothermal Conference - FLORENCE.

SWEDEN - A MINING COUNTRY WITHIN THE EUROPEAN COMMUNITY

by Robert Lilljequist

North Atlantic Natural Resources (NAN). Kungsgatan, 62 Uppsala. Sweden

Abstract

After a historical review of mining in Sweden, the author studies the current situation of mining in the country and concludes that the future of mining in Sweden looks bright meaning interesting working and business perspectives both for geologists and geoscientists and exploration and exploitation companies .

Resumen

Tras un repaso histórico a la minería en Suecia, el autor revisa la actual situación de la minería del país y prevé un brillante futuro para la minería sueca lo que significa interesantes perspectivas de empleo y negocio tanto para geólogos y geocientíficos como para las empresas de investigación y explotación de recursos.

Résumé

Aprés un historique de l'exploitation miniére en Suéde, l'auteur étudie sa situation actuelle dans le pays et en conclut que l'avenir de l'exploitation miniére en Suéde est optimiste, a savoir qu'il existe d'intéressantes perspectives de travail et d'affaires, a la fois pour les géologues et géoscientifiques et pour les sociétés d'exploration et d'exploitation.

Sweden has a long tradition of mining. The small scale mining of iron in the middle ages, the copper mining at Falun and the silver mining at Sala, Garpenberg and Hällefors contributed widely to the economy from the 1200th to the 1700th century and financed several wars at that time on the European continent. With the Bessemer and Thomas processes the large phosphorous iron ore could be mined profitable at Kiruna (from 1898), Malmberget (from 1888) and Grängesberg (first exploited in the 16th century but mining first really flourished towards the end of the last century).

When the Falu Copper mine closed down in December 1992 it had been in more or less continuous operation for over 1 200 years. At about the same time the manganiferous iron mine of Dannemora closed down after "only" 500 years of production of high quality iron ore. Today we have to deal with their leftovers in order to meet modern environmental requirements - problems mainly associated with leakage of heavy metals from mining dumps and acid drainage.

Several metals were originally been identified from Swedish localities, e.g. tungsten (Scheelite), nickel from Los by Cronstedt in 1751, cobalt in Riddarhyttan 1735 by G Brandt, and about 100 years later cerium from the same Riddarhyttan area by Berzelius and Hisinger. Other elements such as Holmium, Scandium and Yttrium were originally described from the Stockholm archipelago.

In the first decade of this century modern exploration was initiated within the Skellefte district in northern Sweden which subsequently led to the discovery of almost one hundred massive sulphide deposits. Of these, 21 deposits have been mined and presently five massive sulphide deposits are in operation in the Skellefte district together with two deposits mined for gold only.

During the last decades exploration and mining has been under the control of only a few actors. Foreign ownership of mineral resources was not allowed since the Swedish financial community pushed out the English interests from the northern iron ore fields just before the end of last century. One exception was the mining company "La Société des mines et fonderies de zinc de la Vieille Montagne" which was mining the Zinkgruvan deposit since 1857 and sent the zinc to smelters in Belgium. Before the Swedish Mineral Act was changed in July 1992, only a few companies were engaged in exploration and mining.

Boliden has continuously been active in exploration since 1918 and the Swedish Geological Survey started an exploration department at about the same time. But the situation was changing notably already at the end of the 1980s. The Norwegian company Norsk Hydro took over the majority of the shares of the Björkdal gold deposit (discovered in 1985 and in production since 1988), the Finnish state company Outokumpo bought the Viscaria and Pahtohavare copper mines close to Kiruna, and the French State company COGEMA entered an exploration agreement with the State Mining Property Commission in 1989.

With new winds emanating from the new mineral legislation in Sweden several large international mining companies started to sniff around. First on the "new" exploration scene was the Australian company Ashton Mining (which initiated a very secret diamond exploration in northern Sweden already in 1990) closely followed by American Barrick (now Barrick Gold, which took over the Lac Minerals exploration ground in northern Sweden), BHP (Australia) and RTZ (United Kingdom).

Following the same scent in the air a large number of so called Junior Companies became attracted by the new atmosphere. About twelve companies from Australia, Canada and UK have secured new concessions in Sweden during the last four years.

The mining activities have also been influenced by new owners. North Ltd (Australia) bought the Zinkgruvan mine from Union Miniére in 1995 and established an exploration office in Åmmeberg in the spring of 1996. William Resources (Vancouver) has bought the shares of the Terra Mining from the stockmarket in December 1996.

The closing down of the Swedish State owned exploration organisations have thus resulted in a fascinating new situation.

The industrial minerals sector is growing more concentrated with Omya Plüss-Staufer (Switzerland) and Askania (earlier SIBELCO) from Belgium as relatively new actors together with large Swedish dolomite/limestone /cement producers.

EXPLORATION COMPANIES IN SWEDEN

Large International Mining Companies	*Commodity*	*Country*
Ashton (Minash)	Diamonds	Australia
Barrick Gold	Gold	USA
BHP	Au and base metals	Australia
Cogema	Gold	France
North Ltd (Ammeberg)	Base metals	Australia
Outokumpu (Viscaria)	Base metals	Finland
RTZ	Au and base metals	UK
Swedish Mining Companies		
Boliden (Trelleborg)	Base metals	Sweden
Terra Mining (Norsk Hydro)	Gold	Norway
(sold to William Resources Dec 96)		Canada
LKAB	Iron	Sweden
North Atlantic Natural Resources	Au and base metals	
International Junior Companies		
North Atlantic Natural Resources	Gold and base met	Sweden
(Boliden AB and South Atlantic Resources)		Canada
Alcaston	Diamonds	Australia
Poplar Resources (ex-Caledonia Mining)	Diamonds	Canada
Evenlen Pty	Au and base metals	Canada
Finnmark Mining	Au and base metals	Canada
Nordic Exploration (EMF and Cambridge Res)	Diamonds	England
Swedish Gold Prospecting (Cranbrock Ltd)	Gold	England
Tertiary Gold	Gold	England
Zappa Minerals	Base metals	Canada
Pegangeo	Gold	Australia
EuroAust	Gold	Australia
Golden Eagle	Gold	Australia
Orvana	Gold	Canada
Swedish junior companies		
Tricorona		
* Mirab, Mineralresurser AB	Industrial min	
* Svensk Koppar	Copper	
* GEXCO		
* AROS	Industrial min	
* ANRO	Industrial min	
Geoforum Scandinavia AB		
HGR AB	Andalusite	
Albatross	Wollastonite	
Mineralanalys		
JOMYA AB		
STGB Mineral		
International Gold	Gold	
South Atlantic Resources:	(Vancouver, Sthlm)	
* Svenska Miljö och Mineral AB	Au and base metals	
* Västernorrlands Mineral AB	Gold	
Jämtlands Mineral	Gold	
Lapplands Guld	Gold	
Lapplands Mineral AB	Gold	
Polstjärnan Position (Artic Star)	Gold	
Scandinavian Mining AB	Gold	
Innova	Iron	
X-Minerals	Gold	
Wermlands Guldcenter	Au and base metals	
Consultance companies		
Malå Mineral	Geol services	
GeoVista AB	Geophysics etc	
Geomanagement (Lars-Göran Ohlsson)	Geol services	
INKO (Bertil Sundqvist)	Concessions	
Geopartner AB	Ornamental rocks	*January 97*

A new graphite mine is recently opened and in operation by Tricorona (Sweden).

While the newcomers from outside countries look for opportunities in the Swedish Precambrian rocks, the Boliden Company expands its activities abroad. Boliden International has successfully increased the geological and mining resources at Sukhaybarat in Saudi Arabia and at Aznacóllar in Spain. In Sweden Boliden has concentrated on deep-seated massive sulphide deposits since 1981. After five years and nineteen drill-holes they went through the first promising mineralized section at Petikträsk in 1986. The mining started in 1992 at this rich deposit, located 300 meters underneath the bedrock surface. In May 1996 Boliden announced a new rich gold deposit (Åkulla) which maybe will be as rich as the famous Boliden Mine (in production 1924-1967), once the major producer of gold in Europe.

The largest lead mine in Europe, the Laisvall Mine, close to the Caledonian mountain range is still producing and Sweden can also boast the largest open pit mine (Aitik), located close to the Arctic Circle, with the lowest grade of copper and gold in Europe if not in the world. It is now producing 16 Mt yearly containing only 0.3 % copper and 0.3 g/t gold, and has been a miraculous technical challenge to maintain this deposit in operation since 1968.

LKAB (established in 1890) is currently the only significant producer and exporter of iron ore products in the European Union. Over 80% of LKAB´s products are exported, and EUs steel producers are the major buyers.

The present and future scenery of Swedish exploration and mining looks bright, also for the Swedish geoscientists involved in this sector. The ongoing exploration boom will most likely result in a major discovery which in turn will rise the temperature on the exploration scene still more and attract even more international mining companies.

The community of Swedish geologists, geophysicists and service companies are quite limited, and it is possible to foresee a need for additional experienced professionals in exploration and mining. The question is if these will move in from other European countries or from North America and Australia?

Sweden, together with the other Scandinavian countries, will most likely continue and maybe expand their mining activities, and further contribute to the exploitation and beneficiation of minerals from the Precambrian bedrock, feeding the European industry with valuable raw material.

HYDROCARBON OCCURRENCE IN PORTUGAL

by João T. Pacheco
Gabinete para a Pesquisa e Exploração de Petróleo
Rua Vale de Pereiro, 4 - 1250 Lisboa - Portugal

Abstract

This paper briefly reviews the Portuguese petroleum geology. It includes short summaries of the geology of the Portuguese sedimentary basins with an emphasis on the factors controlling petroleum generation and accumulation, and of the history of hydrocarbon exploration.

Resumen

Este artículo repasa brevemente la geología del petróleo portuguesa. Incluye un resumen corto sobre la geología de las cuencas sedimentarias portuguesas con especial énfasis en los factores que controlan la génesis y acumulación de petróleo y otro sobre la historia de la exploración de hidrocarburos en Portugal.

Résumé

Cet article passe en revue briévement la géologie pétroliére portugaise. Il comprend de courts résumés sur la géologie des bassins sédimentaires portugais mettant l'accent sur les facteurs contrólant la genése et l'accumulation du pétrole et une courte histoire de l'exploration pétroliére.

Summary of portuguese petroleum Geology

The pre-Mesozoic rocks

The Hercynian foldbelt which outcrops over four fifths of the Portuguese onshore and underlies the Meso-Cenozoic sedimentary basins, is divided into four zones separated by thrust contacts.

The internal zones - Middle Galician/ Trás-os-Montes, Central Iberian and Ossa Morena Zones - are characterised by the predominance of Precambrian and Early Palaeozoic metamorphic and igneous rocks: intense deformation and widespread syn-orogenic magmatism and metamorphism are the dominant features. However, the Central Iberian Zone and the Ossa Morena Zone which presumably underlie the Porto-Galicia basin and part of the Lusitanian basin, include also Upper Carboniferous and Lower Permian bituminous coals which outcrop onshore in localised small limnic basins.

In the external zone, the South Portuguese Zone, Late Palaeozoic rocks prevail; thin skin folded, their deformation and metamorphism are less intense and magmatic activity is scarce. Sea floor samples and regional trend suggest that the South Portuguese Zone directly underlies the Algarve and Alentejo basins (see below) and might partly consist of non-metamorphic marine Carboniferous shales - often organic rich - and sands with subordinate carbonate interbeds.

A Late Hercynian faulting episode, associated with post-orogenic magmatism, led to the development of a wrench fault system of mainly NNE-SSW to ENE-WSW running sinistral faults and NNW-SSE to NW-SE striking dextral faults. Reactivation of these faults played a key role in the successive stages of post-Palaeozoic basin development. Changes in fault-slip directions point to rejuvenation under varying stress conditions.

The Meso-Cenozoic basins

Four Mesozoic-Cenozoic sedimentary basins, related to the opening of the Atlantic Ocean, can be individualised along the western and southern coastal areas of Portugal (Fig. 1).

The northernmost of these, the Porto-Galicia basin, straddles the Portuguese-Spanish border and extends south into Portugal for about 100 km. It is exclusively present offshore and covers an area of about 2,150 km^2 (down to the 200 m water depth line) or 2,800 km^2 (to the 1,000 m water depth) in Portuguese waters. Up to about 6 km of Late Triassic to Late Cretaceous sediments overlain by a generally thin Cenozoic cover, are present in the basin.

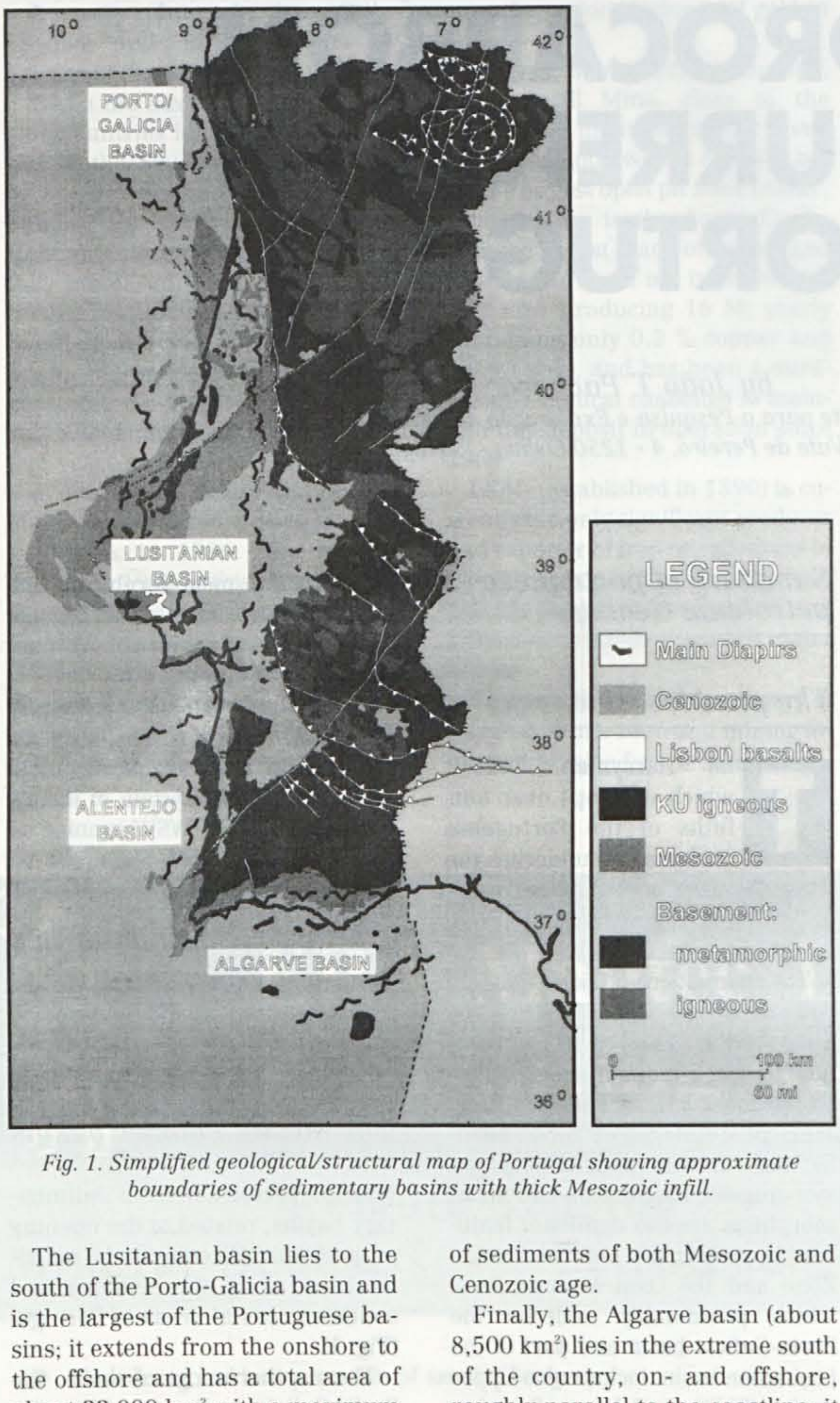


Fig. 1. Simplified geological/structural map of Portugal showing approximate boundaries of sedimentary basins with thick Mesozoic infill.

The Lusitanian basin lies to the south of the Porto-Galicia basin and is the largest of the Portuguese basins; it extends from the onshore to the offshore and has a total area of about 22,000 km^2 with a maximum sedimentary thickness of some 6 km. The age of the sedimentary fill is similar to that in the Porto basin but the thickness of the Jurassic sediment package relative to the Cretaceous is generally larger.

The Alentejo basin is small (some 2,600 km^2), developed only in the offshore mostly in waters deeper than 200 m, and has never been drilled. Judging from seismic data it could contain a significant thickness of sediments of both Mesozoic and Cenozoic age.

Finally, the Algarve basin (about 8,500 km^2) lies in the extreme south of the country, on- and offshore, roughly parallel to the coastline; it continues to the east as the Spanish Cadiz basin. Depth to the Carboniferous basement may exceed 7 km and the fill is again of Late Triassic to Recent age. The relative thickness of the Cenozoic and, particularly, of the Neogene sediments, is larger than in the western basins.

Initial rifting leading to the formation of the basins took place everywhere during the Late Triassic and Early Jurassic.

The earliest sediments are red, continental, more or less coarse clastics of Late Triassic age which are succeeded by thick evaporite deposits mainly made up of salt and anhydrite with subordinate dolomite, marl and clay of Late Triassic to Hettangian age (Fig. 2). The evaporitic sequence is particularly thick in the Lusitanian and Algarve basins where, as a result, halokinesis played a major structural role; it is less developed in the Porto basin and its presence in the Alentejo basin is not evident. The evaporites are overlain by shallow marine carbonates of Sinemurian age.

Regional subsidence continued and during the remainder of the Early and Middle Jurassic mainly deeper marine carbonates were deposited in the Porto and Lusitanian basins. The transgression culminated in Pliensbachian-Toarcian times. Along the east and west edges of the southern Lusitanian basin, however, shallow carbonate platforms were already developed in Bajocian to Callovian times indicating the onset of a regression that would intensify in the Late Jurassic. In the Algarve basin, although subsidence also continued, the sea remained relatively shallow over a well developed carbonate platform. Mainly dolomites, marls and marly limestones were deposited during the Late Lias followed mostly by limestones, often of reefal facies, and marls during the Dogger.

Regional uplift occurred during late Callovian to early Oxfordian times in the Porto and Lusitanian (and probably also in the Alentejo) basins but subsidence resumed at high rates in the Upper Oxfordian with abrupt influx of coarse continental clastics during the Kimmeridgian reflecting the initiation of a second rifting phase that lead to the final separation of the Iberian and North American plates in the Aptian. Deposition of mainly terrestrial clastics proceeded during the Early Cretaceous over most of the Lusitanian and Porto basins. Only in the south of the Lusitanian basin continuous marine conditions persisted through the Late Jurassic

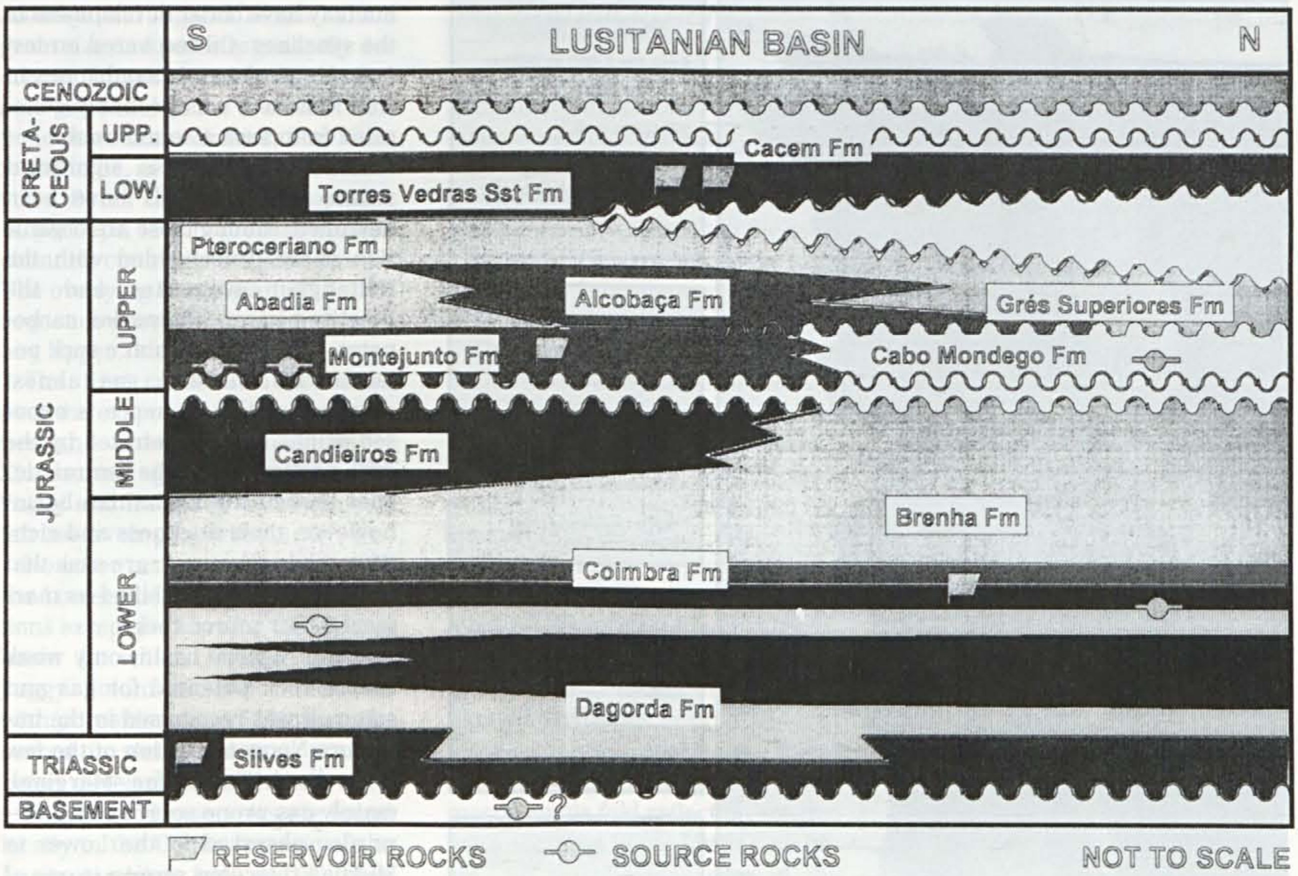


Fig. 2. Generalised stratigrapy of the Lusitanian Basin.

and into the Cretaceous; elsewhere a major unconformity separates the sediments deposited during these times. As subsidence resumed, a shallow transgressive sea spread over the basins during the Cenomanian-Turonian depositing marls and limestones.

In the Algarve basin, more or less continuous shallow marine conditions also prevailed during the Late Jurassic and the Early Cretaceous and there is no clear evidence of a second phase of rifting.

The Cretaceous transgression reached its maximum in the Cenomanian, after which most of the basins were uplifted. Only in the north of the Lusitanian basin and in the Porto basin, sedimentation continued into the Turonian and Senonian.

The sub-volcanic massifs of Sintra, Sines and Monchique were emplaced during the Late Cretaceous and seem to have slightly preceded the extrusion of the Lisboa basalts. These episodes of igneous activity may be related to the rotation of Iberia due to the opening of the bay of Biscay.

During the Paleogene, sedimentation was mainly restricted to continental clastics deposited in the south-eastern Lusitanian basin and shallow marine clastics and carbonates mainly deposited in the northern Lusitanian and the Porto basins. Thin carbonates, sometimes interbedded with sands and shales, were deposited in the deeper Algarve basin.

The Neogene corresponds to subsidence and marine transgression in all basins, particularly in the southern Lusitanian and, especially, the Alentejo and Algarve basins where thick shallow marine to terrestrial carbonates and clastics accumulated.

As a result of the collision of the African and Eurasian plates, the first compressional movements (Pyreneean phase of the Alpine orogeny) were felt in the Eocene and lead to basement shortening and basin inversion, especially in the northern Lusitanian and Porto basins. In contrast, the Miocene Betic phase affected mainly the southern Lusitanian, Alentejo and Algarve basins. Most of the structure of the sedimentary fill of the basins as the result of these compressional episodes was controlled by pre-existing Hercynian basement faulting and was often amplified by halokinesis which, in extreme instances, led to the formation of diapirs that pierced through the entire sedimentary cover.

Hydrocarbon generation

Hydrocarbons - mainly oil - were generated in significant quantities in the Lusitanian and Porto basins as evidenced by the numerous surface manifestations and/or well shows. In the Algarve basin, the

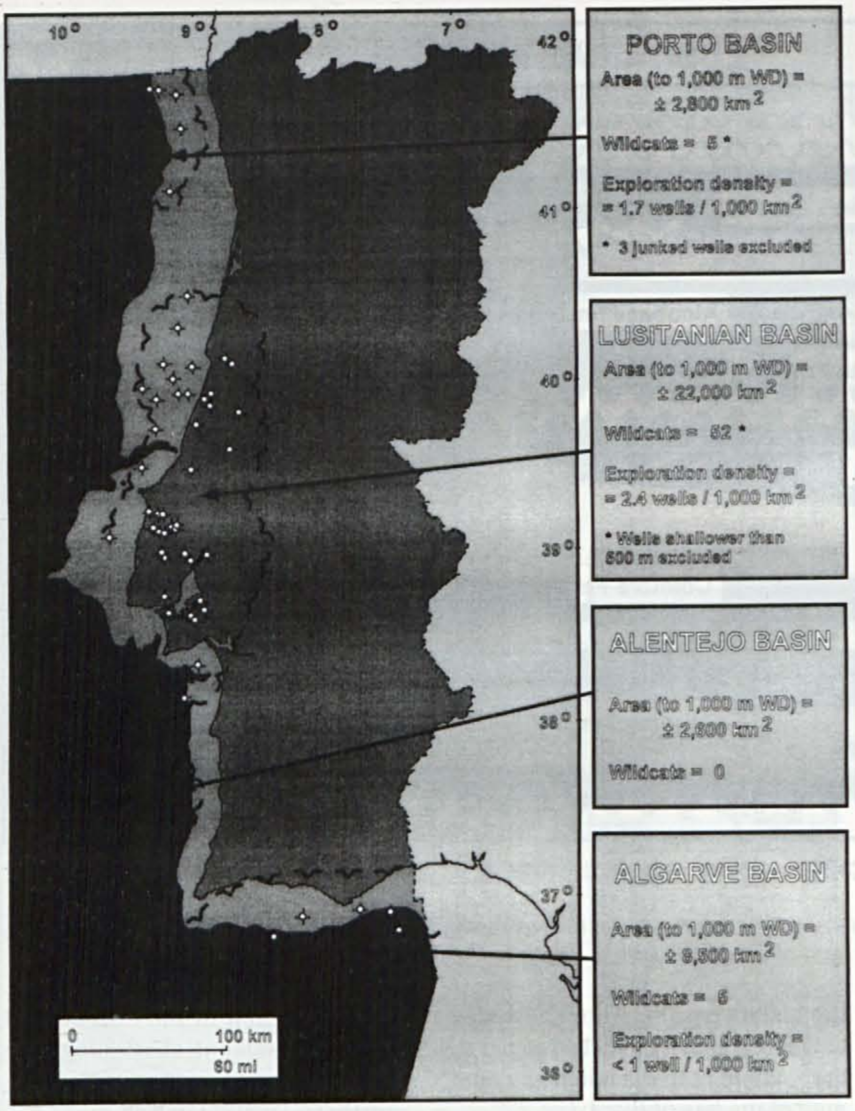


Fig. 3. Areal extent of sedimentary basins and drilling density.

evidence is less convincing although weak gas and/or oil shows were seen in 2 out of the only 5 wells drilled to date. Nothing can be said about the Alentejo basin which lies strictly in the offshore and has never been drilled.

Rich, oil prone, deeper marine paper shales have been identified in the Lower Jurassic (upper Sinemurian-lower Toarcian) of the northern Lusitanian basin, both in wells and on outcrop. Light, low sulphur oil recovered on test from wells in the area has been generated by such source rocks. These organic rich shales seem to have been deposited in significant thickness in the main depocenters where euxinic conditions prevailed, while being absent or thin elsewhere. Marginal source rocks of about the same age and type have been observed in wells drilled in the Porto basin; it is probable that these are richer and better developed off-structure.

The Upper Jurassic sequence includes rich, oil prone upper Oxfordian source rocks in the southern Lusitanian basin. These source rocks occur as massive, deeper marine bituminous limestones both in wells and in outcrop and are responsible for the numerous oil seeps and impregnated rocks observed in the region as well as for the oil seen in many of the wells drilled in the area. In the northern Lusitanian basin, coastal to lacustrine bituminous limestones of similar age have shown locally minor oil source-rock potential in wells and on outcrop, but may have better development in the synclines. Oil recovered on test from Upper Jurassic sandstones in well Moreia-1 was probably generated from such a source rock.

Several other, less significant source rock intervals have been identified. Among these are organic rich shales interbedded with the Hettangian evaporites and the overlying lower Sinemurian carbonates, which show source rock potential for oil and gas almost everywhere the sequence is exposed or has been penetrated by the drill, particularly in the central, deeper part of the Lusitanian basin; however, their thickness and richness, where observed, are such that they can only be classified as marginal to fair source rocks.

In the Algarve basin, only weak source rock potential for gas and some oil was recognised in the immature Neogene section of the few (5) wells drilled so far. Marginal, mainly gas prone source rocks were also observed in the Lower to Middle Cretaceous section in one of these wells. Although these results are disappointing, it is felt that the presence of richer, better developed source rocks elsewhere in the basin can not be excluded, in view of the limited number of wells drilled to date. Particularly, the lower part of the Mesozoic section which was only penetrated by one well could contain potential source rocks by analogy with the Lusitanian basin.

In addition to the above mentioned source rocks, it may be speculated that the Upper Carboniferous coals and perhaps also the organic rich marine shales discussed in the context of the Hercynian basement of the basins, constitute potential source rocks for (mainly) gas in the Lusitanian, Alentejo and Algarve basins.

Reservoirs and seals

The coarse, red clastics of Late Triassic age which were first deposited in the basins show fair to good reservoir characteristics in outcrop along the rims of the Lusitanian, Alentejo and Algarve basins. Their grain size and porosity generally decrease, however, towards the basins' axes and in the few wells that penetrated these clastics, they were found to be, at best, mediocre reservoirs. Better reservoir development is, perhaps, locally present in river channels cutting through the basins. The overlying Hettangian evaporitic sequence provides ample sealing to any Upper Triassic reservoirs.

The first carbonates deposited over the evaporitic section, limestones and dolomitic limestones of Sinemurian age, include some thin vuggy and fractured intervals with fair reservoir properties.

No other reservoirs are known in the Lower and Middle Jurassic sections except perhaps for the Algarve basin in which Middle Jurassic vuggy dolomites and limestones with porosities up to 11% were observed in wells and may present better development elsewhere.

Fair to good reservoirs are found locally in the Upper Jurassic of the Lusitanian basin both as Oxfordian reefal carbonates and Kimmeridgian to Portlandian coastal clastics. The presence of similarly aged reefal build-up reservoirs is assumed in the Porto basin.

The Lower Cretaceous, mainly terrestrial friable sands and conglomerates which occur over most of the Lusitanian basin with a more or less constant thickness of some 300-400 m and porosities of up to 35% constitute an excellent reservoir. Seals for these sands could be provided by interbedded shale and/or by the overlying Cenomanian marls and marly limestones. Seeps and oil impregnations occur in outcrops of these sandstones pierced by salt diapirs in the northern Lusitanian basin onshore.

No significant reservoirs are known in the Cenozoic section in the Porto and Lusitanian basins. However, in the Algarve basin, good Miocene sand reservoirs with average porosities of up to 35% were drilled in several wells. Sandy limestones of the same age do also possess fair reservoir properties with up to 15% average porosity.

Exploration history

The earliest reference to hydrocarbons in Portugal dates from 1844 when a mining concession for asphalt was granted. The asphalt mine, located at the coast in the northern Lusitanian basin, exploited the most important of several occurrences of petroleum impregnated rocks in this basin.

The first exploration wells were drilled in the early years of the century. These were mostly very shallow wells located in the proximity of seeps, in both the northern and southern parts of the Lusitanian basin onshore.

A hydrocarbon exploration and production concession, covering most of the Lusitanian and Algarve basins onshore, was granted in 1938. The concession changed hands a few times but remained in force until 1969. During the life of the concession some 4,000 km of mostly single fold reflection seismic were acquired in the Lusitanian basin. No seismic was shot in the Algarve basin. Gravity surveys were carried out in both basins and a small magnetic survey was executed in the Lusitanian basin near Lisbon. A total of 68 wells was drilled in the Lusitanian basin, only 33 of which were deeper than 500 m. No wells were drilled in the Algarve basin. Many of the wells had strong shows and some of them achieved sub-commercial production.

After the relinquishment of the above concession, under a new oil legislation, the prospective areas on- and offshore were divided in rectangular blocks in a regular grid, and offered for bidding to the industry in general. This bidding round resulted in the signing of 30 contracts for offshore areas in 1973 and 1974. The last of these contracts was terminated in 1979. During this period, about 20,000 km of offshore seismic plus gravity and magnetics were acquired and 22 wells were drilled, of which 2 in the Porto basin, 14 in the Lusitanian basin and 3 in the Algarve basin. All wells were plugged and abandoned although some encountered good shows and/or produced significant amounts of oil on test (fig. 2).

After 1979 the rate of exploration decreased considerably at the same time that interest in the onshore returned: 12 offshore (3 in the Algarve basin and 9 in the Porto basin) and 15 onshore blocks (all in the Lusitanian basin) were the object of exploration contracts to the present (April 1997). During the period, about 4,000 km of offshore seismic and 2,000 km of onshore seismic were acquired; 13 wells were drilled of which 4 offshore (3 in the Porto basin and 2 in the Algarve basin) and 8 onshore (Lusitanian basin). Again, despite some good shows, no commercial discoveries were made during this period.

Currently, 2 oil companies are exploring in Portugal. The Swedish firm Taurus Petroleum AB, holds 3 offshore licenses in the northern Porto basin, adjacent to licences held across the border in Spain. They drilled a dry wildcat in 1995 and have plans for further drilling. In the central Lusitanian basin, Mohave Oil & Gas Corporation of the U. S. A. hold 3 licences since 1991 in the onshore and are currently preparing to drill their first exploration well.

Conclusions

A significant amount of exploration work has beew carried out so far in the Portuguese sedimentary basins (Fig. 3) although even the Lusitanian basin, the most explored one with a drilling density of 2.4 wildcats per 1,000 km^2, must still be considered underexplored. Results were often encouraging, and there is no question about the presence of all the necessary ingredients (mature source rocks, sealed reservoirs, traps) for potential economic acumulations. However, these ingredients have not yet been found in the right combination and no commercial production has been yet achieved. Further exploration efforts are warranted as attested by the companies which continue to find worthwhile to invest in Portugal.

LA NORMA ESPAÑOLA DE BALASTO FERROVIARIO: SU ADAPTACION AL PROYECTO DE NORMATIVA EUROPEA (C.E.N.)

Jesús Rodríguez
Geólogo. Master en Ingeniería Geológica. SERINCO, S.A.
c/ Añastro n.º 5 Bloque A-1.º izda. 28033 Madrid

Eur.Geol. Luis Suárez
Jefe de Geotecnia de la U.N. de Mantenimiento de Infraestructura de RENFE
Caracola, 22. Est. Chamartín. Madrid. España
Master en Ingeniería Geológica. Abogado.

Resumen

El Grupo Ad Hoc de CEN/TC154/SC-4/ denominado «Áridos para balasto de ferrocarril» está desarrollando la futura «Norma Europea para Balasto de Ferrocarril» relativa tanto a los ensayos como a las especificaciones técnicas. La compañía nacional de ferrocarriles española (RENFE)ha llevado a cabo un estudio sobre la aplicación de la futura norma europea a los balastos españoles.

Abstract

CEN/TC154/SC-4/ Ad Hoc Group «Aggregates for Railway Ballast» is developing the future «European Standard for Railway Ballast» concerning both test methods and technical specifications. Spanish national railway company (RENFE) has carried out a research on the application of the future European Standard to the Spanish ballast.

Rèsumè

Le groupe Ad Hoc CENT/TC154/SC-4/applé «Agrégats pour le ballast de chemin de fer» prépare la future «Norme européenne pour le ballast de chemin de fer» qui concerne les méthodes d'essai et les spécifications techniques. La compagnie nationales des chemins de fer espagnols (RENFE) a effectué des recherches sur l'application de la future norme européenne aux ballats espagnols.

El desarrollo y futura aplicación de la Directiva Europea de Productos de Construcción (Directiva 89/106/CEE) encauzará la vertebración de los diferentes reglamentos para homologar la calidad de los materiales de construcción.

La necesidad de armonizar los criterios de normalización de la calidad de los áridos destinados a balasto se ha articulado a través de dos niveles técnicos sucesivos en el tiempo. Primeramente, el Comité Especial D-182 del European Railway Research Institute (ERRI) de la Unión Internacional de Ferrocarriles (UIC) y el grupo «Ad Hoc Ballast», dependiente del subcomité SC-4 «Aridos con o sin ligantes hidráulicos», perteneciente al Comité Europeo de Normalización de Aridos CEN/TC-154.

Miembros del grupo ad hoc sobre ballasto. Reunión de Kirbuhel (Austria).

La representación española en el citado Grupo corre a cargo de la U.N. de Mantenimiento de Infraestructura de la Red Nacional de Ferrocarriles Españoles (RENFE), junto a la Dirección General de Ferrocarriles y Transportes por Carretera del Ministerio de Fomento y la Asociación Española de Fabricantes de Aridos (ANEFA).

NORMAS EUROPEAS	NORMAS ESPAÑOLAS
Análisis granulométrico por tamizado. prEN 933-1	Análisis granulométrico. N.R.V. 3-4-0.2.
Determinación de la forma de las partículas de los áridos. Indice de lajosidad (flakiness). prEN 933-6	Determinación de elementos de espesor máximo. N.R.V. 3-4-0.2.
Determinación de la forma de las partículas de los áridos. Indice de forma (shape). prEN 933-4	Determinación de los elementos aciculares N.R.V. 3-4-0.2.
Determinación de los finos. prEN 933-10	Ensayos de limpieza del balasto. N.R.V. 3-4-0.2.
Determinación de la resistencia a la fragmentación. Ensayos de Los Angeles prEN 1097-2	Ensayo de desgaste Los Angeles. N.R.V. 3-4-0.2.
Determinación de la densidad aparente y de la porosidad intergranular. prEN 1097-3	Densidad aparente de los áridos. N.L.T. 156/72
Determinación de la densidad de las partículas y de la absorción de agua. prEN 1097-6	Aridos para hormigones. Determinación de las densidades, porosidades, coeficiente de absorción y contenido en agua del árido grueso. UNE 83-134-90
Determinación de la resistencia al hielo-deshielo. prEN 1367-1	
Ensayo del sulfato de magnesio. prEN 1362-2	Ensayo del sulfato de magnesio. N.R.V. 3-4-0.1.
Ensayo de ebullición. prEN 1367-3	

Tabla 1. Comparación de ensayos.

RENFE ha desarrollado el marco normativo de referencia en el ámbito español, cuyas normas y pliegos de prescripciones técnicas han sido tradicionalmente utilizadas, de forma genérica, por el resto de empresas y administraciones ferroviarias involucradas en la ejecución de obras de infraestructura ferroviaria; estas normativas españolas son las siguientes:

P.R.V. 3-4-0.0 4™ edición «Pliego de Prescripciones Técnicas y Administrativas para el Suministro y Utilización del Balasto.» (septiembre, 1996)

N.R.V. 3-4-0.1 «Balasto. Homologación de canteras suministradoras.» (en fase de encuesta)

N.R.V. 3-4-0.2 «Balasto. Control de Calidad. Toma de muestras y ensayos.» (diciembre, 1996)

Con objeto de llevar a cabo un estudio comparativo del documento técnico final «Especificaciones Técnicas para Balasto Ferroviario», aprobado el 3 de marzo de 1997, en Munich, por el Grupo Ad hoc «¡ridos para balasto ferroviario» del Comité Europeo de Normalización (C.E.N.), con el P.R.V. 3-4-0.0. 4™ edición reseñado anteriormente, RENFE ha dirigido el estudio de investigación titulado «Análisis comparativo teórico y experimental de las Normativas P.R.V. y C.E.N».

La investigación realizada ha contemplado un estudio pormenorizado del documento técnico final y las Normas Españolas, así como también la realización de una serie de ensayos de laboratorio, según las prescripciones de los proyectos de Normas Europeas y las normas de ensayo homólogas contempladas en las Normas N.R.V. 3-4.0.1 y 3-4.0.2.

La Tabla 1 recoge los proyectos de normas de ensayo europeas del CEN y las Normas españolas que se consideran análogas o comparables, habiéndose efectuado la totalidad de los ensayos europeos y españoles que se indican, sobre una población integrada por 10 muestras procedentes de canteras homologadas por RENFE y que muestran una óptima representatividad, tan-

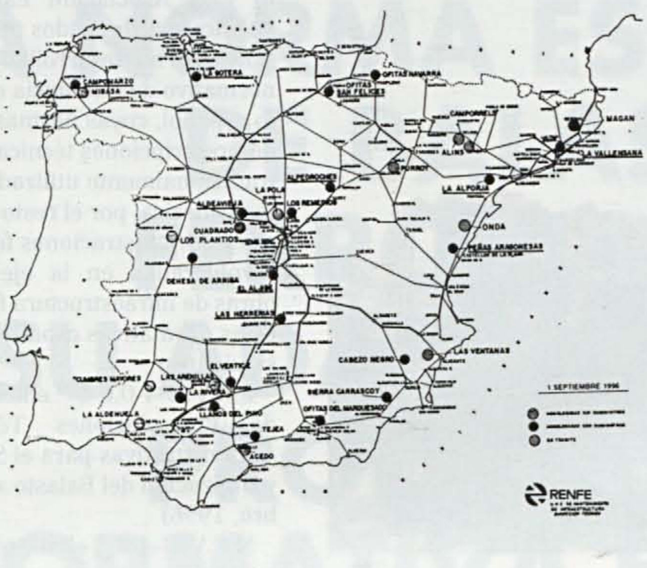


Figura 1. Situación de canteras.

to petrológica, como geográfica Figura 2).

El estudio comparativo se ha estructurado en tres grupos genéricos de determinaciones: Propiedades Geométricas, Propiedades Físicas y Mecánicas, y Propiedades Térmicas y de Meteorización.

Propiedades geométricas

La caracterización geométrica de los áridos comprende la distribución de tamaños y la caracterización de la forma de las partículas.

Análisis granulométrico.

La diferencia fundamental entre los procedimientos analíticos de las Normas españolas y europeas radica en el tipo de tamices que se emplean, cuyas aberturas tienen geometría cuadrada en tamices europeos mientras que en las Normas españolas tienen agujeros circulares variando, así mismo, el tamaño nominal de las mismas, con respecto a la serie UNE empleada en la norma N.R.V. 3-4-0.2.

Los resultados obtenidos por ambos procedimientos no son directamente comparables entre sí, si bien se debe destacar el buen grado de adaptación de las curvas granulométricas de los ensayos efectuados sobre balasto español al huso granulométrico europeo, con muy ligeros a ligeros incumplimientos, que fundamentalmente ocurren en el porcentaje de material que se pasa por el tamiz # 40 mm.

Con objeto de contrastar la validez del huso granulométrico definido en el P.R.V. 3-4-0.0., se ha elaborado manualmente en laboratorio, sendas muestras de 40 kg.. de balasto, conformes a los límites superior e inferior de dicho P.R.V., que posteriormente se han tamizado conforme al proyecto de ensayo europeo. La figura 2, que refleja los resultados, pone en evidencia unos ciertos incumplimientos en las clases pasantes por el # 40 y 22.4 mm., mientras que en el resto no se aprecia incumplimiento alguno.

Indice de Lajosidad

Este ensayo está establecido como el método de referencia, en el marco europeo, para caracterizar la forma del árido grueso, entendiendo una partícula como lajosa aquella cuya dimensión mayor es superior a tres veces la dimensión ortogonal menor. El valor medio obtenido es de 4.2%, siendo el valor máximo y más desfavorable de 8.2%, que representa casi la mitad del límite 15%, correspondiente a las especificaciones europeas. Con respecto al valor medio obtenido el límite europeo del 15% es casi el triple.

Solamente se ha encontrado buena correlación en el ensayo español de Determinación de Elementos Aciculares y Lajosos (N.R.V. 3-4-0.2).

Indice de Forma

Este ensayo se considera como una metodología alternativa para caracterizar la forma del árido grueso.

Figura 2. Análisis granulométrico comparativo entre husos españoles y europeos.

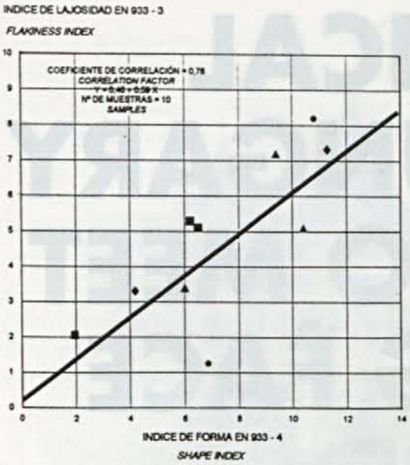


Figura 3. Representación gráfica de los resultados de los ensayos de determinación de los índices de forma (Shape) y lajosidad (Flakiness).

La media de los ensayos del Indice de Forma es de 7.36%, con un máximo de 11.3%, que representa casi la mitad del límite de 20% de las especificaciones europeas. Con respecto al valor medio 7.36%, este límite es casi el triple. Los resultados de este ensayo muestran una buena correlación con el ensayo español de determinación de Elementos Aciculares y Lajosos (N.R.V. 3-4-0.2).

La Figura 3 refleja el buen grado de correlación que existe entre los ensayos de determinación del Indice de Lajosidad (Flakiness Index) y Forma (Shape Index), que corrobora la validez de ambos ensayos para caracterizar la forma del árido grueso.

Determinación de los Finos.

Se han efectuado ensayos por partida doble, con la finalidad de determinar el contenido de finos sobre muestras de áridos, tal como llegan de la cantera y sobre las mismas, lavando los finos adheridos a la superficie.

Se observa un incumplimiento generalizado en las determinaciones efectuadas sobre áridos con superficie lavada, cuyos valores medios superan el doble de los límites de tolerancia europea, incumplimiento que no se aprecia en ninguna de las determinaciones que se han efectuado sobre las muestras sin lavado.

Longitud de las partículas.

El valor medio obtenido es de 2.52% que muy ligeramente excede la mitad del límite 5% de las prescripciones europeas. El máximo valor obtenido es 8.1% que excede el límite citado; por el contrario, el mínimo es 0%.

Propiedades físicas y mecánicas

Resistencia a la Fragmentación: Ensayo de Los Angeles.

Ambos marcos normativos, español y europeo presentan metodologías similares, salvo en los tamices utilizados y la carga abrasiva que se dispone.

Con respecto a las prescripciones europeas se observan tres casos de ligero incumplimiento con un máximo del 17.9% que excede el límite de 15% para la categoría A. El valor medio 12.83% es inferior al mismo.

Densidad de partículas y absorción de agua.

Los procedimientos analíticos de ambas normativas muestran una fuerte analogía, apreciándose una óptima adaptación a las prescripciones europeas. En el caso de la absorción de agua, cuyo límite es 1%, sólo se ha excedido en un caso.

Densidad Aparente y Porosidad intergranular.

No existiendo prescripciones técnicas en la referencia normativa europea, sólo cabe apuntar la fuerte similitud existente entre los procedimientos analíticos europeos y españoles.

Propiedades térmicas y de meteorización

Resistencia al sulfato de magnesio.

El ensayo europeo deriva de la misma metodología analítica, que sirve como referencia para el ensayo español, por lo que ambas metodologías se consideran homólogas.

El valor medio obtenido es 0.54%, superando el 1% en una única ocasión. En ningún caso se alcanza ni siquiera la cuarta parte del límite inferior del 8% de las prescripciones españolas, margen de referencia que necesariamente se toma en consideración, dada la ausencia de límites establecidos en las prescripciones europeas.

Resistencia al hielo-deshielo.

Este ensayo se ha realizado exclusivamente sobre las muestras que registraron los valores de absorción de agua más elevadas, obteniéndose unas variaciones que se consideran nulas a efectos prácticos.

Ensayo de ebullición.

Se trata de un ensayo que se efectúa exclusivamente sobre áridos de origen basáltico con efecto de evaluar la posible aparición del proceso «sonnebrand», ligado a la presencia de sulfuros metálicos como componentes mineralógicos de la roca.

Este ensayo evalúa la pérdida de masa en árido y de resistencia en probetas de roca, tras ser sometidas a ebullición. En ambos casos no se ha apreciado pérdida alguna, tanto en masa, como de resistencia.

Conclusiones

En líneas generales, *el actual balasto español muestra una adecuada adaptación a las especificaciones técnicas de la futura Norma Europea,* observándose *ciertos incumplimientos en las tolerancias granulométricas* (clases pasantes por # 40 y 22.4 mm.) *y en* valores de resistencia al desgaste mediante *el ensayo de los Angeles, cuyo límite europeo (15%) es más restrictivo.*

Por el contrario, se observa *un incumplimiento generalizado en el contenido en finos* cuando el tamizado que se realiza sobre la muestra, incluye el lavado del polvo adherido a la superficie del árido.

THE GEOLOGICAL INSTITUTE OF HUNGARY (MÁFI): READY TO MEET THE CHANGING FACE OF EUROPE

by Károly Brezsnyánszky[1]–Annamária Nádor[2]
Geological Institute of Hungary (MAFI) H-1442 Budapest, Stefánia ut 14. Hungary

Abstract

The Geological Institute of Hungary (Magyar Állami Földtani Intézet – MÁFI) has been in existence for more than 125 years, making it one of the oldest surveys in Europe. This fact alone, however, does not guarantee its right to survival in the rapidly changing face of Europe. Like all geological surveys of Europe, MÁFI has to adapt its services and products to the needs of the national and international markets, while at the same time preserving its professional and academic integrity, by pursuing a line of fundamental research, and maintaining it position as archiver of the geological past of the nation.

In this paper we present a brief resumé of MÁFI's history and core activities, before discussing the steps taken now and in the past.

Resumen

El instituto Geológico Húngaro (Magyar Állami Földtani Intézet-MÁFI) lleva funcionando más de 125 años, por lo que es uno de los servicios geológicos europeos más antiguos. Este hecho exclusivamente no garantiza su derecho a la supervivencia en esta Europa de cambios vertiginosos. Como todos los servicios geológicos de Europa, MÁFI tiene que adaptar sus servicios y productos a las necesidades de los mercados nacionales e internacionales, y al mismo tiempo conservar su integridad profesional y académica siguiendo una línea de investigación básica y manteniendo su posición como depositario del pasado geológico de la nación.

En este artículo se presenta un breve resumen de la historia de MÄFI y sus principales actividades, antes de pasar a discutir los pasos que se han seguido ahora y en el pasado.

Résumé

L'Institut Géologique Hongrois (Magyar Allami FFoldtani Intézet-MAFI) fonctionne depuis 125 ans, il est en cela un des plus anciens services géologiques d'Europe. Ce seul fait ne garantit pas son droit a la survie dans cette Europe aux changements vertigineux. Comme tous les services géologiques européens, MAFI doit adapter ses services et ses produits aux nécessités des marchés nationaux et internationaux, et en méme temps conserver son intégrité professionnelle et académique en poursuivant un but de recherche fondamentale et en maintenant son statut de dépositaire du passé géologique de la nation. Cet article présente un bref résumé de l'histoire du MAFI ainsi que ses principales activités avant de discuter les chemins suivis aujourd'hui et dans le passé.

Origins

The Geological Institute was founded on June 18th 1869 by Emperor and King of Hungary, Franz Joseph I, who later in October 1899 inaugurated the palatial building, designed by Ödön Lechner, in Budapest in Stefánia Street. This has been the unbroken headquarters of MÁFI from that day to the present (Fig. 1).

The character of the Geological Institute laid down four fundamental tasks which were to form the basis of MÁFI core activities up to 1992. These tasks were:

- A detailed geological survey of the lands of the Hungarian crown along with the publication of the results corresponding to the demands of science, agriculture and industry.

[1] Director of the Geological Institute of Hungary.
[2] External Relations, Geological Institute of Hungary.

Fig. 1. The headquarters of the Geological Institute of Hungary.

- To compile and publish general and detailed geological maps of the territory of the Hungarian state.
- Establish petrographical and palaeontological collections to demonstrate the geological build-up of the country.
- To make chemical analyses of soils, minerals and rocks used for agricultural, mining and industrial purposes.

Efforts have always been made to keep these tasks central in the activities of MÁFI, but some compromises have had to be reached in the past decennia in order to balance research activities with the requirements of the annual budgets.

Core activities

As with any geological survey, MÁFI tries to embrace all aspects of earth sciences and their relationship to the Hungarian state. Through the past 127 years it can be said that a broad multidisciplinary view of earth sciences has been maintained, so that disciplines which are fundamental in their research have been supported as equally well as those which are of a more applied nature. Changing requirements of society and industry means, however, that the emphasis of products from MÁFI has shifted from exploration maps for metallic raw materials in the first 100 years of the survey to a current focus on engineering geology, agro- and limnogeology, environment, hydrocarbons and thermal waters. This change reflects the change of emphasis in those earth science products which can generate funding. Some of the main activities are summarised below:

Geological mapping

A fundamental reappraisal of policy towards geological mapping and its value to earth sciences as practised by MÁFI had to be made over the past years. The question to be answered was if geological mapping could still be function as core activity. A new perspective has been defined to allow a maximum continuation of this historically important activity, while at the same time working under tighter restrictions imposed by budgetary considerations. The advent of Geographical Information Systems (GIS) at the beginning of the nineties led to the concept of developing a unified geological map system for the territory of Hungary. The aim of this project is to provide maps of a uniform, high quality, on a scale of 1:100000 for the whole country, thereby replacing the largely heterogeneous sets of maps issued in older times. Previously published maps need updating and revision, and must be prepared for computer processing. The digitised map series will be linked to the geological database, thereby achieving a multifunctionality.

Hydrocarbon exploration and basin analysis

Basin analysis is the largest single project undertaken by MÁFI, and started in 1992, quickly becoming one of the most effective tools for interpreting the subsurface geology of the rock units which cover the majority of the Hungarian land surface. The Pannonian basin is the largest and most important in Hungary, formed more than 10 Ma ago, and responsible for 95% of petroleum and natural gas production, as well as contributing the major part of drinking and thermal waters in Hungary. Basin analysis forms one of the main aspects of hydrocarbon resource assessment, since the formation, maturation and migration of hydrocarbons is governed by the basin geometry and geology. A major survey of hydrocarbon reserves in Northern Hungary has been performed by MÁFI. This two phase project covered an area in excess of 15000 sq. km.

Geochemical research

The analytical laboratories of MÁFI have been operational for more than 100 years, providing geochemical data on rocks, minerals and water. In the past few years research into environmental geochemistry has become one of the spear point activities of MÁFI. This means that water rock samples are now also collected with a view of understanding their environmental parameters. Anthropogenic effects of the environment can be deduced and evaluated by studying the surface and subsurface using geochemical tools. Ongoing geochemical water and rock surveys pay particular attention to the environmental aspects of the data.

Another important aspect of geochemical work carried out by MÁFI is the correlation of hydrocarbons with their source rocks, the interpretation of thermal genesis, and migration processes of hydrocarbons in molasse basins, which is now performed using computer modelling.

Environmental geology

Thematic vulnerability maps have been compiled for some regions of Hungary on a scale of 1:100000 and 1:500000 map was completed for the entire country in 1988. The department has looked at present and former sources of pollution, such as waste disposal, mine tailings, industrial waste control. A computer database of environmental contamination has also been established.

Limnogeology

Lake Balaton is the largest and most beautiful of the lakes in Hungary but over the past decennia a number of problems have become apparent. These include the steady silting up of the lake, increasing eutrophication, and disturbed ecological balance. While these, in part be natural processes resulting from the ageing of the lake, they can also be brought on, or accelerated by anthropogenic processes. The paleoevolution of the lake, including paleoecology and paleoclimate changes have been investigated by sedimentological, hydrological, geochemical, paleontological and isotope studies. Although the lake water was originally clear, meso- and eutrophic conditions have gradually become predominant. The volume of unconsolidated mud on the lake floor is estimated to be 2.5 to 3 cubic km, about 1.5 times the volume of water in the lake, indicating the lake has entered its senile phase. All the results from previous and ongoing research can be used to develop a model for the long term evolution of the lake, and help in suggesting which remedial measures should be implemented to regenerate Lake Balaton.

Agrogeology

This discipline is the study of soil–rock–water system in its totality, taking into account the effect of natural processes as well as anthropogenic effects such as irrigation, use of fertilisers, cultivation practises, and the interaction with the biosphere. Agrogeological studies are carried out in order to investigate and evaluate a number of type areas in the Great Hungarian Plain. The results can also be used to guide or formulate remediation measures. Soil amelioration also falls under agrogeology, since the use of environmentally friendly, natural soil improvers is a major aspect of agriculture in Hungary. These soil improvers include alginite, zeolites, basalt, dolomite and limestone.

Information technology

The technological revolution sweeping through all branches of sciences has meant that MÁFI has also had to adapt to keep up with the pace of change. The management of earth science related GIS databases which will be used to produce thematic maps for numerous applications by society, industry is now one of the main fields being developed by MÁFI. GIS map production system is currently used for both large scale and small scale projects. The related databases are designed to support such diversed topics as regional environmental issues, or municipal digitising and processing techniques. In all cases the highest standards and quality are maintained, producing clean line work for analysing and cartographic purposes.

Reorganisation maintain efficiency

The political and economic reforms instigated in 1989 led to a rapid change in the relationship between organisations such as MÁFI and the Hungarian state which until that time had been an uncritical financier. The dismantling of a centralised economy meant that the State could no longer avail itself over unlimited funds, and therefor no longer had the means to fund MÁFI or similar organisations as it had done in the past. Drastic and uncoordinated reductions of State funding have allowed, with little time for new sources of funding to be defined and tapped. A direct consequence of budgetary reductions was the internal reorganisation which was carried out in 1992, resulting in a cut in personnel from 525 to 145, matching a drop in State funding from 344 Mft to 192 Mft annually. To maintain the activities performed by MÁFI, six new divisions were created, in addition to the Museum, Library and Informatics departments (Fig. 2).

The new directorate maintains a watchful eye over the activities of the six divisions. Each division is responsible for a number of cost effective projects in which budgets are carefully monitored to ensure efficient production of results for the end users.

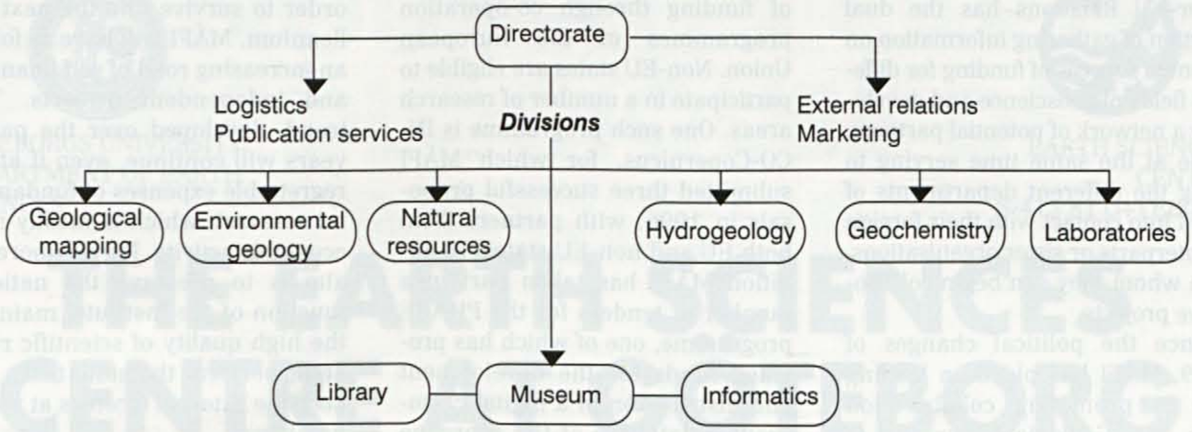


Fig. 2. The organigram of Maics.

Economics versus research

To survive the tide of economic fluctuations it is essential that MÁFI develops and maintains a degree of financial independence from governmental funding. A policy of actively seeking external funding has been vigorously pursued over the past 5 years, and it is continued by the current directorate. In 1991 about 10 % of the annual MÁFI budget came from external sources. 5 years later this amount had been increased to 45 % due solely to the efforts of the staff (Fig. 3).

International co-operation

The Geological Institute of Hungary has, since it was created in 1869, considered co-operation with international organisations to be essential for the exchange and development of scientific knowledge, as well as for the dissemination of

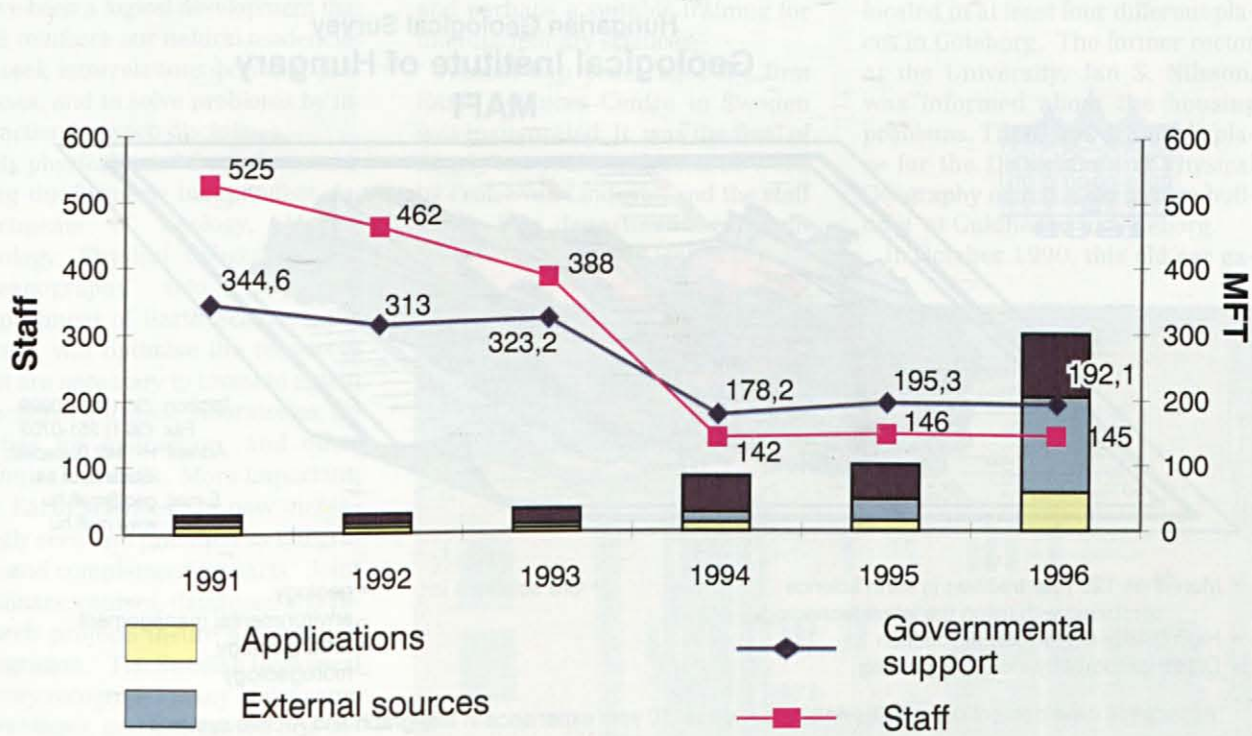


Fig. 3. Finances and staff in Maics.

Hunga-rian expertise. The Office for Exter-nal Relations has the dual function of gathering information on potential sources of funding for different fields of geoscience and developing a network of potential partners, while at the same time serving to bring the different departments of MÁFI into contact with their foreign counterparts or sister organisations, with whom they can begin collaborative projects.

Since the political changes of 1989, MÁFI has played a leading role in promoting collaboration with the Geological Surveys of Europe. MÁFI has held the chair of FOREGS and hosted the annual meeting in Budapest in 1996.

A reduction in government funding of MÁFI has meant that external sources of finance must be found in order to undertake new projects. One of the main activities of the Office for External Relations is therefor to explore the potential of funding through co-operation programmes of the European Union. Non-EU states are eligible to participate in a number of research areas. One such programme is INCO-Copernicus, for which MÁFI submitted three successful proposals in 1996, with partners from both EU and non-EU states. In addition MÁFI has taken part in a number of tenders for the PHARE programme, one of which has provided funds for the development and distribution of a digital cartographic database of the shoreline area of Lake Balaton.

Máfi and the future

Reductions in government funding have continued this years, demonstrating once more that it is impossible to place any reliance on this source of funding. It is clear that in order to survive into the next millennium, MÁFI will have to follow an increasing road of self financing and independent projects. This trend, developed over the past 5 years will continue, even if at the regrettable expenses of fundamental research which is mostly non-economic activity. Furthermore the aim is to preserve the national function of the Institute, maintain the high quality of scientific research, perform the state tasks and keep the external incomes at an optimal level.

Publications of MÁFI

- Annual Report
- Annales (Yearbook)
- Geologica Hungarica
- Special Issues
- Geological maps

GÖTEBORGS UNIVERSITY
DEPARTMENT OF EARTH
SCIENCES

EARTH SCIENCES
CENTRE
S-413 81 G÷TEBORG

THE EARTH SCIENCES CENTRE AT GÖTEBORG UNIVERSITY IN SWEDEN

Jimy Shgh & Jan Brouzell
Göteborg University, Department of Earth Sciences. S-41381. Göteborg, Sweden

Research and educational knowledge in the Earth Sciences is, by the nature of the earthis systems, interdisciplinary. Therefore the construction of the new Earth Sciences Centre have been a logical development that will reinforce our natural tendencies to seek interrelations between processes, and to solve problems by interaction between disciplines.

By physically and formally combining the formerly independent departments of Geology, Marine Geology, Physical Geography and Oceanography into the new Department of Earth Sciences, the faculty will optimise the resources that are necessary to invest to obtain functional libraries, laboratories, facilities for instruction, and other technical services.. More important, the Earth sciences are now increasingly seen and practised as integrated and complementing parts. Joint seminars, courses, databases and research projects insure a continued integration. The Swedish Geological Survey recognised many of the same advantages, and also moved into the Earth Sciences Centre. However, there are problems that relate to this reorganisation, but these are quite similar to those that have been common over the last 20 years of rapid expansion and changing departmental character. Geology and Marine Geology did not even exist before this period. Coping with instability is both distractive and stimulating, and perhaps a suitable training for interdisciplinary sciences.

Almost two years ago, the first Earth Sciences Centre in Sweden was inaugurated. It was the final of nearly ten years enthusiastic work by Prof. Sven Lindqvist and the staff at the four departments in Earth Sciences at Göteborg University.

Prof. Sven Lindqvist was installed as professor in Physical Geography at Göteborg University in 1984. The year after, plans were taken in purpose to solve the housing for the Department, which at that time was located in at least four different places in Göteborg. The former rector at the University, Jan S. Nilsson, was informed about the housing problems. There was a suitable place for the Department of Physical Geography on top a car garage building at Guldheden in Göteborg.

In October 1990, this old car ga-

rage-building had received a new look with yellow bricks on the fourth floor. Modern localities for the Department of Physical Geography were secured.

The same year, Prof. Sven-≈ke Larson and Prof. Jimmy Stigh, both at the Department of Geology, made their interest very clear, that the Department of Geology was in need of new localities. Geology was by then a joint department between Göteborg University and Chalmers University of Technology.

Planning begun for a quite new building next door to Physical Geography with localities for the three other departments in Earth Sciences. In September 1995 the new complete Earth Sciences Centre with all departments inaugurated during a whole week. The final day of this was an open house for the public. This day the staff and the students demonstrated their research and teaching. We had planned for about 400 visitors - over 1 200 visited our centre this very hectic and stimulating day. Weeks after we had a lot of telephone calls from students who were interested to study Earth Sciences.

The teaching and research in Earth Sciences at the University has an intensive and interesting history. Except from Oceanography and Physical Geography - Geology and Marine Geology are fairly young subjects About ten years ago the teaching and research in Earth Sciences were questioned, not only at Göteborg. The Swedish Governmentís national board for higher education started an investigation of all-academic teaching and research in Sweden. After the investigation it was clear that, specially the teaching at Bachelor and Master level in Earth Sciences at Göteborg University had very good results and also a very good reputation among employers in the field of Earth Sciences.

During the last ten years, the total amount of undergraduate students has more than doubled. This tendency has even increased during the most recent years, especially since the Earth Sciences Centre was opened. Students from other universities in Scandinavia move to Göteborg to study Earth Sciences. The new and stimulating environment in the Centre could be compared with a university campus, where close contacts between staff and students will result in a successful research and teaching.

More information of the Earth Sciences Centre at Göteborg University can be given by Prof. Jimmy Stigh, tel +46 31 773 2802, Email: Jimmy@geo.gu.se or from careers and study adviser Jan Brouzell, tel +46 31 773 1954, Email: Jan@gig.gu.se

LES NOUVELLES CARTES GEOLOGIQUES DE BELGIQUE

by M. LALOUX, P. LAGA, A. COPPENS
UBLG (Union Belgo-Luxembourgeoise des Géologues)

Abstracts

A new geological of Belgium is being prepared both in Flandes and in Wallonia, the old existing maps are aproximately dated in the last century. This paper displays the organisation of this mapping and the technics used in its production and pointes out the state of advancement of those projects at the beginning of 1997.

Resumen

Se está realizando un nuevo mapa geológico de Bélgica tanto en Flandes como en Balonia, los antiguos mapas datan aproximadamente del fin del siglo pasado. El presente artículo presenta la organización de dicha cartografia y los medios técnicos utilizados en su realización y destaca el estado de realización de dichos proyectos a principios de 1997.

Rèsumè

Une nouvelle cartographie géologique de la Belgique est en cours tant en Flandre que en Wallonie, les anciennes cartes datant parfois de la fin du siècle dernier. Cet article présente l'organisation de cette cartographie, les choix techniques effectués pour leur réalisation et fait point sur l'état d'avancement de ces projets au début de l'année 1997.

La carte géologique de la Flandre

La nouvelle série de cartes géologiques de la Région Flamande, dont les travaux ont débuté en 1989, est le fruit de la collaboration entre le Service géologique de Belgique (SGB), le ministère fédéral des Affaires Economiques et le "gewestelijke Bestuur Natuurlijke Rijkdommen en Energie" (BNRE) du Ministère de la Communauté Flamande.

Le projet prévoit l'élaboration de 2 cartes géologiques au 1/50.000 par an, effectuées dans le cadre d'une collaboration contractuelle entre les institutions universitaires néerlandophones (Université de Gent, Université Catholique de Leuven) et le ministère concerné. Le choix de l'échelle 1/50.000, au lieu de 1/25.000 comme les anciennes, a divisé par quatre le nombre de cartes à effectuer. Ces cartes sont lithostratigraphiques et reprennent les formations géologiques sans leur couverture quaternaire qui fait l'objet d'une carte indépendante.

Le rythme élevé de production des nouvelles cartes (4 anciennes cartes par équipe et par année) impose que seules les données géologiques existantes soient utilisées et aucun forage additionnel n'est prévu. Il existe cependant un budget limité permettant de réaliser éventuellement quelques forages complémentaires qui amélioreraient sensiblement la qualité de l'une ou l'autre carte.

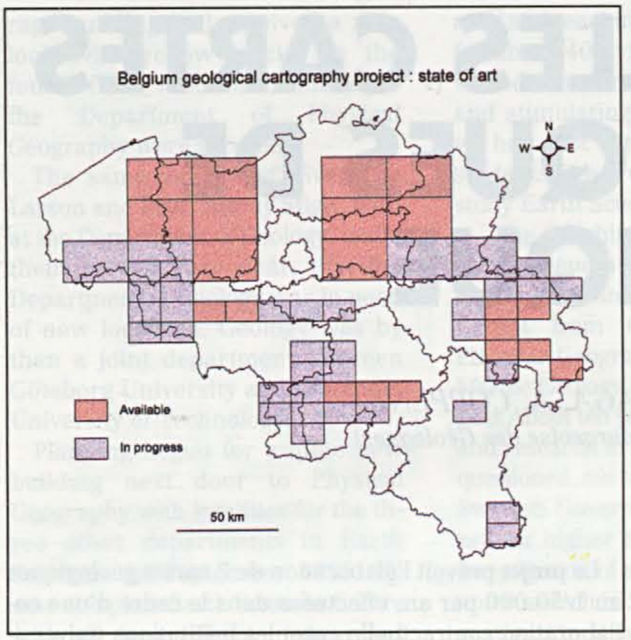
La réalisation de ces nouvelles cartes est l'occasion de créer une base de données rassemblant toutes les données géologiques employées et qui pourra être consultée par les utilisateurs. Cette base de données permettra une révision beaucoup plus facile et donc plus fréquente des cartes en fonction des nouvelles données disponibles.

Chaque carte est accompagnée d'un texte explicatif avec des itinéraires d'excursion et les descriptions des affleurements observables. Les légendes stratigraphiques des cartes sont rédigées en néerlandais, français, anglais et espagnol.

Actuellement 10 cartes sont terminées et en vente sur la vingtaine prévue, et 4 supplémentaires seront disponibles d'ici la fin de l'année 1997.

La carte géologique de la Wallonie

C'est en 1989 que l'Exécutif de la Région Wallonne a admis le principe d'une révision de la carte géologique associant le Service Géologique de Belgique et les quatre universités francophones. Après une période probatoire de deux ans, le projet est entré dans sa phase de production.



Un Comité de pilotage réunissant des représentants de la Région Wallonne, du Service géologique de Belgique, de l'Université Catholique de Louvain, de l'Université Libre de Bruxelles, de l'Université de Liège, des Facultés Polytechnique de Mons et de divers organismes fédéraux gère ce projet qui emploie actuellement 10 géologues, une dessinatrice et une dactylo sous contrats annuels. Collaborent à cette équipe plusieurs des géologues du service géologique et des professeurs d'université en activité ou honoraires.

Le principe de la cartographie en cours est lithostratigraphique (cartographie de formations) et inclut un nouveau levé de terrain avec la description et l'intégration de chaque affleurement dans une base de données informatique. L'exécution des nouveaux forages n'est envisagée que pour résoudre des problèmes géologiques particuliers.

Pour mener à bien le projet, la Région Wallonne s'est équipée d'un GIS (Arc-Info). Il permet la consultation interactive des cartes et des descriptions d'affleurements. Comme pour la Flandre, chaque carte est accompagnée de coupes géologiques et d'une notice explicative fournissant, entre autres, la traduction des légendes en néerlandais, anglais, et allemand. Des cartes et notices bilingues français-allemand sont prévues pour les feuilles situées dans la Communauté Germanophone.

Cette méthode de travail basée sur de nouveaux levés de terrain aboutit à une refonte complète des anciennes cartes mais impose un rythme relativement lent à la réalisation du projet. La cadence prévue est d'une carte au 1/25.000 par an et par équipe de deux géologues, soit 4 à 5 cartes par an. En tenant compte de diverses considérations, le coût total du projet a été estimé en 1991 à quelques 600 millions de FB et la durée à 30 ans pour les 142 cartes prévues, avec l'effectif initial de 8 géologues.

Le projet wallon est compétitif par rapport à d'autres projets européens au niveau de la qualité du travail de cartographie et de l'impression malgré les différences de moyens et de stratégies mis en oeuvre. Une de ses singularités est sa liaison avec une base de données des affleurements.

A l'heure actuelle, 7 cartes au 1/25.000 sont disponibles, 5 sont à l'impression et dix autres devraient être disponibles pour la fin 1997.

Conclusion

Les programmes de cartographie géologique en cours en Flandre et en Wallonie permettront de disposer d'une couverture cartographique complète et moderne de la Belgique au début du siècle prochain. Ces projets sont le fruit d'une collaboration entre le Service Géologique de Belgique, les régions Wallonne et Flamande, des organismes fédéraux et les universités francophones et néerlandophones. Les deux cartographies sont lithostratigraphiques et comprennent une base de données informatique. Cependant le projet flamand se base sur les données existantes alors que le projet Wallon est basé sur un nouveau levé de terrain.

A EUROPEAN GEOLOGIST'S EXPERIENCE IN SIBERIA

by Eurogeol Ed Slowey
CSA, Dublin, Ireland

Abstract

Working in Siberia might be a pleasant task if taken with the right attitude. The author describes his extraordinary experience in a place more a neighbourhood of Dublin than of Moscow, looking for gold in one of the largest underdeveloped gold deposits in the world: Sukhoi Log.

Not really a Gulag except for the drastic temperature changes outdoors (+30°C in summer to –42°C in winter), underground work was considered a frozen (sub-zero) paradise.

Resumen

Trabajar en Siberia puede ser una labor agradable si se toma con la actitud adecuada. El autor describe su extraordinaria experiencia, en un lugar más vecino de Dublín que del propio Mosú', buscando oro en una de los mayores depósitos sin explotar del mundo: Sukhoi Log.

No es precisamente un Gulag excepto por los drásticos cambios de temperaturas exteriores (de +30°C en verano a –45°C en invierno), por lo que el trabajo subterráneo se puede considerar un paraíso congelado.

Résumé

Travailler en Sibérie pourrait e·tre une t·che agréable a condition de la prendre du bon côté. L'auteur décrit son expérience extraordinaire dans un endroit plus proche de Dublin que de Moscou, ou il cherchait de l'or dans un des plus grands gisements d'or sous-développé dans le monde : Sukhoi Log.

Pas vraiment un goulag si ce n'est les changements drastiques de température extérieure (de + 30° en été A - 42° en hiver), le travail souterrain y était considéré comme un paradis glacé.

I had worked for most of my 20+ year career as an exploration and mining geologist based in Ireland, with some relatively short spells elsewhere in Europe. The time was opportune to spread my wings and I let it be known among my contacts that I was keen to expand my geographical horizons. I had in mind South America, Africa, perhaps Australia or SE Asia - somewhere warmer than Ireland.

I received a phone call from Pat O'Connor of the CSA Consultancy Group, based in Dublin, inviting me to meet with him regarding an overseas contract that was coming up shortly. Which of my chosen locations was it to be? Chile, Brazil, Tanzania? Well, not exactly. In fact, nowhere near - what would I think about a three month assignment in Siberia? I tried to sound enthusiastic and I must have convinced someone, because within a few days I was on my way to London to meet representatives from Steffan Robertson Kirsten of South Africa to discuss the project. They evidently did a good sales job because by the time I returned home I was quite enthusiastic

Surhoi log, Siberia underground.

Surhoi log, Siberia.

about the project. Besides, it was early July and the weather in Siberia would be quite warm.

SRK was carrying out a feasibility study on the giant Sukhoi Log gold deposit in Siberia on behalf of Star Mining, an Australian company which had formed a joint venture with the Russian company, Lensoloto. Underground bulk sampling for metallurgical testing had already been carried out by SRK and the next phase of the feasibility study called for completion of an underground channel sampling programme to confirm previous Lensoloto gold assays. A geologist was required to oversee this phase of the study. The main base was in the town of Bodaibo (population c.20,000), with the field base near the small town of Kropotkin, 130km to the north.

When I returned home I pulled out the atlas and spent many minutes looking for Bodaibo. My eye kept moving further and further to the right of Moscow until I the name suddenly jumped out at me. I was surprised to note that it was over 4,000 kilometres east of Moscow. In fact, in Dublin I lived nearer to Moscow than the citizens of Bodaibo. There was no going back on my commitment at this stage and, within a week, I was flying to Moscow via London, complete with summer clothes for outdoor wear and winter clothes for underground work. I had been warned that permafrost conditions prevailed underground, with temperatures averaging -3 to -4 degrees C.

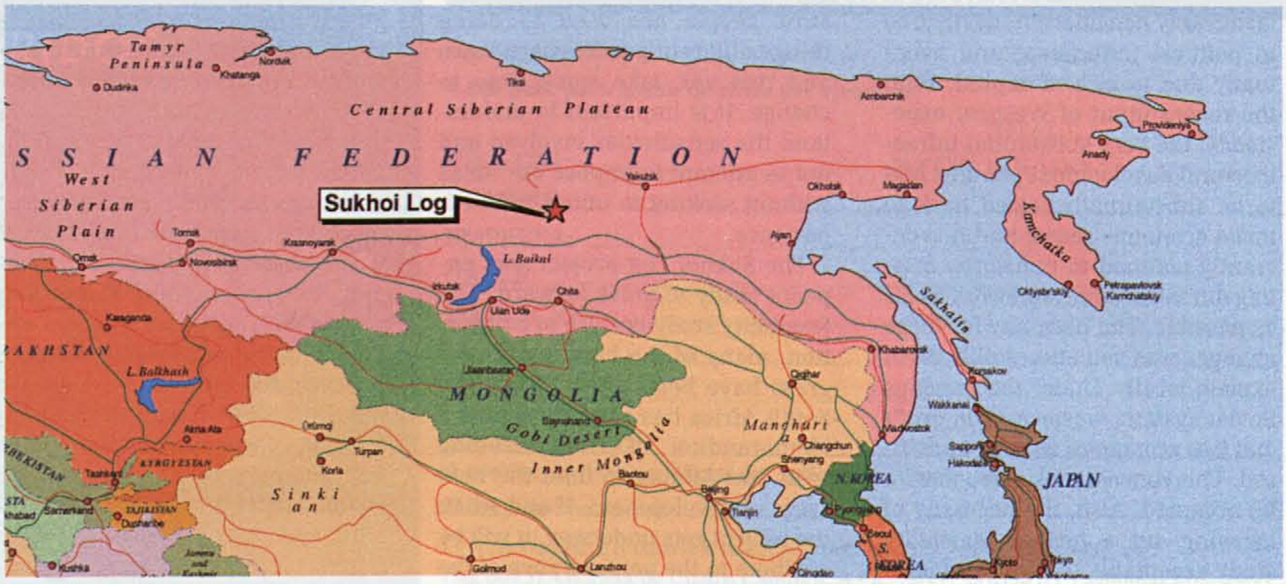
In Moscow I met up with a group of Chilean samplers and their supervisor who were to undertake the channel sampling. We had one very pleasant evening strolling around the tourist sites of Moscow. The next afternoon we boarded the 51/2 hours flight through the night to Irkutsk and then a 21/2 hour flight to Bodaibo. I had been told that Siberia could be warm in summer but I was not prepared for the midday heat that hit me as I disembarked from the plane. The temperature was close to 35 degrees C. There was one day to acclimatise in Bodaibo but, despite jet lag, I was not going to be allowed to depart from Bodaibo without sampling the delights of the local bar/disco and having my first sample of real Russian vodka. The 4 hour journey the following day to Kropotkin on Siberian 'roads' was to test my stamina to its limits, but, once I had survived that journey, I knew that things could only get better.

We stayed in a cottage attached to a small operating vein-gold deposit at Pervenets, about 10km from Sukhoi Log mountain. This was later to shut down because of falling head grades and other problems, but did prove a useful learning exercise for all involved. The cottage was to be 'home' for some time. It was fairly basic and, initially, overcrowded, but the food was good and the adjacent banja (Russian sauna) was welcome, especially as the weather turned colder.

The Sukhoi Log gold deposit occupies a long, low mountain at approximately 1,000m elevation within the Lena goldfield region. The resource is reported as 384Mt grading 2.5-2.7g//t Au, with a further possible 165Mt grading 2.0-2.3g/t Au. Additionally, there is a large, lower grade mineralisation envelope and the deposit is open down-dip. Sukhoi Log is, therefore, one of the largest undeveloped gold deposits in the world. A major open pit development is planned.

The deposit occurs within weakly metamorphosed Upper Proterozoic marine carbonaceous turbidite slates and phyllites. The main structural control is the Sukhoi Log anticline, which encloses the deposit. It is a large, reclining, almost isoclinal fold with its axis striking east-west and plunging at approximately 30 degrees to the north. The fold axis is exposed for 8.8km along the crest of Sukhoi Log mountain. Bedding is not always apparent but a strong axial planar cleavage is developed. Several generations of quartz veining occur, the most important of which roughly follow the axial plane/cleavage direction and are typically 0.5-2cm wide. These veins or sheeted vein swarms are pyritic and the gold is contained within fractures in the pyrite or along pyrite/quartz boundaries. Larger quartz veins are seen at surface, generally parallel to the fold axis, and these sometimes contain visible gold, but otherwise gold is rarely seen. A detailed description of the deposit was given recently by Wood*

Previous work at Sukhoi Log by the Russian company, Lensoloto, included extensive trenching, drilling and underground exploration. Two separate exploration drives, totalling 11.7km, were developed from the eastern and western ends of the deposit. Lensoloto carried out a de-



tailed underground channel sampling programme, and part of the feasibility study included re-channelling of a portion of the original samples to check the accuracy of the previous sampling methods and assays. Both drives were extensively refurbished to permit access and to meet safety requirements. Initially, it was strange to pass from temperatures of +30 degrees centigrade on surface to sub-zero underground. In areas of undisturbed underground development the ice crystal growth was like an icy wonderland.

The channel sampling programme in the western drive was completed during my first period at Sukhoi Log using both Chilean samplers and personnel from a local contractor. I was persuaded to return for a second time in October to oversee the refurbishment and sampling of the eastern drive. A combination of long drawn-out wrangling over the cost of the refurbishment contract and then slower than expected progress on the refurbishment work resulted in the channel sampling programme eventually being postponed until late January 1996. In January/February outside temperatures as low as -42 degrees centigrade meant that underground was a relative sanctuary. The channel sampling programme was eventually completed in March.

In the meantime, preparations were in hand to carry out a confirmatory surface programme of 2,000m diamond and open hole drilling in 10 holes. This programme commenced in May 1996 and ran to August. I decided to return for one last period to see the drilling programme through to completion.

Two rigs were employed, utilising local drilling contractors and equipment, supplemented with some imported sample tubes and diamond bits. A particular concern was to obtain 95% minimum core recovery to provide the necessary confidence level in the assays and geotechnical results. During the previous Russian drilling, carried out in the 1960's and 1970's, high core recovery was not a priority, but it was considered essential for the feasibility study. After a few hiccups in the early stages of the drilling, all the targets were eventually achieved or exceeded. The drilling programme was completed on time, within budget, and average core recoveries worked out at 98%.

It might be misleading to give the impression that the sampling/drilling programme was undertaken without any hitches. A number of frustrating problems arose during the work that delayed the completion of the study. These included difficulties in exporting samples for independent assay due to customs restrictions (eventually, it was found necessary to assay the samples locally under the supervision of a Western laboratory chemist). Also, because of the large quantity of contained gold, the Sukhoi Log gold data was officially classified as 'State Secret'. Therefore, although a major part of the feasibility study sampling programme was designed to test the accuracy of the previous sampling and assay work, we were denied open access to the previous assay data to carry out the necessary comparisons. This also seriously impeded the mineral reserve calculation work. The problem was eventually overcome in early September, when secrecy was finally lifted.

It is interesting to consider the long drawn out history of the discovery and planned development of Sukhoi Log and the differences of the old Soviet approach. After the discovery of the deposit in 1961, and its subsequent delineation throughout the following decade, an ambitious development plan was drawn up which involved the building of a major new town, access road, airstrip and associated infrastructure. The development was never undertaken, partly due to lack of experience in hard rock gold mining (alluvial gold mining was more favourably considered); partly due to political indecision; and eventually due to lack of capital. With the recent input of Western experience, the very substantial infrastructural development planned had to be substantially scaled back to make economic sense, and it is currently planned to utilise the existing infrastructure framework as far as possible. The necessity for these changes was sometimes difficult to explain locally. Under the previous Soviet system, western-style profit and loss economics were not practised. This concept took some time to be accepted. Also, the necessity of carrying out a further feasibility study acceptable to Western financial institutions met some resistance from technical personnel who felt that it reflected poorly on their work. It was necessary to explain that an independent feasibility study would be carried out on any such project, regardless of location.

In general I found the Russian technical personnel, and the general population, to be well educated. Most people are used to doing things differently to Western ways and this will take some time to change. It is important to understand the sensitivities involved and not to attempt to impose our ideas without seeking to utilise local experience.

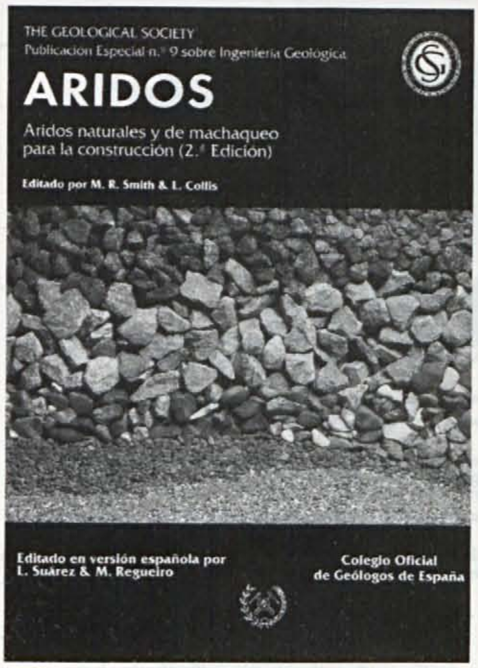
The Sukhoi Log project now appears ready to move forward. The feasibility study is close to completion, many of the barriers to progress have been lifted. JCI Ltd of South Africa has recently signed a Memorandum of Understanding with Star Mining to fund the next stage of development. If and when the project gets underway, it will be a tribute to the perseverance of the personnel of Star Mining, its contractors and, perhaps especially, the Russian geologists and mining personnel who discovered the deposit back in 1961 and who must have wondered if they would ever see it developed.

So, having come to Siberia for three months, with considerable misgivings, I stayed for over a year. Siberia cannot have been all bad. In truth, I did not require much persuasion to return on each occasion. Being involved with a project as big as Sukhoi Log, and working in unfamiliar terrain and climatic conditions, represented a challenge and invaluable experience, and there was considerable satisfaction in seeing the programme successfully concluded. The money was also useful but, in the end, despite the many bureaucratic frustrations, I enjoyed the experience of working with my Russian colleagues (and those of other nationalities). The Russians have an ability to 'switch off' from work and enjoy themselves socially, which is a pleasant change from the west, where often, nowadays, work seems to dominate our lives.

*Reference

WOOD, BRYCE L., Chief Geologist, Star Mining Corporation N.L. - The Sukhoi Log gold deposit, Siberia. Presented to a conference in Moscow in May 1996.

PUBLICACIONES DEL COLEGIO



TARJETA DE PETICION

Les ruego me envíen .... al precio de 5.500 ptas. ❒

+ 600 ptas. para gastos de envío por ejemplar:

TOTAL ....

CIF o DNI: .... N.º COLEGIADO ....

NOMBRE: ....

EMPRESA: ....

CALLE: ....

POBLACION: ....

CP: .... TFNO.: ....

FECHA: .... Firma:

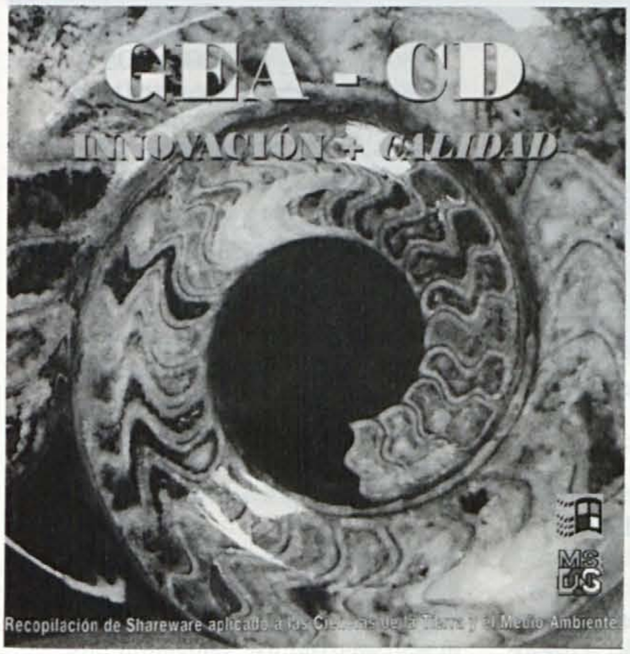
FORMAS DE PAGO

A nombre del Colegio Oficial de Geólogos de España

❒ Adjunto cheque por .... ptas.

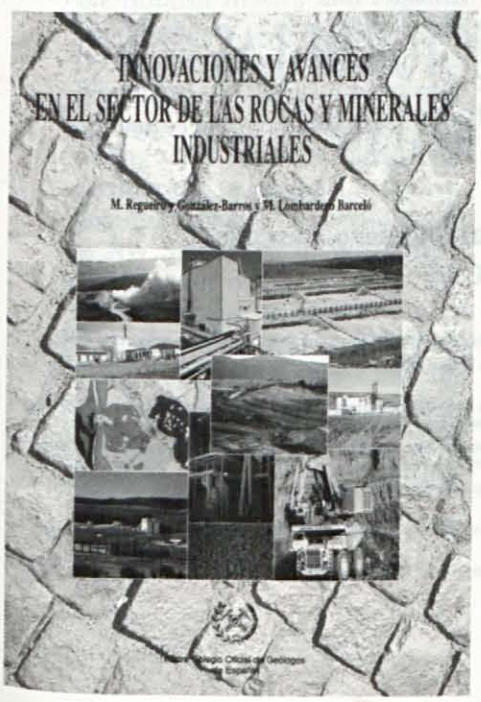
❒ Transferencia Bancaria a la C/C n.º 0601372378 BANCO POPULAR (Ag 0075). Glorieta de Cuatro Caminos, n.º 4. 28003 MADRID. (Adjuntar fotocopia)

Se ruega remitan sus pedidos a: ICOG, Avda. Reina Victoria, n.º 8, 4.º B.



La más amplia recopilación de shareware en soporte CD-ROM

- Ingeniería Geológica
- Hidrogeología
- Medio Ambiente
- SIG Teledetección
- y mucho más, 250 aplicaciones, fotografías, textos, etc...



TARJETA DE PETICION

Les ruego me envíen .... ejemplares, al precio de 3.500 ptas. ❒ No colegiados

+ 700 ptas. para gastos de envío 2.500 ptas. ❒ Colegiados

TOTAL ....

CIF o DNI: ....

NOMBRE: ....

EMPRESA: ....

CALLE: ....

POBLACION: ....

CP: .... TFNO.: ....

FECHA: .... Firma:

FORMAS DE PAGO

A nombre del Colegio Oficial de Geólogos de España

❒ Adjunto cheque por .... ptas.

❒ Transferencia Bancaria a la C/C n.º 0601372378 BANCO POPULAR (Ag 0075). Glorieta de Cuatro Caminos, n.º 4. 28003 MADRID. (Adjuntar fotocopia)

Se ruega remitan sus pedidos a: ICOG, Avda. Reina Victoria, n.º 8, 4.º B.

ARIDOS

Aridos naturales y de machaqueo
para la construcción (2.ª Edición)

THE GEOLOGICAL SOCIETY
Publicación Especial n.º 9 sobre Ingeniería Geológica
editado por M. R. Smith & L. Collis
editado en versión española por
L. E. Suárez & M. Regueiro

Vendidos más de 1.900 ejemplares

Tenemos el gusto de presentarle, la versión española del manual de **ARIDOS,** subtitulado **áridos naturales y de machaqueo para la construcción.** Este libro de más de 400 páginas y de más de 200 figuras, ha sido galardonado con el Trofeo Brewis de la Sand and Gravel Association (SAGA), siendo comentado por la prestigiosa **Canadian Geotechnical Journal** de esta manera: **"Si su trabajo tiene que ver con el uso de los áridos, compre este libro y no lea más".**

Además de estos reconocimientos, las razones que nos ha llevado al ICOG a adquirir los derechos de la versión española a la Geological Society fueron:

1.–Sin miedo a equivocarnos, podemos afirmar que es el **más avanzado manual de áridos** editado en lengua inglesa, totalmente actualizado, ya que esta segunda edición fue publicada en 1993.

2.–Puesto que en España y demás países de la Unión Europea, la normativa de áridos está siendo adaptada a las directrices del Comité Europeo de Normalización CEN/TC 154 "Aggregates", este libro **nos informará sobre la normativa de áridos europea en el horizonte del año 2000,** dado que el Reino Unido es el país más avanzado en el conocimiento técnico de los áridos, estando un importante número de presidencias de los subcomités y la secretaría del CEN/TC 154, gestionadas para la British Standard Institution.

3.–Además de la versión española, los capítulos normativos están completados por addendas realizadas por el panel de Presidentes del Comité Técnico de Normalización AEN/CTN 146 "Aridos", en las que analizan la normativa española en el proceso de normalización europea.

En definitiva, este libro no es una foto fija acerca de los áridos de España. Si quiere conocer todo acerca de la normativa de los áridos en España, pero **necesita saber cuál será el estado del arte de los áridos en España en el horizonte del año 2000,** a causa del proceso de armonización normativa europea, adquiera este libro : será una referencia esencial y valiosa que Vd. podrá utilizar durante muchos años.

Si es de su interés adquirir ese manual de ARIDOS, envíanos la tarjeta de encargo adjunta, bien por Fax (91) 5330343, correo o telefónicamente (91) 5532403 y se lo remitiremos con celeridad.

460 páginas. Noviembre 1994. PRECIO: 5.500 pts.

TARJETA DE PETICION

Les ruego me envíen .... al precio de
+ 700 ptas para gastos de envío por unidad:

3.500 ptas. ☐ COLEGIADOS
5.000 ptas. ☐ NO COLEGIADOS
TOTAL .... ptas.

CIF o DNI: .... N.º COLEGIADO ....

NOMBRE: ....

DIRECCION: ....

POBLACION: ....

CP: .... TFNO.: ....

FECHA: .... Firma:

FORMAS DE PAGO

A nombre del Colegio Oficial de Geólogos de España

☐ Adjunto cheque por .... ptas.

☐ Transferencia Bancaria a la C/C n.º 0601372378 BANCO POPULAR (Ag 0075). Glorieta de Cuatro Caminos, n.º 4. 28003 MADRID. (Adjuntar fotocopia)

Se ruega remitan sus pedidos a: ICOG, Avda. Reina Victoria, n.º 8, 4.º B. 28003 MADRID (ESPAÑA). Teléf. 5532403. Fax: 5330343

INNOVACIONES Y AVANCES EN EL SECTOR DE LAS ROCAS Y MINERALES INDUSTRIALES

Manuel Regueiro y González-Barros y Manuel Lombardero Barceló
Editado por el Ilustre Colegio Oficial de Geólogos

El ICOG se complace en presentar esta obra, que recoge la mayoría de los principales avances en la extracción, procesado y aplicaciones de las rocas y minerales industriales (**RMI**).

Áridos, piedra natural y minerales industriales, constituyen los tres grandes grupos de las **RMI,** que ha adquirido en los últimos tiempos una importancia indiscutible en todo el mundo desarrollado.

En España el crecimiento de este subsector minero ha sido constante en los últimos años, según ponen en evidencia los datos estadísticos de 1995, ya que en dicho año, el valor de la producción a pie de cantera de las **RMI**, *superó. por primera vez en la historia de la minería española, al conjunto de los minerales metálicos y recursos energéticos.*

La bibliografía en español sobre estas sustancias minerales es muy escasa. Sin embargo, en los últimos tiempos se han producido importantes avances técnicos, que hacen de este libro una aportación actualizada al conocimiento de los principales rocas y minerales industriales utilizados en multitud de aplicaciones hoy en día.

El texto refleja también las innovaciones en desarrollo y las perspectivas de futuras aplicaciones de algunas de las sustancias descritas, por lo que representa una ventana abierta al previsible futuro del amplio mundo de los nuevos materiales.

Esta obra está dirigida a geólogos, técnicos y especialistas, explotadores, transformadores y consumidores de **RMI.** Es un libro de fácil lectura también para estudiantes y personas no familiarizadas pero interesadas en el mundo de las **RMI.**

Si es de su interés adquirir el libro **Innovaciones y Avances en el sector de las Rocas y Minerales Industriales,** sírvase rellenar y enviar la tarjeta de petición adjunta con el justificante de pago, por correo o fax (91) 5330343, por correo electrónico a **icog@telprof.eurociber.es** y se lo remitiremos inmediatamente.

80 páginas a todo color. Febrero de 1997

WILLIAM BOWLES (1720-1780) EUROGEOLOGIST

by George Reynolds
CSA Consultans. Parkview House. Beech Hill, Clonskeagh. Dublin 4, Ireland

Abstract

William (Guillermo) Bowles was born near Cork (Ireland) in 1705 and studied Law in London. Not much is known about his early life, but he went to Paris in 1740 where he studied Natural History, Chemistry, Metallurgy and Anatomy. He travelled widely in France, studying the flora, fauna and geology. In 1752 Bowles was invited to Spain to reconstruct the famous Almadén mercury mine, which had been destroyed by a fire. Later he was appointed Superintendent of Mines and visited every region of Spain observing the mineral deposits and other natural phenomena.. He became director of the Museum of Natural History and a Chemical Laboratory involved in research into military applications.

Bowles observed the geology, fauna and flora of Spain, and collected mineral and biological specimens and published *"An Introduction to the Natural History and Physical Geography of Spain"* in Madrid (1775), the first truly scientific description of the physical geography of Spain. He is credited with introducing the species *"Daboecia Cantabrica"* (a heather) to cultivation in England. The species grows in NW Spain and in W. Galway-Mayo, and nowhere else. The Peruvian genus *"Bowlesia"* was dedicated to him. He also studied the Merino species of sheep and the Spanish locust. His chemical researches included platinum and its alloys.

William (Guillermo) Bowles.

Finally, after retiring in 1776, he settled in Madrid, where he died on August 25, 1780. He is buried in the Church of Saint Martin (Madrid) and his portrait was donated by his widow to the Museum of Natural History. His work is well recognised in Spain but he remains an unknown figure in his native country. In this age of free movement of European citizens, it is interesting to reflect on the practical difficulties that must have confronted Bowles, and perhaps we can still learn something from him.

Resumen

Guillermo Bowles nació cerca de Cork (Irlanda) en 1705 (o bien 1720, según ciertas referencias) y estudió Derecho en Londres. No se sabe mucho sobre su vida de joven, pero fue a París en 1740 donde estudió historia natural, química, metalurgia y anatomía. Recorrió casi toda Francia, donde realizó observaciones sobre la fauna y la flora y la mineralogía. En el año 1752, conoció a Antonio de Ulloa, quien le invitó a trasladarse a España por encargo del Gobierno, a fin de reconstruir la mina de mercurio de Almadén, destruida en un incendio. Más tarde, Bowles fue encargado de estudiar el estado y riqueza natural e industrial del país y del establecimiento del Laboratorio de la Platina y del Real Gabinete de Historia Natural.

Bowles realizó observaciones sobre la geología, la botánica y la zoología y hizo una colección de los minerales y otras curiosidades. Como fruto de sus trabajos, publicó en 1775 el importante *"Introducción a la Historia Natural, y a la Geografía Física de España"*, siendo la primera obra científica sobre la geografía física del país. Introdujó "Daboecia Cantabrica" en Inglaterra, un arbusto que se encuentra en Galicia y en el Oeste de Irlanda. Sus estudios incluyen el ganado "Merino", la langosta española, el platino y sus aleaciones, y el genero Peruano "Bowlesia" fue dedicado a su memoria.

Después de jubilarse en 1776, Bowles falleció en Madrid, el 25 de agosto de 1780. Está enterrado en la iglesia de San Martín (Madrid) y su retrato fue otorgado al Museo de Ciencias Naturales por su viuda, Ana Regina de Alemania. Sus trabajos están reconocidos en España pero Bowles sigue siendo un personaje desconocido en su país de ori-

Carlos III.

gin. En esta edad de libre movimiento de trabajadores en Europa, es interesante reflexionar sobre las dificultades prácticas que tuvo que superar, y tal vez podamos aprender algo de él.

Résumé

William (Guillermo) Bowles est né près de Cork en Irlande en 1705 (où en 1720, selon certaines références). Il fit ses études de Droit à Londres. On en sait très peu sur le début de sa vie, mais on sait qu'il se rendit à Paris en 1740 où il étudia l'Histoire Naturelle, la Chimie, la Métallurgie et l'Anatomie. Il parcourut la France, y étudiant la flore, la faune et la géologie. En 1752, Bowles fut invité à se rendre en Espagne pour y reconstruire la célèbre mine de mercure de Almadén, qui avait été détruite lors d'un incendie. Plus tard, il fut nommé Inspecteur des Mines et visita toutes les régions d'Espagne, y analysant les gisements miniers et divers phénomènes naturels. Il devint Directeur du Musée d'Histoire Naturelle et d'un Laboratoire de Chimie engagé dans la recherche sure les applications militaires.

Bowles observa la géologie, la faune et la flore de l'Espagne. Il fit collection de spécimens minéraux et biologiques et publia *"Introducción a la Historia Natural, y a la Geografía Física de España"* à Madrid (1775). Ce fut la première description résolument scientifique de la géographie physique de l'Espagne. Il passe pour avoir introduit en Angleterre l'espèce de bruyère appelée *"Daboecia Cantabrica"* dans le but d'en faire la culture. Cette espèce croit aujourd'hui dans le N.Ouest de l'Espagne et dans l'Ouest d'Irlande et nulle part ailleurs. L'espèce Péruvienne baptisée *"Bowlesia"* lui fut dédiée. Il porta également ses recherches sur le mouton "Merino" et la locuste Espagnole. Ses travaux en matière de chimie portèrent sur le platine et ses alliages.

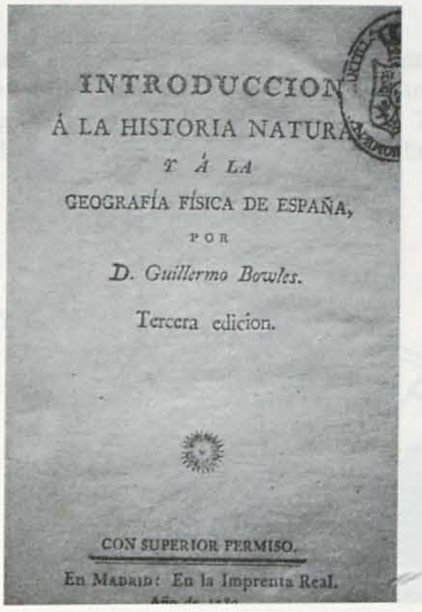
A la fin de sa vie, après avoir accompli toutes ses recherches en 1776, il s'installa à Madrid où il mourut le 25 Août 1780. Il repose à l'Eglise de Saint-Martin (Madrid). Sa veuve, Ana Regina de Allemagne, fit don de son portrait au Musée d'Histoire Naturelle. Ses travaux sont bien connus en Espagne alors qu'il reste un personnage méconnu dans son pays d'origine. En cette période de mobilité géographique que traversent les Européens, il est intéressant de réfléchir aux difficultés que Bowles a du rencontrer sur le plan partique. Et peut-être que son expérience pourra nous en révéler davantage.

Geologists are innate travellers. It is necessary to travel to study geology, and our mètier often takes us to exotic destinations, where tourists never go. In this modern age of jet travel, international conferences and the opening of European frontiers, it is difficult to imagine the challenges faced by a young geologist going abroad to study 250 years ago and taking up employment in a country where he did not speak the language. Such a man was William Bowles from County Cork, Ireland.

In 1775 he published *"Introducción a la Historia Natural, y a la Geografía Física de España"* (An Introduction to the Natural History and Physical Geography of Spain). in Madrid (1775), second Ed. 1782, third Ed. 1789, which was translated into several languages. (into English by Thompson, inaccurately). The book was written in a popular and ironic style, and Bowles himself said that this work was full of "facts and deductive reasoning". This book influenced the writings of several foreign travellers, especially J.T. Dillon (Viajes por España, 1781), J.F. Peyron (Nuevo Viaje a España, 1780) and J. Townsend (Un Viaje por España, 1791). The following resumé has been compiled from the few available sources, most of them in Spanish, including his book.

Bowles was born in 1720, (although some references state 1705) and little is known about his early life other than that his parents wanted him to study Law, which he did in London. He went to Paris in 1740 where he studied natural history, chemistry, metallurgy and astronomy. He travelled extensively in France and Germany, visiting the mining districts of Saxony and Hanover. He investigated its natural history, mineral deposits and other products and his notes were recorded in diaries which were retained in the possession of Joseph Nicholas de Azara, (Spanish Ambassador in Rome) who wrote the foreword to Bowles' famous publication in 1775

In 1752, having become acquainted with Don Antonio de Ulloa (1716-1795) , who later became Admiral of the Spanish fleet, Bowles was appointed to superintend the Spanish state mines, organise a natural history collection and set up a chemical laboratory to study platinum and its alloys. One of his early successes was the re-instatement of the Almadén mercury mine, which had been damaged by fire. He afterwards travelled extensively in Spain, observing the fauna and flora, and commenting on the inhabitants and their customs, in addition to his work of collecting information on the mineral deposits of Spain. Once in Madrid, his closest collaborators who accompanied him on many travels, were Joseph Solano (Lieut. General of the Royal Armada), Salvador de Medina (who died in California on an expedition to observe the eclipse of the Sun by the planet Venus), and Pedro Saura, a lawyer.



Bowles'book.

In his work, Bowles observed the geology, fauna and flora of Spain, and collected mineral and biological specimens. He noted the action of the sea on the coastline and sea-level changes. There are notes on springs and groundwater, fluvial dynamics (but not marine sedimentation), and the extinct volcanism in Spain. Familiar with the geological thinking in Freiberg (Saxony), and the geology of France and The Alps, he could appreciate the idea of geological uniformity on a worldwide scale, comparing Spanish with European geological formations.

Bowles paid particular attention to the weathering and alteration of rocks. Reflecting on the immensity of geological time while contemplating a mountain range, he commented: "Human logic cannot comprehend the time needed to form this and other mountains". This was 10 years before Hutton. Bowles expounded the idea of the geological cycle, although in an incomplete form. The work of Bowles, apart from being the first truly scientific description of the physical geography of Spain in the modern sense, demonstrated that many of the ideas which men like Hutton were to expound years later, were already popular and accepted by Bowles.

In 1752, Ulloa convinced the king, Fernando VI, of the need to have a Council of Natural History to consolidate the teaching of mineralogy, botany and zoology. He rented a house from José Prado in the calle de la Magdalena in Madrid, which became the Museum of Natural History in 1753, with Ulloa as director and Bowles as principal scientist. The species "*Daboecia Cantabrica*" (a heather) was introduced to cultivation in England by Bowles. The species grows in NW Spain and in W. Ireland. The Peruvian genus "*Bowlesia* " (Ruiz. & Pavon) was dedicated to him. It is also possible that he anticipated some of the ideas of Charles Darwin on the evolution of species by natural selection, published 84 years later.

In Bowles, we can recognise many of the aspects of the life of a typical Eurogeologist. He married a German lady, Ana Regina Rustein, whom he probably met on his travels there. She accompanied him frequently on his travels throughout Spain as they were very devoted to each other. They moved house several times, living in Madrid and Bilbao on four occasions. To avoid putting their furniture in storage, they sold it each time a long trip was planned. Bowles had difficulty learning Spanish, and he enlisted the help of friends to translate important documents. The second edition of his book was edited by Don J.N. de Azara (1731-1804), who rendered considerable assistance in preparing the first edition. Likewise, his friends in London and Paris assisted him in publishing short articles on the Merino breed of sheep and the locust, in England and France.

Many people, and geologists are no exception, find the food and customs of a new country difficult to adapt to at first, and Bowles too, had his problems. Three days after arriving in Spain, Bowles stated "All the roads are bad", "the hotels worse", " the country is a hell, stupidity reigns, no Spaniard has, nor has had, (good) upbringing"; "They eat meat on Fridays and put a statue of the Virgin on the table".

It appeared to him as though "all Spain was stupid, lethargic, poor, dirty, jealous and melancholy". However, he seems to have changed his opinion very quickly, staying in Spain until his death 28 years later. In fact, he became well-accepted in Spanish society, and was described as being tall and good-looking, generous, honourable, active, ingenious and well-informed. His company was much valued in the best Spanish circles.

In 1909, Nathaniel Colgan, an Irish naturalist and Member of the Royal Irish Academy, was turning over the second-hand books on Astonís Quay in Dublin, when he found a copy of Bowles' book, which he bought for 2 pence, about 3 ecues. Colgan summarised several points of particular interest to Irish readers who might otherwise be unaware of Bowles or his works. He mentions Bowles' assertion that the potato came to Ireland from Galicia (NW Spain) *"Potatoes came from America and were brought by the Spaniards to Galicia where they have spread all over Europe. The first place to which they were carried from Galicia was Ireland, where they throve to such a degree that they have become almost the sole sustenance of the people"*. On the export of Irish Wolfhounds to Spain he says *"the common wolf is rare because few sheep are kept or because the country being overspread with farmsteads the animals are chased and killed as soon as they are sighted, and for this work the hounds brought into the country from Ireland are excellent."*

Bowles observed the similarities between Spanish and Irish people, their customs and behaviour. He describes in some detail the peasants of Vizcaya (Basque region) and their love of fairs and dancing to tambourines, which the Irish do to celebrate the feast-days of their Patron Saints. He describes the tradition of "fist-fights" at these fairs in both countries, where seldom is serious injury sustained! He compares the "Chacoli" of Vizcaya with the "Sheebeen" of Ireland, both locations to drink illicit spirit. The women of Ireland and Vizcaya show remarkable similarities in their dress and customs, according to Bowles, and he asserts that "the Irish have always professed a great love for the Spanish Nation".

Bowlesia.

His observations of people extends to the professional. The use of forced labour at Almadén did not appeal to him as "any local worker would do twice as much for half what it costs the State to supply forced labour, dreadful delinquents who merely dump earth into wagons". He lauds the Spanish workforce as "daring, robust, skillful and requiring understanding". Nevertheless, he recommended employing German foremen and miners to organise and train them, respectively.

Geologists have to consider the economics of the materials they deal with, and Bowles was charged with research into platinum and its alloys. The King, Carlos III, brought two eminent French chemists, Francisco de Chabaneaux (1754-1872) and José Luis Proust (1754-1826) to Spain to work with him. Bowles refuted the ideas current at the time, that platinum was merely an alloy of iron and gold. He was sent to Germany with José Agustin de Llano to study the preparation of cobalt blue, having discovered the raw material in the Gistain Valley. Raw materials for military use were also on the agenda, including saltpetre (nitre) for gunpowder and alloys for cannon barrels.

It is fashionable to consider the impact of modern activities on the environment and on groundwater in particular, these were of concern to Bowles also. He devotes a chapter to the Madrid water supply and quality, but perhaps an illustration of the continuing value of his work can be seen from the following: In 1932, following a heavy rainfall in the Cuenca del Cardoner where an important deposit of rock salt is located, an increase in the sodium chloride content of the nearby river resulted in the death of many fish. The blame was attributed to the company operating the deposit, whose waste dumps were situated on the sides of the valley. The following paragraph was found in Bowles' book: "The mountain has a large surface area, but nevertheless the rain does not dilute the salt. The river at the foot of the mountain is salty, and when it rains the saltiness increases, killing the fish. But this effect does not extend more than three leagues (approx. 30 km) beyond which the fish survive."

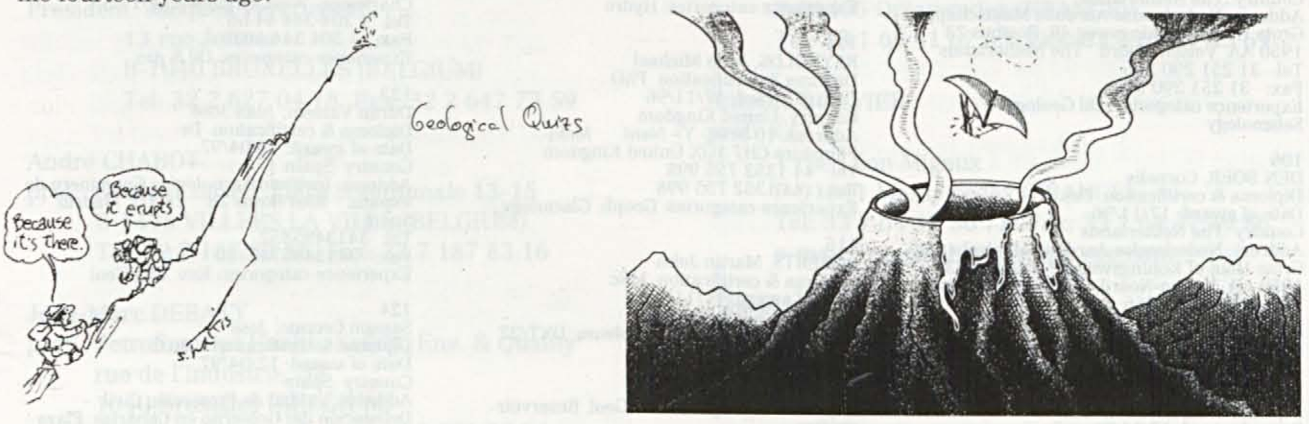
Bowles died in Madrid, on August 25, 1780, and is buried in the church of San Martin. A layer of concrete covers his tomb since recent renovations took place.

There is no translation of his book into English in existence today, as far as is known, although translations into French and Italian were published shortly after his death. Several bibliographic summaries of his works are to be found in Spanish and English, but he remains unrecognised in the Ireland of his birth until such time as a complete translation of his book is made.

The life and works of Bowles, which spanned five European countries, and addressed many disciplines and aspects of applied geology, must resonate with many of us today who confront the economic necessity of looking for work in another European country, with all the inherent practical and bureaucratic obstacles.

News from EurGeol

Christian Schaffalitzky EurGeol No. 9. Christian has ben appointed the Managing Director of Ennex International, the Irish mineral exploration company. He has resigned from Ivernia West where he helped discover the major new zinc-lead mine which should shortly go into production at Lisheen, Co. Tipperary. He continues with Crow Schaffalitzky & Associates, the major Irish consultancy firm as non-executive director. He was a co-founder of CSA some fourteen years ago.



Real Geologists...

- DON'T EAT QUICHE. THEY DON'T EVEN KNOW WHAT IT IS. REAL GEOLOGISTS LIKE RAW MEAT, BEAR AND TONSIL-KILLER CHILI.
- DON'T NEED ROCK HAMMERS. THEY BREAK SAMPLES OFF WITH THEIR BARE HANDS.
- DON'T SIT IN OFFICES. BEING INDOORS MAKES THEM CRAZY.IF THEY HAD WANTED TO SIT IN OFFICES, THEY WOULD HAVE BEEN GEOPHYSICISTS.
- DON'T NEED GEOPHYSICS. GEOPHYSICISTS MEASURE THINGS NOBODY CAN FEEL OR SEE,MAKE UP A WHOLE LOT OF NUMBERS ABOUT THEM, THEN DRILL IN ALL THE WRONG PLACES.
- DON'T GO TO MEETINGS, EXCEPT TO POINT AT A MAP AND SAY "DRILL HERE!" AND LEAVE.
- DON'T WORK 9 TO 5. IF ANY REAL GEOLOGISTS ARE AROUND AT 9:00AM IT'S BECAUSE THEY'RE GOING TO MEETINGS TO TELL THE MANAGERS WHERE TO DRILL.
- DON'T LIKE MANAGERS. MANAGERS ARE A NECESSARY EVIL, FOR DEALING WITH BOZOS FROM HUMAN RESOURCES, BEAN COUNTERS FROM ACCOUNTING, AND OTHER MENTAL DEFECTIVES.
- DON'T MAKE EXPLORATION BUDGETS. NERVOUS MANAGERS MAKE EXPLORATION BUDGETS. ONLY INSECURE MAMA'S BOYS TRY TO STAY WITHIN EXPLORATION BUDGETS. REAL GEOLOGIST IGNORE EXPLORATION BUDGETS.
- DON'T USE COMPASSES. THAT SMACKS OF GEOPHYSICS. REAL GEOLOGISTS ALWAYS KNOW EXACTLY WHERE THEY ARE AND THE NEAREST PLACE WHERE BEER IS AVAILABLE.
- DON'T MAKE MAPS. MAPS ARE FOR NOVICES, THE FORGETFUL, MANAGERS, AND PANSIES WHO LIKE TO PLAY WITH COLOURED PENSILS. A REAL GEOLOGIST WILL ONLY DRAW A MAP TO SHOW THE ILLINFORMED MANAGERS WHERE TO DRILL.
- DON'T WRITE REPORTS. BUREAUCRATS WRITE REPORTS, AND LOOK AT WHAT THEY'RE LIKE.
- DON'T HAVE JOINT VENTURE PARTNERS. PARTNERS ARE FOR WIMPY BEDWETTERS WHO ARE UNABLE TO THINK BIG.

We didn't write it, we just posted it. Everything else is ALLEGATIONS. This posting is not the direct views of this Federation or those members contained within.

For sale

Get your own official seal with your personal EurGeol number with which to impress your professional reports. For more delails contact the EFG Paris Office.

Directory of the European Geologists

The directory contains name, degrees, country of professional membership, address, telephone fax and e-mail and areas of expertise of the European Geologists.
It is available on paper or on disk.

Price: paper: 50 FF
disk: 100 FF

New European Geologists

105
FRANSSEN, Raimundus
Diploma & certification Dr
Date of award: 17/11/96
Country :The Netherlands
Address: Nederlandse Aardolie Maatschappij Grote Hout of Koningsweg 49 Postbus 23 1950 AA Velsen-Noord The Netherlands
Tel: 31 251 290 396
Fax: 31 251 290 579
Experience categories: Oil Geology Seismology

106
DEN BOER, Cornelis
Diploma & certification Drs
Date of award: 17/11/96
Country :The Netherlands
Address: Nederlandse Aardolie Maatschappij Grote Hout of Koningsweg 49 Postbus 23 1950 AA Velsen-Noord The Netherlands
Tel: 31 251 261 566
Fax: 31 251 290 579
Experience categories: Oil Dev Seismology

107
BUSSER, Wouter
Diploma & certification Drs
Date of award: 17/11/96
Country :The Netherlands
Address: Nederlandse Aardolie Maatschappij AFD. TM/1 Postbus 28000 9400 HH Assen The Netherlands
Tel: 31 592 362 401
Experience categories: Oil Prod

108
COPPER, Jacob
Diploma & certification Drs
Date of award: 17/11/96
Country :The Netherlands
Address: Nederlandse Aardolie Maatschappij Schepersmaat 2 9400 HH Assen The Netherlands
Tel: 31 592 369 111
Experience categories: Oil Prod

109
SWALES, Jonathan Mark
Diploma & certification MSc
Date of award: 17/11/96
Country :United Kingdom
Address: Soil Mechanics Ltd Askern Road, Carcroft Doncaster DN6 8DG United Kingdom
Tel: 44 1302 723 456
Fax: 44 1302 725 240
Experience categories: Soil mechanics

110
BECKETT, David
Diploma & certification PhD
Date of award: 17/11/96
Country :United Kingdom
Address: British Gas E&P 100 Thames Valley Park Drive Reading Berkshire RG6 1PT United Kingdom
Tel: 44 1734 292 371
Fax: 44 1734 292 226
Experience categories: Carbonate sediment.

111
COCKERTON, David George
Diploma & certification MSc
Date of award: 17/11/96
Country :United Kingdom
Address: Edmund Nuttall Ltd St James House, Knoll Road Camberley Surrey GU15 3XW United Kingdom
Tel: 44 1276 634 84
Fax: 44 1276 660 60
Experience categories: Geotech

112
JOSEPH, Jeremy Belmore
Diploma & certification BSc (Hon)
Date of award: 17/11/96
Country :United Kingdom
Address: Shanks & McEwan Woodside House, Church Road Woburn Sands Bucks MK17 8TA United Kingdom
Tel: 44 1908 288 803
Fax: 44 1908 282 728
Experience categories: Hydro

113
LYNESS, Lucien Stanley
Diploma & certification MSc
Date of award: 17/11/96
Country :United Kingdom
Address: Komex International Ltd Suite 100, 4500-16th Avenue N.W.Calgary Alberta T3B 0M6 Canada
Tel: 1 403 247 0200
Fax: 1 403 247 48 11=20
Experience categories: Hydro

114
REYNOLDS, John Michael
Diploma & certification PhD
Date of award: 17/11/96
Country :United Kingdom
Address: 10 Bron- Y- Nant Mold Flintshire CH7 1UX United Kingdom
Tel: 44 1352 755 998
Fax: 44 1352 755 998
Experience categories: Geoph Glaciology

115
ROBERTS, Martin John
Diploma & certification MSc
Date of award: 17/11/96
Country :United Kingdom
Address: Brunei Shell Petroleum DXT/22 Seria 7082 Brunei
Tel: 673 337 40 69
Fax: 673 337 20 40
Experience categories: Oil Geol Reservoir studies

116
WILLIS, Matthew Guilder
Diploma & certification PhD
Date of award: 17/11/96
Country :United Kingdom
Address: Shell Exploration Pakistan Khayaban -e-Ikbal, F 6/2, P.O. Box 3031 Islamabad Pakistan
Tel: 92 51 82 31 36
Fax: 92 51 82 25 84
Experience categories: Oil Geol Basin analysis

117
PLOTTO, Pierre
Diploma & certification Dr en Sc
Date of award: 17/11/96
Country :France
Address: 3 avenue St Eynard 38700 Corenc France
Tel: 33 4 76 90 42 59
Experience categories: Eng Geol Nat hazard

118
D'ENGELBRONNER, Erik Robert
Diploma & certification Drs
Date of award: 17/11/96
Country :The Netherlands
Address: Interconsult Namibia P/O Box 20690 Windhoek Namibia
Tel: 264 61 220400
Fax: 264 61 230934
Experience categories: Palaeont Lect

119
HALIMI, Dany-Paule
Diploma & certification DESS
Date of award: 17/11/96
Country :France
Address: 19 bd Soult 75012 Paris France
Tel: 33 1 43 40 34 63
Experience categories: Hydro Eng Geol

120
Bouvier, Antoine
Diploma & certification Dr en Sc
Date of award: 12/04/97
Country :France
Address: CGG 1 rue l=E9on Migaux 91341 Massy France
Tel: 33 1 64 47 36 72
Fax: 33 1 64 47 39 86=20
e-mail: abouvier@cgg.com
Experience categories: Geoph

121
Cosma, Radu
Diploma & certification Dipl.-Geol
Date of award: 12/04/97
Country :Germany
Address: GKW INGENIEURE Gottlieb-Daimler-str 12a 68165 Mannheim Germany
Tel: 496214006328
Fax: 496214006350
Experience categories: Env

122
Walbe, Kim Arthur
Diploma & certification BSc PMIAEG
Date of award: 12/04/97
Country :Ireland
Address: Walbe &Associates Ltd Box 3626 Charleston West Virginia 25301 USA
Tel: 1 304 344 44 66
Fax: 1 304 344 4020
Experience categories: Oil & gas

123
Durán Valsero, Juan José
Diploma & certification Dr
Date of award: 12/04/97
Country :Spain
Address: Instituto Tecnológico Geominero de España Ríos Rosas 23 28003 Madrid Spain
Tel: 3413495852
Fax: 3413495742=20
Experience categories: Env Eng Geol

124
Sansón Cerrato, José
Diploma & certification Ldo C
Date of award: 12/04/97
Country :Spain
Address: Unidad de Protección Civil Delegación del Gobierno en Canarias Plaza de la Feria, 24 35071 Las Palmas de Gran Canaria Spain
Tel: 34367155
Fax: 34363994=20
Experience categories: Nat Hazard

125
Van Moerkerken, Bruno
Diploma & certification Drs
Date of award: 12/04/97
Country :The Netherlands
Address: GEODISQ Plantage Muidergracht 162-164 1018 TW Amsterdam The Netherlands
Tel: 31 20 626 45 42
Fax: 31 20 626 97 04
Experience categories: Comp

126
Bowles, John Frederick
Diploma & certification PhD Cgeol, Cing, PMIAEG
Date of award: 12/04/97
Country :United Kingdom
Address: Mineral Science Ltd 109 Asheridge Road Chesham HP5 2PZ Buckinghamshire United Kingdom
Tel: 44 1494 772 740
Fax: 44 1494 791 680
Experience categories: Min eval

127
Duncan, Ian Gordon
Diploma & certification PhD
Date of award: 12/04/97
Country :United Kingdom
Address: Crude Petroleum Exploratie 3V Mauriskade 35 2514 HD Den Haag The Netherlands
Tel: 31707424545
Experience categories: Oil & gas

128
Fowler, Jonathan
Diploma & certification PhD Cgeol, Cing
Date of award: 12/04/97
Country :United Kingdom
Address: Monopros Ltd Waterpark Place 10 Bay street, suite 1510 Toronto M5J 2R8 Ontario Canada
Tel: 1 416 363 266 5
Fax: 1 416 363 427 8
Experience categories: Min expl man

129
O'Liath=E1in, Míche=E1l
Diploma & certification PhD
Date of award: 12/04/97
Country :United Kingdom
Address: Environmental Protection Agency Ardcavan Wexford Ireland
Tel: 3535347120
Fax: 3535347119=20
Experience categories: Stratig Env

MEMBER ASSOCIATIONS

BELGIUM

* UNION BELGO-LUXEMBOURGEOISE DES GEOLOGUES (UBLG)
President: Jacques Vercruysse
13 rue Jenner
B-1040 BRUXELLES (BELGIUM)
Tel: 32 2 627 04 18. Fax: 32 2 647 73 59

André CHABOT
prof: Géobel Conseil, Place communale 13-15
B-1495 VILLERS LA VILLE (BELGIUM)
Tel: 32 7 187 83 16. Fax: 32 7 187 83 16

Jean-Marc DEBATY
prof: Petrofina Dpt Health, Safety, Env. & Quality
rue de l'industrie, 52
1040 Bruxelles (BELGIUM)
Tel: 32 2 288 91 05. Fax: 32 2 288 33 34

Jacques VERCRUYSSE
prof: Envico
Generaal de Wittelaan 9/3
B-2800 Mechelen
Tel: 32 15 28 19 64. Fax: 32 15 28 19 70

FINLAND

* FINNISH UNION OF ENVIRONMENTAL PROFESSIONALS (FUEP)
Rawtatieläisenkatu 6
00520 Helsinki, Finland
Tel: 358 9 1502 383. Fax: 358 9 142 604
e-mail: tuula.kilpelainen@ykl.fi

Karita ÅKER
prof: Soil & Water Iltd
Itålahdenkatu 2
FIN-00210 HELSINKI (FINLAND/FINLANDE/FINLANDIA)
Tel: 358 0 68 26 61. Fax: 358 0682 66 00

Jukka MARMO
prof: Geological Survey of Finland
Betonimiehenkuja 4
SF-02150 ESPOO (FINLAND)
Tel: 358 2 05 50 11 Fax: 358 205 50 12
e-mail: jukka.marmo@gsf.fi

FRANCE

* UNION FRANCAISE DES GEOLOGUES (UFG)
President: Jean-Michel Quenardel
Maison de la Géologie, 77 rue Claude Bernard
F-75005 PARIS (FRANCE)
Tel: 33 1 47 07 91 95 (tuesday, wenesday, thursday; mardi, mercredi, jeudi)
Fax: 33 1 47 07 91 93
2-mail: ufg@hol.com

Jean-Michel QUENARDEL
prof: Université de Paris-Sud
Labo géologie Struct. et App., Bât. 504
F-91405 Orsay cedex (FRANCE)
Tel: 33 1 69 41 67 53. Fax: 33 1 69 41 83 69

Antoine BOUVIER
prof: CGC
1 rue Léon Migaux
F-91341 Massy cedex (FRANCE)
Tel: 33 1 64 47 36 72. Fax: 33 1 64 47 39 86
e-mail: francis. brvere@qm.cgg.com

GERMANY

* BERUFSVERBRAND DEUTSCHER GEOLOGEN, GEOPHYSIKER UND MINERALOGEN EV (BDG)
President: Detlev Doherr
Oxfordstraße 20-22
D-53111 BONN (GERMANY)
Tel: 49 228 69 66 01. Fax: 49 228 69 66 03
(Please direct all communication for the German delegates to the BDG office in Bonn)

Detlev DOHERR
prof: Fachhochschule Offenburg
Badstr, 24
D-77652 Offenburg (GERMANY)
Tel: 49 781 205 281. Fax: 49 781 369 66
E-mail: doherr @ fh-offenburg. de
Internet: http: // www fh-offenburg. de /

Martin FLECKENSTEIN
prof: BEB Erdgas und Erdö/Gwbh
Riethorst 12
D-30659 Hannover (GERMANY)
Tel: 49 511 641 22 87. Fax: 49 511 641 123 08
e-mail: 0513683874-000@t-online.de

GREECE

* ASSOCIATION of GREEK GEOLOGISTS (AGG)
President: Stavros Papastavrou
Didotou 26
10680 - ATHENS (GREECE)
Tel: 30 1 36 05 579 Fax: 30 1 36 05436

Stavros PAPASTAVROU
prof: I.G.M.E., Dpt. Econ. Geol.
Messoghion 57
G-11527 ATHENS (GREECE)
Tel: 30 1 77 155 61. Fax: 30 1 77 522 11

Maria-Hara ALEXIADOU
prof: GEOSCOPIO LTD
Delfon 5B - 15125 Maroussi (GREECE)
Tel: 30 1 68 97 568. Fax: 30 1 68 97 581

IRELAND

* IRISH ASSOCIATION FOR ECONOMIC GEOLOGY (IAEG)

President: Eibhlin Doyle

Gareth Ll. JONES
prof: Conodate International Ltd.
Parkview House Beech Hill O. C., Clonskeagh
DUBLIN 4 (IRELAND)
Tel: 353 1 269 84 64. Fax: 353 1 260 16 35
e-mail: conodate @ iol. ie Compuserve: 100302, 1100

Christian SCHAFFALITZKY
prof: CSA Ltd
Parkview House Beech Hill Office Campus
Clonskeagh
Dublin 4 (IRELAND)
Tel: 353 1 269 4077. Fax: 353 1 269 4424
e-mail: csa @ iol. ie Compuserve: 100302, 1100

ITALY

* CONSIGLIO NAZIONALE DEI GEOLOGI ITALIANI (CNGI)

President: Pietro De Paola
Via Vittoria Colonna, 40
I-00193 ROMA (ITALY)
Tel: 39 6 68 80 77 36/39 68 80 77 37
Fax: 39 6 68 80 77 42

* ASSOCIAZIONE NAZIONALE FRA I GEOLOGI ITALIANI (ANGI)

President: Floriano Villa
Via C. Battisti n.° 4
I-20122 MILANO (ITALY)
Tel: 39 2 551 28 42. Fax: 39 2 760 071 82

DELEGATES

Pietro DE PAOLA (ONG)
prof: Consiglio Nazionale dei Geologi (CNGI)
(Please, note preference for correspondence to be faxed)
(De préférence la correspondance sera télécopiée)
Via Vittoria Colonna, 40
I-00193 ROMA (ITALY)
Tel: 39 6 68 80 77 36 / 39 68 80 77 37
Fax: 39 6 68 80 77 42

OBSERVERS

Vittorio ILICETO
prof: Consiglio Nazionale dei Geologi (CNGI)
Via Vittoria Colonna, 40
I-00193 ROMA (ITALY)
Tel: 39 6 68 80 77 36 / 39 68 80 77 37
Fax: 39 6 68 80 77 42

Floriano VILLA
prof: Associazione Nazionale fra i Geologi Italiani (ANGI)
Via C. Battisti n.° 4
I-20122 MILANO (ITALY)
Tel: 39 2 551 28 42. Fax: 39 2 76 00 71 82

NETHERLANDS

* KONINKLIJK NEDERLANDS GEOLOGISH MIJNBOUWKUNDIG GENOOTSCHAP (KNGMG)

President: Elisabeth Kosters
Postbus 157
2000 AD HAARLEM (THE NETHERLAND)
Tel: 31 23 5300300 or 31 15 2786025
Fax: 31 23 535 16 14 or 31 15 278 11 89

Mrs. Elisabeth Kosters
ITC
Hengelosestaat 99
P. O. Box 6
7500 AA Ensechede (THE NETHERLAND)
Tel: 31 53 48 74 444
Fax: 31 53 48 74 200
e-mail: kosters@ITC.nl

PORTUGAL

* ASSOCIAÇÃO PORTUGUESA DE GEÓLÓGOS (APG)

President: Joachim Renato Araújo
Apartado 2109 P-1103 LISBOA (PORTUGAL)
Tel: 351 1 346 39 15
Fax: 351 1 342 46 09

Pedro Artur NOGUEIRA DE CARVALHO
prof: SOMINCOR, Mina Neves-Corvo
Sta. Bárbara dos Padrões
7780 CASTRO VERDE (PORTUGAL)
Tel: 351 86 68 000
Fax: 351 86 68 250/351 86 68 289

Joào M. M. TELO PACHECO
prof: GPEP
Rua Vale do Pereiro, 4
1200 Lisboa (PORTUGAL)
Tel: 351 1 388 35 41 Fax: 351 1 388 27 75
e-mail: IPP@ip.pt

SPAIN

* ASOCIACION DE GEOLOGOS ESPAÑOLES (AGE)

President: Luis Suárez Ordóñez
Avenida Reina Victoria, 8, 4.° B
E-28003 MADRID (SPAIN)
Tel: 34 1 553 24 03 Fax: 34 1 533 03 43

* ILUSTRE COLEGIO OFICIAL DE GEOLOGOS (ICOG)

President: Luis Suárez Ordóñez
Avenida Reina Victoria, 8, 4.° B
E-28003 MADRID (SPAIN)
Tel: 34 1 553 24 03
Fax: 34 1 533 03 43
e-mail: icog@telprof.eurociber.es
web: http://www.telprof.es/icog

Luis SUAREZ ORDOÑEZ
prof: RENFE, Jefe de Geotecnia
Estación de Chamartín, Caracola 22
Prolongación del Andén 1
Tel: 34 1 314 29 14
Fax: 34 1 323 20 93/94

Manuel REGUEIRO Y GONZÁLEZ-BARROS
prof: ITGE, Mineral Resources Division
Ríos Rosas, 23, 28003 Madrid
Tel. 34 1 349 57 78. Fax: 34 1 442 62 16
Dpt. Cristalografía y Mineralogía
Facultad de Ciencias Geológicas
Ciudad Universitaria
28040 MADRID (ESPAÑA)
Tel: 34 1 3944868 Fax: 34 1 3944872
e-mail eurgeomr@eucmax.sim.ucm.es (University)
mregueir@santandersupernet.com(home)

SWEDEN

* SVERIGES NATURVETAREFÖRBUND (SN)/GEOLOG-SEKTIONEN

President: Christer Åkerman
Box 760, S-13124 NACKA (SWEDEN)
Tel: 46 8 466 24 80. Fax: 46 8 466 24 04

Christer ÅKERMAN
prof: Sveriges Geologiska Undersökning (SGU), Box 670, S-75128 UPPSALA (SWEDEN)
Tel: 46 18 17 93 18 Fax: 46 18 17 92 10
e-mail: chaakc@sgu.se

Gunnar HULTQUIST
prof: Ålandsdal
S-740 20 BRUNNA (SWEDEN)
Tel: 46 18 39 21 38. Fax: 46 18 39 21 38
e-mail: gunnar.hultqvist@swipnet.com

UNITED KINGDOM

* GEOLOGICAL SOCIETY (GS)

President: Richard Hardman
Burlington House, Picadilly
LONDON W1V 0JU (UK)
Tel: 44 1 714 34 99 44. Fax: 44 1 714 39 89 75
http: //www.geolsoc.org.uk/

Richard A. FOX
prof: Land Search & Exploration Dept.
Ready Mixed Concrete (UK) Ltd., RMC House, High Street
FELTHAM, MIDDLESEX TW 13 4HA (UK)
Tel: 44 1 932 56 88 33. Telex: 935547 RMC G
Fax: 44 1 817 51 00 06
2-mail: rfox@rmcfeltham.u-net.com

Richard SELLEY
prof: Department of Geology
Royal School of Mines. Imperial College
Prince consort Rd.
London SW7 2 BP (UNITED KINGDOM)
Tel: 44 1 7 159 46 425. Fax: 44 1 7 159 46 464
e-mail: r.selley@ic.ac.uk

OTHER COUNTRIES

OBSERVERS

AUSTRIA

* Jean F. SCHNEIDER
prof: ETM Hönggerberg
8093 Zürich (SWITZERLAND)
Tel: 41 1 633 25 21/41 1 633 27 42 (secretariat)
Fax: 41 1 633 11 88

BULGARIA

* Kiril ANGUELOV
prof: University of Mining & Geology
SOFIA 1100
BULGARIA/BULGARIA/BULGARIE
Tel: 359 26 25 81 (ext 377)
Fax: 359 2 62 10 42 or 359 2 77 63 38

CANADA

* ASSOCIATION PROFESSIONNELLE DES GEOLOGUES ET DES GEOPHYSICIENS DU QUEBEC

2093, 7ème rue, Val-d'Or
Québec J9P 6P6 (CANADA)
Tel: 1 819 874 1293. Fax: 1 819 874 5264

Neville-Warren CLOUTIER
419 boul. Saint Joseph Ouest
Outremont, Québec H2V 2P3 (CANADA)
Tel: 1 514 279 0730. Fax: 1 514 279 7139
e-mail: nevillew@login.nct

* CANADIAN COUNCIL OF PROFESSIONAL GEOCIENTISTS
Suite 1600, 734 Seventh Avenue Sw, Calgary AB
T2T 3P8 (CANADA)
Tel: (403) 232-8511. Fax: 403 269-27

Gordon D. WILLIAMS
Tel/Fax: (403) 247-3225
e-mail: williago@cuug.ab.ca

CZECH REPUBLIC

* CZECH ASSOCIATION OF ENGINEERING GEOLOGISTS (CAIG)
* CZECH ASSOCIATION OF HYDROGEOLOGISTS (CAH)

Presidents: Jaroslav Pasek and Miroslav Lobontka
Albertov 6 CS-12843 PRAHA 2
CZECH REPUBLIC)
Tel: 42 2 29 75 41

Jaroslav PASEK
prof: Department of Hydrogeology & Engineering Geology
Faculty of Sciences, Charles university, Albertov 6
CS-12843 PRAHA 2 (CZECH REPUBLIC)
Tel: 42 2 29 75 41

DENMARK

Svend STOUGE
prof.: Dansk Geologisk Forenig (Danish Geological Society)
Øster Volgade 5-7
1350 København (DENMARK)
Tel: 45 33 13 50 01.
Fax: (Danish Geological Society) 45 31 19 68 68
e-mail: st010@mmdgu.dgu.dk

Marianne VASARD NIELSEN
prof: The Danish Geological Society
Dansk Geologisk Forening
Elstedvaenge 27
8520 Lystrup (DENMARK)
Tel: 45 86 22 24 33. Fax: 45 86 74 24 33
e-mail: mvn.pka@po.ia.dk

HUNGARY

* MAGYARHONI FOLDTANI TARSULAT (MFT) (Hungarian Geological Society)

President: István Bérczi
Fö u. 68
1027 Budapest (HUNGARY)
Tel: 36 1 201 91 29. Fax: 36 1 156 12 15

István BÉRCZI
prof: MOL, Exploration and production Division
Batthyony út 45
H- 1039 Budapest (HUNGARY)
Tel: 36 1 180 0122 Fax: 36 1 180 2145
e-mail: iberczi@molkummi.datanet.hu

POLAND

* POLSKIE TOWARZYSTWO GEOLOGICZNE

President: Andrzej Slaczka
prof: Universytet Jagiellonski
Jagiellonian University, Institut of Geological Sciences
Oleandry 2a
30-063 Kraków (POLAND)
Tel/Fax: 48 12 33 22 70
e-mail: slaczka@ing.uj.edu.pl

RUSSIA

R. VOLKOV: Executive Secretary
USSR National Comittee of Geologists
Pyzhevky 7
109017 Moscow Zh - 17 (RUSSIA)
Tel: 7 095 231 75 00.
Fax: 7 095 230 21 79 / 7 059 233 55 90

SLOVAKIA

* UNION OF SLOVAKIAN GEOLOGICAL ASSOCIATIONS (UGAS)

President: Rudolf Ondrasik

Rudolf ONDRASIK
prof: Department of Engineering Geology
Faculty of natural Sciences, Comenius University
Mlynska dolina-CS-84215 BRATISLAVA (SLOVAKIA)
Tel: 42 7 72 89 81. Fax: 42 7 72 89 81
e-mail: ondrasik@fns.uniba.sk

SWITZERLAND

* SWISS GROUP OF ENGINEERING GEOLOGISTS (SGEG)

President: Peter Haldimann
Bühlstrasse 33
CH-8700 Küsnacht (SWITZERLAND)
Tel: +41 1 341 25 00. Fax: +41 1 341 25 70

EFG delegate: Johannes van STUIJVENBERG
prof: Umweltgeologe
Bernstrasse 34
3072 OSTERMUNDIGEN (SWITZERLAND)
Tel: 41 31 931 16 57. Fax: 41 31 931 34 79

* SWISS SOCIETY OF HYDROGEOLOGY (SSH)

President: Federico Matousek
Matousek, Baumann & Niggli AG
Mäderstrasse 8
CH-5401 Baden (SWITZERLAND)
Tel: 41 56 222 09 45. Fax: 41 56 221 50 45

EFG delegate: Johannes van STUIJVENBERG
prof: Umweltgeologe
Bernstrasse 34
3072 OSTERMUNDIGEN (SWITZERLAND)
Tel: 41 31 931 16 57. Fax: 41 31 931 34 79

USA

* AMERICAN INSTITUTE OF PROFESSIONAL GEOLOGISTS (AIPG)
National headquarters
7828 Vance Drive, Suite 103,
Arvada, Colorado 80003
Tel: 1 303 431 0831. Fax: 1 303 431 1332
e-mail: aipg@ix.netcom.com

Russell G. SLAYBACK
prof: Leggette Brashears Graham Inc
dom: 4 Increase Lane
Greens farms. CT 06436
Tel: 1 203 452 3100. Fax: 1 203 452 3111

William KNIGHT
prof: AIPG
Tel: 1 303 431 0831. Fax: 1 303 431 13 32

dom: 9721 West 87th Avenue
Arvada, Colorado 80005 (USA)
Tel: 1 303 424 4063
e-mail: aipgwvk@aol.com

Robert FONT
prof: President, Geoscience data Management
dom: P/O Box 795151
Dallas Texas USA 75379
Tel et Fax: 1 214 516 47 25
e-mail: 72263.1036@compuservc.com

PARIS OFFICE:

Jean-Claude VIDAL (Assistant-Secretary)
prof: UFG, Maison de la Géologie
77 rue Claude Bernard
F-75005 PARIS (FRANCE/FRANCIA)
Tel: 33 1 47 07 91 95
(tuesday, wenesday, thursday 9 h-17 h GMT)
Fax: 33 1 47 07 91 93
e-mail: efgparis@hol.fr

CGEU OFFICE:

C/O UBLG
Service Géologique de Belgique
Rue Jenner 13
1040 Bruxelles (Belgium)
Tel: 32 2 627 04 18. Fax: 32 2 647 73 59

REGISTRATION COMMITTEE MEMBERS FOR THE TITLE OF EUROPEAN GEOLOGIST

Dr. Eric Groessens. Chairman
Service Géologique de Belgique
13 rue Jenner, B-1040 Bruxelles
Tel: 32 2 627 04 02. Fax: 32 2 647 73 59

John Shanklin. Member
The Old Rectory, Dodleston
Chester H4 9JR, UK
Tel: 44 244 66 03 18

Dr. Jose Carvalho. Member
Sondageus E Fundacôes A Carvaco LDA
Av Eng. Duarte Pachec 212
1018 Lisboa codex. Portugal
Tel: 351 1 65 80 71/4. Fax: 351 168 07 05

Reserve Members

Leif Carserud
Kastanjegatan 20
22359 Lund (SWEDEN)
Tel: 46 46 13 14 56

John Colthurst
Blackhall Clane,
co Kildare (IRELAND)
Tel: 353 45 68868. Fax: 353 45 68934

Richard A. Fox
prof: Land Search & Exploration Dept.
Ready Mixed Concrete (UK) Ltd., RMC House,
High Street
FELTHAM, MIDDLESEX TW13 4HA (UK)
Tel: 44 932 56 88 33. Fax: 44 817 51 00 06

J. M. Baltuille
prof: Instituto Tecnológico Geominero de España
C/ Ríos Rosas, n.° 23
28003 Madrid (SPAIN)
Tel: 34 1 3495788. Fax: 34 1 4426216

Gérald Clément
5 Residence de la poste
F. 91370 VERRIERES LE BUISSON (FRANCE)
Tel: 33 1 69 30 68 64

EUROGEOJOBS THE JOB SERVICE OF THE EUROPEAN FEDERATION OF GEOLOGIST

Fédération Européenne des Géologues, Maison de la Géologie, 77 rue Claude Bernard, 75005 Paris France,
Tel : 33 1 47 07 91 95, Fax: 33 1 47 07 91 93 e-mail : efgparis@hol.fr
Co-ordinator : J.C. Vidal

Services

Circulation of lists of offers collected throughout Europe from National Associations, official national job services, web sites, professional press, newspapers, offers received at Eurogeojobs.

- Selection of potential candidates for offers directly received from companies
- Advice
- Directory of companies employing geologists: this service is still not available, you will be advised once it exists.

Lists of offers

A new list is circulated to all the members of Eurogeojobs every two or three weeks, depending on the number of new offers and/or the time table of the co-ordinator of Eurogeojobs.

Selection

Eurogeojobs gives companies the opportunity of selecting from its files potential candidates for their offers. You can choose to use this service or not. Details, qualifications, experience and CVs of the members of Eurogeojobs are put in a database. When an offer for selection is received, the potential candidates are selected by Eurogeojobs using the database and the CVs. Then , according to the company choice:

- The offer is sent only to the potential candidates
- The CVs are sent to the company making the offer.

For persons who want confidentiality, for example those who don't wish their CVs sent to their own company, it is possible to send the CV with only a reference number. In that case, Eurogeojobs later organises the contact if the person is selected.

Registration

Requirements

- Proof of membership of one of the National Association members of the EFG, specify unemployed if it is the case.
- Registration form, containing details of bank card, filled and signed (English or French)
- A CV in any language

Registration

Each registration covers a period of about 4 to 6 months which corresponds to the mailing of 8 lists of offers

New registration

You are informed when the last list of offers is sent, so that you can register again if you like.

For a new registration you have to send a new registration page, filled, dated and signed.

Inform Eurogeojobs whenever your personal details change.

Filling the form

Type it, if possible, or write it in block capitals, specially for the address; a wrong address will cut communication between you and Eurogeojobs.

Keep a blank copy of the form which you will use for further registration or send changes in your personal details

Fees

The fees only cover the costs that the EFG cannot pay for.

- Unemployed: 17 ECU for each registration period
- Employed: 34 ECU for each registration period

Because bank charges for cheques or transfers are still very high, about the same amount as the fees, only payment by bank card is accepted. You have to give your card details, date and sign the registration form. The equivalent in French francs of the fee in ECU will be drawn out from your bank account.

CV

Send a CV with your registration form.

- Specifications: only one page size A4, well printed, without grey tint (to be scanned on the computer) with at least a margin of 1 cm on each side and without photograph (it takes a lot of space on the computer)
- If you desire confidentiality, send 2 copies, one with and one without your personal details
- Some advice:

- Give the name of your diplomas in the original language and not an equivalent of another foreign diploma, Eurogeojobs will send the companies a correspondence key for European diplomas

- With the diploma give a short list, in small characters, of the relevant main subjects of your curriculum, that will help.

- Give the names of your diplomas in other subjects, like computer sciences or management.

- Language skills: for each language, try to be as specific as possible (re the registration form), mention your diplomas in this language and your significant stays in countries where it is used.

SUSCRIPTION FORM - EUROPEAN GEOLOGIST MAGAZINE

EUROPEAN GEOLOGIST

Send to
European Federation of Geologists
ICOG
Avda. Reina Victoria, 8, 4.º B
28003 Madrid
Tel.: 34-1-3495778
Fax: 34-1-5330343
e-mail: icog@telprof.eurociber.es

☐ Yes, I want to receive the European Geologist magazine (2 issues)

Name .... VAT n.º ....
Company ....
Activity ....
Address ....
P.O.B. .... City .... Country ....
Tel ....
Fax ....

Payment: by credit card: Access / Mastercard / Visa / American Express

Amount due: ....
Card n.º ....
Expiry date: ....
Name of bearer: ....
Signature: ....

(Company seal)

EUROGEOJOBS

The job service of the EUROPEAN FEDERATION OF GEOLOGIST

Fédération Européenne des Géologues, Maison de la Géologie, 77 rue Claude Bernard, 75005 Paris France,
Tel : 33 1 47 07 91 95, Fax: 33 1 47 07 91 93 e-mail : efgparis@hol.fr
Co-ordinator : J.C. Vidal

REGISTRATION FORM

Personal details

Surname:.. Nationality:...

Name: .... Country:..

Sex:.............. National Association:..

Date of birth:...................................

Address: ....

....

....

Telephone:.. Fax..

e-mail...

Employment situation

Qualified student looking for its first job ☐ Unemployed ☐

Permanent job ☐ Temporary job ☐ Job outside earth sciences ☐

REGISTRATION DETAILS

Selection

I do not want to use this service ☐ I want my CV sent to companies with my personal details ☐

I want my CV sent to companies without my personal details ☐

Lists of offers

I want the lists sent by mail ☐ by fax ☐ by e-mail ☐

Payment

Card name.. Card number...

Name of the holder.. Date of end.........................

Amount to be drawn out...............ECU (For 1 registration period: Unemployed: 17 ECU, Employed: 34 ECU)

Date :....................................

Signature:

QUALIFICATION AND EXPERIENCE

QUALIFICATIONS

University diploma in Earth Sciences (give highest only, in original language) ....

....

National certification: ....

Other diploma in Sciences ....

....

Diploma, non scientific ....

EXPERIENCE

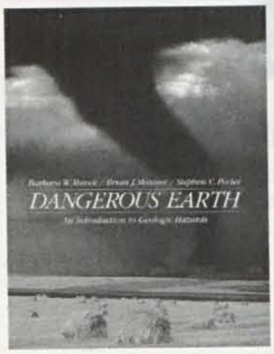
Professional experience:............years.

Scientific domains *Learned*			
	Applied geology (Environment, Eng geol, Hydrogeol,		....
			Other languages Level*
Statigraphy/palaeontology	Applied geophysics) ☐	.......years	English. ....
Sedimentology	Environment ☐	.......ears	French. ....
Petrograhy/mineralogy	Hydrogeology ☐	.......years	Spanish. ....
Structural geology/tectonics	Engineering geoL ☐	......years	Other........................
Geodynamics/regional geology	Mining ☐	.......years	....
Marine geology	Industrial minerals ☐	.......years	....
Hydrogeology	Oil & Gas ☐	.......years	....
Geophysics	Geophysics ☐	.......years	
Geochemistry	Mapping ☐	......years	• *bilingual or quasi: 1
Geomorphology	Research ☐	......years	• *good enough to work: 2
Remote sensing	Other.................. ☐	.......years	• *good scholar knowledge: 3
Modelling	.... ☐	.......years	• *notions: 4
Physics	.... ☐	.......years	
Chemistry	.... ☐	.......years	
Biology	Outside geology ☐	.......years	Expatriation outside
Computer sciences	Management ☐	.......years	Europe accepted ☐
Other	Team management ☐	.......years	
....	Law ☐	......years	
....	Other.................. ☐	.......years	
....	.... ☐	.......years	

Lenguage skills

Professional domains Learned Expérience

Mother tongue:



DANGEROUS EARTH. An Introduction to Geological Hazards.

Barbara W. Murck, Brian J. Skinner & Stephen C. Porter
John Wiley & Sons Ltd. 1997, 300 pp.
ISBN 0-471-13565-8. £18.99 Hardback. EurGeol M.Regueiro

The 90's were declared by the United Nations the International Decade of Natural Hazards Reduction. This book, part of a more comprehensive text, Environmental Geology, by the same authors, was born out of the need to educate undergraduates students about natural processes that affect our lives every day, with a clear objective: that future decision-makers were better prepared to take informed decisions resulting in a real Natural Hazards reduction world-wide.

1997 has been so far considerable disastrous; huge floods in the USA and a very recent earthquake in Afghanistan killing thousands and many other minor events everywhere damaging properties and lives. Thus this is a very appropriate and needed text to improve peopleís awareness of the proximity to danger that living in the Earth means.

The book is organised in two parts. A first one (Geological Framework) provides the basic geological knowledge to be able to understand the second part (Hazardous Geological Processes) covering the broad range of geological events that result in damage to people or goods: earthquakes, volcanic eruptions, landslides, floods, meteorite impacts and others.

Each chapter commences with an everyday situation or historical anecdote, to enhance the close relation between human beings and their geological environment, and ends with a comprehensive summary, a list of terms to remember and ìquestions and activitiesî, with proposals to stimulate critical thinking and debate.

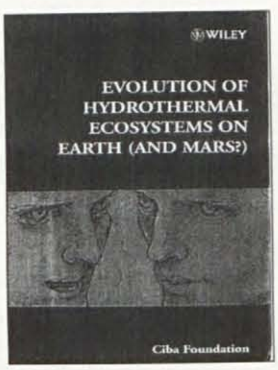
Expanded sub-chapters on technical aspects of geology and related sciences and particular aspects of the human-planet relationships achieve a very systematic review of Geology and Natural Hazards.

The book ends with a useful appendix including geological and chemical reference charts for students and teachers and an interesting list of WWW links on most of the subjects revised.

All chapters have a complete selection of excellent photographs and very clear graphics helping the reader to understand Earth behaviour and the geological reasons for its potential danger.

The book does not deal in detail with hazards from geological materials such as reactive minerals, asbestos and radon, as these have not been considered within the «Dangerous Earth» scope, butit is no doubt an excellent text to learn and lecture about geological hazards and how to prevent and mitigate its sometimes devastating effects.

Its mostly formative bias is represented by a full range of supplementary material that can be available to both teachers and students. Guides, instructors manual and text bank, transparency sets, slide sets and even a CD-ROM, completes the most powerful set of teaching tools that can be found to teach and learn more about our Blue Planet and how to live upon it in a safer way.



Evolution of Hydrothermal Ecosystems on Earth (and Mars?)

Bock, G.R. & Goode, J.A. (editors),
Ciba Foundation Symposium 202, Wiley, 1996, 334pp.
EurGeol Gareth Ll. Jones

This conference volume arises from one of the Ciba Foundation's multidisciplinary symposia held in London in 1996. It brought together scientists from the fields of geology, botany, biochemistry, microbiology, molecular biology, oceanic and atmospheric sciences, physics, mineral exploration, planetary and space science, NASA. They were looking for signs of the start of life on Earth and possibly on Mars.

This well produced volume presents seventeen papers that were given at the symposium. Indicative of the nature of this meeting are the extensive discussions that took place after each presentation, together with periodic general discussions on specific topics. Of some concern is the total lack of reference to any refereeing of the papers. Presumably this may reflects the pioneering aspect of the field, but it is one of which the participants should be extremely wary.

Stetter opens the volume by describing the anaerobic chemolithoautotrophic hyperthermophiles which justify the symposium. These primitive organisms like it hot (80-100°C), wet and without oxygen. They have been found in terrestrial hot springs, deep sea 'smoker' vents on spreading midoceanic ridges and in subterranean locations in oil reservoirs, etc.

Fascinating work by Barnes et al. on the rRNA of hot spring micro-organisms reveals a phylogenetic tree for Eucarya, Archaea and Bacteria, which has implications for extinct communities. In discussion Nisbet asked a "dumb geologist's" question - "Isn't it highly significant that you have just discovered eight or nine new phyla and a new kingdom?" Barnes replies that this is only the beginning! Shock demonstrates the complex chemistry associated with hydrothermal system environments which host observed micro-organisms and concludes that the rock composition is a crucial factor. Henley shows that volcanic collapse systems on oceanic ridges are favourable settings for life initiation and development on Earth. Des Marais explores the use of stable isotope geochemistry to delineate modern and ancient hydrothermal systems and their biological component. From hot springs and microbial mats, Pentecost suggests that sedimentary carbonate is important for travertine deposition by bacteria, but it may be silica and ochre that are common on Mars.

Walter reviews the ancient hydrothermal systems on Earth and covers 12 Phanerozoic deposits which have been demonstrated to be fossiliferous. The oldest is a Cambro-Ordovician submarine thermal spring, but there are several Proterozoic and Archaean deposits which provide exciting opportunities for examining early life on Earth. Trewin looks at the Devonian Rhynie Cherts and hopes that this hydrothermal sinter system, which buried and preserved terrestrial and fresh water biota, may also yield information from the four species of possibly thermophilic cyanobacteria described. Cady and Farmer also look at fossilisation in siliceous thermal springs and suggest from recent samples that lower temperature biota are more likely to be fossilised.

Summons et al. have looked at lipids produced by bacteria and can use them as diagnostic markers for biological processes in contemporary sediments. They suggest that searches of hydrocarbon-bearing fluid inclusions in ancient systems should be fruitful.

Knoll and Walter review the palÊobiological evidence from spring precipitates and hydrothermal metal deposits. Although this may be of limited value for interpreting Martian fossils, it provides useful points of comparison in what must be a broad approach.

Huntington shows how remote sensing with non-invasive spectroscopy allows the identification of hydrothermal systems on Earth. He suggests the technique should also work on Mars. Horn reviews current mineral exploration techniques and suggests that geochemistry and passive geophysical methods would be used for exploring for hydrothermal systems on Mars.

Carr then reviews the evidence for water on Mars. 3.8Ga ago there was the equivalent of a planetary water cover of a few hundred metres. This is indicated by large flood channels, valley networks and ground ice features. Today there is still a significant amount of water trapped in the planetary megaregolith below a thick permafrost zone. Although volcanism declined after the end of heavy bombardment, it is expected that hydrothermal activity continued and played a major role in recycling water. However, it is not yet clear which are the best places to look for such activity. However Kuzmin then lead a general discussion and suggested two possible locations for potential hydrothermal systems on Mars.

Farmer then assessed the evidence for hydrothermal systems on Mars and suggested that present Earth-based exploration methods used by the mining industry should be adapted. Especially a high spacial, hyperspectral, near-infrared spectroscopy tool. He lists possible sites including channels on volcanic slopes, caldera floors, volcanic fissures, fretted channel terranes, chaotic terrains and associated outflow channels, rifted basins and channels surrounding impact craters. He also notes the iron-rich deposits on the floors of some chasmata and compares them terrestrial stratiform ore deposits.

Davies then examined the possible transfer of viable micro-organisms between planets. He reviews the history of bombardment of the planets by cosmic debris and shows that ejecta from these impacts can achieve an escape velocity to enter space. After exploring the theoretical dynamics of the transfer and survival of any micro-organisms within ejecta, he suggests that this is a possible mechanism for the transfer of life throughout the solar system.

Finally Walter sums up this interesting book and points the direction that future research must go. If you want to know what is happening at the cutting edge of research in this disparate field, then this book will inform you about all aspects of primitive life on Earth and the possibility of it existing, or having existed, on Mars.

EUROPEAN GEOLOGIST MAGAZINE

Characteristics

Name: EUROPEAN GEOLOGIST
Print run: 10000
Periodicity: Twice per year
Print mode: Offset
Size: 210 × 297 mm

ADVERTISING RATES

INSERTIONS	ONE INSERTION	TWO INSERTIONS
Outside back cover	700 ecu	1.120 ecu
Inside front and back cover	600 ecu	960 ecu
Full page (colour)	500 ecu	800 ecu
Half page (colour)	250 ecu	400 ecu
Quarter page (colour)	150 ecu	240 ecu
Full page (b&w)	250 ecu	400 ecu
Half page (b&w)	125 ecu	200 ecu
Quarter page (b&w)	75 ecu	120 ecu
Preferential location	20 % plus	
Advertising Article	20 % plus	

METHOD OF PAYMENT

☐ By cheque made payable to Federation Europèenne dos Géologues written in Francia and payable in a French bank. Att: Jean Claude Vidal. Secretariat of the European Federation of Geologists «Maison de la Géologie» 77-79. Rue Claude-Bernard. 750005 Paris. France.

☐ By bank transfer to Crédit Lyonnaise 50, Rue Mouffetar. 750005. Paris. France. Bank code 30002. Branch code: 00807, Account number: 5774 L.

☐ By credit card: Access / Mastercard / Visa / American Express.

Card. n.º: ....

Expiry date: ....

Name of beacer: ....

EUROPEAN GEOLOGIST MAGAZINE ADVERTISEMENT ORDER FORM
(* delete as appropriate)

Please reserve a: quarter/ half/full page advertisement *

The advertisement will be black & white/ colour *

in the following issues of European Geologist:

Dec97/ June98/ Dec98/ June99 *

Advertisement material is enclosed/ will follow/ other * (please state) ....

....

....

....

Date: ....

Total remittance payable with this form: .... ECU

GEO CALENDAR

1997

JULY

July 4-6. *Field Excursion: Quaternary Geology of West Cumbria.* Att: Michael Browne, BGS, Murchison House, West Mains Road, Edinburgh EH9 3LA. Ph: 0131 650 0289. E-mail: m.browne@bgs.ac.uk. Fax: 0131 668 2683.

July 7-9. *1st International Conference on Environmental Restoration.* Ljubljana, Slovenia. Slovenian WPCA. Fax: 386 61 125 9244.

July 9-12. *Mining Philippines'97.* Att.: Stephen Luffi, Director. Ph.: 44 0 171 486 1951. Fax: 44 0 171 413 8222.

July 10. *Using the Internet for Geoscience Teaching and Learning.* Geoscience Information Group. At University of Derby. Convenor: Paul Browning, Dept of Geology, University of Bristol, Bristol BS8 1RJ, UK, Ph: 44 117 928 7788, Fax: 44 117 925 3385. E-mail: paul.browning@bris.ac.uk.

July 10-12. *European Palaentological Association, 2º Congrès européen de Paléontologie: climates past, present and future.* Vienne, Autriche. L. Grauvogel-Stamm, Institut de Géologie, 1, rue Blessing, 67084 Strasbourg Cedex, France. Tél. 33/88 35 85 70. Fax. 33/88 36 72 35.

July 14-17. *I Congreso Paraguayo de Ingeniería Geotécnica.* Asunción, Paraguay. S.P.G. Att: Ing. Miguel Stanickevsky, Presidente. I. COPAINGE, Ave. España 919, Casilla de Correo 336, Asunción, Paraguay. Fax: 595 (21) 80 592.

July 15. *Ground Water Hydrology,* Dayton, OH. Att: Wright State University, Center for Ground Water Mgmt., 3640 Colonel Glenn Hwy; 056 Library, Dayton, OH 45435, Ph: 513 873 3648, Fax: 513 873 3649, E-mail: IRIS@desire.wright.edu , htpp: //biology.wright.edu/cgwm/cgwm_home.html.

July 16. *GSA Presidential Conference on « Ethics in the Geosciences «*, Welches, OR. Att: Heidi Hortin, South Pass Resources, 11259 E. via Linda, St.100 - 949, Scottsdale, Z 85259

July 22-25. *AIR FILTRATION & PURIFICATION ASIA'97.* Conferencia y exposición sobre productos y tecnología para mejorar la calidad del aire. Singapur.

July. 28-Aug. 1. *GeoSciEd II.* Second International Conference on Geoscience Education. University of Hawaï.Hilo; Hawaï. Contact: M. Frank Watt Ireton, GeoSciEd II Registration, Education & Research Directorate, American Geophysical Union, 2000 Florida Avenue, NW, Washington, DC 20009. E-mail: fireton@agu. org.

July 30- Aug. 3. *Bicentenial Conference: Charles Lyell,* London UK. Att: Geological Society, Burlington House, Piccadilly, London W1V - JU,UK, Ph: 44 171 434 9944. E-mail: conf@geolsoc.cityscp.co.uk.

AUGUST

Aug. 9-12. *Discussion Meeting on the Caledonides of Britain and Scandinavia.* Tectonics Studies Group. At Glasgow University. Convenorss: Drs. Geoff Tanner, Tim Dempster & Professor Brian Bluck, Dept of Geology & Applied Geology, University of Glasgow, Glasgow G12 8qq. E-mail: G.Tanner@geology.gla.ac.uk. T.Demmpster@geology.gla.ac.uk. and b. Bluck@geology.gla.ac.uk. Fax: 0141 3304817. Ph: (Univ exchange) 0141 3398855, (Dept Office) 0141 3305437.

Aug. 10-17. *12º Congrès International de spéléologie et 6º Colloque d'hydrologie en pays calcaire et en milieu fissuré.* La Chaux-de-Fonds (Neuchatel). Suisse. Sublime, Case postale 4093. CH- 2304. La Chaux-de-Fonds. Suisse. E-mail: congress.uis97@chyn.unine.ch.

Aug. 15-17. *6th Conference on «Limestone Hydrology and fissured Aquifers».* La Chaux-de-Fonds (Switzerland). Organized within the framework of the 12th International Congress of Speleology. Prof. F. Zwahlen, Hydrogeology Centre, Rue Emile Argand 11, CH-2007 Neuchatel. Tel. 0041/38/23 26 00. Fax. 0041/38/23 26 01. E-mail: darko. semic @ chyn. unine. ch, Address internet: http.// www.unine.ch/UIS 97/

Aug. 18-29. *29th General Assembly of the International Association of seismology and physics of the Earth's Interior.* Thessalonique, Gréce. 29th IASPEI general assembly geophysical laboratory, University, GR- 54006, Thessaloniki, Grèce. Tél.30/31 998 526. Fax 30/31 998 528. E-mail: iaspei@olymp. ccf.auth.gr.

Aug 26. *Contaminant Hydrogeology, Monitor Well Desing and Construction, Aquifer Test Analysis, Well Hydraulics, Ground Water Flow Modeling Using MODFLOW,* Dayton, OH. Att: Wright State University, Center for Ground Water Mgmt. 3640 Colonel Glenn Hwy; 056 Library, Dayton, OH 45435, Ph: 513 873 3648, E-mail: IRIS@desire.wright.edu , htpp: //biology.wright.edu/cgwm/cgwm_home.html.

Aug 28 - Sep 3. *AIG IVth international Conference on Geomorphlogy.* Bologne, Italie. Paolo Forti, Planning Congressi, via Crociali 2, I -40138 Bologne, Italie. Fax: 1939/51309477.

SEPTEMBER

Sept. 1-5. *International Symposium on Geology and Environment.* Istanbul, Turkey. Secretary GEOENV'97. P.K. 464 Yenisehir, 06444 Ankara, Turkey. Tel. 90-3124343601. Fax. 90-3124342388. e-mail: degan @ jco.hun.edu tr.

Sept. 1-5. *Association of European Geological Societes 10th Meeting,* Challenges to Chemical Geology'97, Carlsbad, Czech Republic. Att: Vojtech Janousek, Czech Geological Survey, Klorov 3, 118 21 Prague 1, Czech Republic, 420 2 581 6620, E-mail: janousek@cgu.cz ,http: //www.cgu.cz/maegs.htm.

Sept. 2-6. *Symposium Int. on geosciencie and environmental protection.* Istanbul, Turquie. T. Cebi, Int. symposium geosciencie, PK 464 06 424 Kizilay-Ankara, Turquie. Tél. 90/312 432 30 85. Fax 90/434 23 88. E-mail: jdogan@et.cc.hun.edu.tr

Sept. 2-4. *RSS97. Geological Remote Sensing Group.* At Reading University. Convenor: Dr. Gavin Hunt, RTZ Mining & Exploratio, 4 The Broadway, Newbury, Berks RG13 1BA. Ph: 44 0 163548511. Fax: 44 0 1635 35542. E-mail: gavin@me.rtz.co.uk.

Sept. 2-5. *Minecon Africa'97.* South Africa. Mining Construction Africa. Inf: Africa's Exhibition Specialists-P.O. Box 650302, Benmore 2010, Johannesburg, South Africa.

Sept. 2-6. *Exploiter les Reseaux d'eau potable.* Limoges, France. Inf: Office International de l'Eau (Nadine Vilatte), Rue Edouard Chamberland, 87065 Limoges Cedex. Ph: 55 11 47 73 ou 55 11 47 77.

Sept. 3-4. *Alexandria University Third Conference in Geochemistry,* Alexandria. Egypt. Att: A.M. El Bouseily, Alexandria University, Faculty of Science, Geology Dept., Alexandria, Egypt, Ph: 20 3 492 1595.

Sept. 4-5. *Applying Hydrogeology and Fluid Flow Modelling to Metamorphic Systems.* Metamorphic Studies Group. At University of Leeds. Convenor: Professor Bruce Yardley, Dept of Earth Sciences, University of Leeds, Leeds LS2 9JT UK. E-mail: b.yardley@earth.leeds.ac.uk.

Sept. 6-12. *14th International Congress of the ISSMFE.* Hamburg, Germany.Scientific organization: XIV ICSMFE 97, Deutsche Gesellschaft für Geotechnik e.v. Hohenzollernstr. 52, D45128 Essen.Tel. 201/78 27 23 et 201/77 08 21. Fax. 201/78 27 43. Organizing Committee: XIV ICSM-FE 97, c/o CPO Hanser Service, B.P. 1221, D-22882 Hamburg-Barsbüttel. Tel. 40/670 88 20. Fax. 40/670 32 83.

Sept. 7-10. *AAPG - International Conference and exhibition.* Vienne, Autriche. AAPG. Convention Dept., Box 979, Tulsa, OK 74101, USA. Tél. 1/918 560 26 79. Fax 1/918 560 26 84.

Sept. 8-11. *EUROFILLERS'97. International Conference on Filled Polymers and Fillers.* Industrial Minerals and in co-operation with The institute of Materials. Att: Susanne Wolf, British Plastics Federation, 6 Bath Place, Rivington Street, London ECAA 3JE. Ph: 44 0 171 457 5000. Fax: 44 0 171 457 5045.

Sept. 9-13. *4th Annual Conference & Trade Exhibition, Soil and Water Mgmt. for Urban Development, « Beyond the Drain- Future Direction for Stormwater Mgmt.»*, Sydney, New South Wales, Australia. Att: Alison Frost, Hawkesbury Technologies Ltd., UWS-Hawkesbury, P.O. BOX 415, Richmond, NSW 2753, Australia, Ph: 61 45 701 690. Fax: 61 45 701 520.

Sept. 10-14. *Geo-Engineering of Hazardous and Radioactive Waste Disposal.*At University of Newcastle upon Tyne. Att: George M. Reeves, EEG'97, Geological Society Engineering Group, Geotechnical Group, Drummond Building, Dept. of Civil Engineering, Newcastle University, Newcastle upon Tyne, NE1 7RU. Ph: 0191 2227121. Fax: 0191 2226613.

Sept. 10-15. *New MexicoFaults and Subsurface Fluid Flow: Fundamentals and Applications to Hidrogeology and Petroleum Geology.* Conveners: Laurel B. Goodwin, New Mexico Institute of Mining and Technology. William C. Haneberg, New Mexico Bureau of Mines and Mineral Resources. J. Casey Moore, University of California, Santa Cruz. And, Peter S. Mozley, New Mexico Institute of Mining and Technology. Application deadline: March 1, 1997. Send applicatios to William C. Haneberg, New Mexico Bureau of Mines and Mineral Resources, 2808 Central Avenue SE, Alburquerque, NM 87106, USA. E-mail: haneberg@nmt.edu

Sept. 12-15. *Short Field Meetng: Brittany.* Joint Association for Quaternary Research. Convenor: Dr. Brigitte Van Vliet-Lanoe, Geosciences, Universite de Rennes 1, 35042 Rennes cedex, France. Ph: 33 99 28 69 10. Fax: 33 99 28 61 00. E-mail: lanoe@univ-rennes 1.fr.

Sept. 17-20. *2nd Symposium on the Atlantic Iberian Continental Margin.* Cadiz, Spain. Att. Dr. Fx Javier Hernandez Molina. Facultad de Ciencias del Mar. Apdo. 40. Polígono del Río San Pedro s/n. 11510 Puerto Real, Cadiz. Spain. Ph. 956 470864. Fax: 956 470811. E-mail: margen@merlin.uca.es

Sept. 21-26. *XX Congreso Internacional de Procesos de Minerales.* Aachen, Alemania. GDMB, Gesellschaft Deutscher Metalhütten, und Bergleute e.V. P.O. Box 10 54. D-38668 Clausthal, Zellerfeld, Alemania.

Sept. 21-27. *International Association of Hydrogeologists XXVII Congress on Groundwater in the Urban Environment.* Nottingham, G.B. Stephen Foster (BGS), c/o Conference Nottingham, 309 Haydn Road, Nottingham NG5 1DG, G.-B. Tél. (44-115) 985 65 45. Fax (44-115) 985 66 12.

Sept. 22-26. *XXIII Convención de Ingenieros de Minas del Perú.* Arequipa. Perú. Inf: Instituto de Ingenieros de Minas del Perú. Srta. Marisol Palacio de Soldi. Las Camelias, 555 2 Lima 27, Perú.

Sept. 23-28. *Tectonics of Continental Interiors.* Brian Head Resort. Utah (near Cedar City). Conveners: Michael W. Hamburger, Indiana University. Stephen Marshak, University of Illinois. And, Ben A van der Pluljm, University of Michigan. Application deadline: February 15, 1997. Send applications to Michaek W. Hamburger, Dpt. of Geological Sciences, Indiana University, Bloomington, IN 47405, USA. E-mail: hamburg@indiana.edu Lois Elms

Sept. 21-27. *Groundwater in the urban environment.* Nottingham, G.B. Stephen Foster (BGS), c/o Conference Nottingham, 309 Haydn Road, Nottingham NG5 1DG, G.-B. Tél. (44-115) 985 65 45. Fax (44-115) 985 66 12.

Sept. 29 - Oct. 3. *ISWA'97 WORLD CONFERENCE.* Conferencia anual de la Asociación Internacional de Residuos Sólidos. Wellington, Nueva Zelanda.

Sept. 29 - Oct. 3. *7º Conference Internationale «Espace Souterrain.* Villes intérieures de demain». Montréal, Québec, Canada. Organizing Committee, 303 Notre-Dame St. E. 5º floor Montreal, Quebec, Canada H 2Y 3Y8. Ph.:(514) 872-8343. Fax (514) 872-0024. E-mail: 7e Confso @ odysee. net / 7e confso.

Sept. 29 - Oct. 3. *7º Conference Internationale «Espace Souterrain. Villes intérieures de demain».* Montréal, Québec, Canada. Organizing Committee, 303 Notre-Dame St. E. 5º floor Montreal, Quebec, Canada H 2Y 3Y8. Ph.:(514) 872-8343. Fax (514) 872-0024. E-mail: 7e Confso @ odysee. net / 7e confso.

OCTOBER

Oct. 1-8. *Détection et repérage de réseaux enterrés.* Limoges, France. Office International de l'Eau (Nadine Vilatte), Rue Edouard Chamberland, 87065, Limoges Cedex. Ph: 55 11 47 73/77

Oct. 4-5. *Geophysical Applications in the Quaternary.* Environmental and Industrial Geophysics Group. Secretary: Dr. John Reynolds, Reynolds Geo-Sciences Ltd, The Stables, Waen Farm, Nercwys, Mold, Flintshire CH7 4ED. Ph: 01352 753196. Fax: 01352 759353.

Oct. 5-8. *Chinese Minerals/Fluorspar.* IMIL. Hilton Hotel, Shanghai, China. Contact: Sharon Thomas, Industrial Minerals, Park House, Park Terrace, Worcester Park, Surrey KT4 7HY. Fax: +44 (0) 181 337 8943.

Oct. 14-18. *XVII Congreso Mundial de Minería y XII Convención de Ingenieros de Minas.* Acapulco, México. Asociación de Ingenieros de Minas,Metalurgistas y Geólogos de México, A.C. Att. Srta Monica Medellín Avda. del Parque 54, Col. Nápoles, 03810 México D.F.

Oct. 15. *Geoscience GIS Used in Anger.* Geoscience Information Group. BGS, Keyworth, Nottingham. Conveners: Jenny Walsby, BGS, Keyworth, Nottingham NG12 5GG, Ph: 0115 936 3198. Fax: 0115 936 3475. E-mail: h.baxendale@bgs.ac.uk. John Gibson, BGS, Keyworth, Nottingham NG12 5GG. Ph: 0115 936 3172. Fax: 0115 936 3475. E-mail: j.gibson@bgs.ac.uk.

Oct. 15-16. *Like-Time Environmental Management of UK Offshore Oil and gas Operations.* Burlington House. Petroleum Group. Colin Macduff-Duncan, Esso Exploration & Production. UK Ltd. Ph.: 01372222567. Fax: 01372223469, e-mail:collin.r.macduffduncan@exxon.sprin.com.

Oct. 16-17. *Structuring and Selling Oil and Gas Programs for Profit,* New Orleans, LA. Att: The University of Tulsa, Div. of Cont. Educ. ,600 S. College Ave., Tulsa, OK 74104, Ph: 918 631 2347.

Oct. 19-23. *Conjunctive Use of Water Resources: Aquifer Storage & Recovery,* Long Beach, CA. Att: American Water Resources Association, 950 Herndon Parkway, Ste. 300, Herndon, VA 20170 5531.

Oct. 20-23. *Geological Society of America, ann. mtg.*, Salt Lake City. UT. Att: GSA Meetings Department, Box 9140, Boulder, CO 80301, Tel. 800 472 1988. E-mail: meetings@geosociety.org ,http: //www.geosociety.org.

Oct. 21-25. *FICOP, Feria de la Maquinaria para Construcción, Obras Públicas, Minería y Manutención.* Madrid, España. Inf.: INFOIFEMA, Parque Ferial Juan Carlos I, 28067 Madrid, España.

Oct. 22-23. *Course 170: Petroleum Geology of the North Sea. Basic Concepts and Recent Advances.* Joint Association for Petroleum Exploration. Secretary: Mrs. Jean Drury, JAPEC Administrative Secretary, c/o Geological Society, Burlington House, Piccadilly, London W1V 0JU. h 0171 434 9944. Fax: 0171 439875.

Oct. 29. *Material Characterisation from Near-Surface Geophysics,* at Burlintong House.EIGG. Convenor: Dave McCann, BGS Keyworth, Nottingham NG12 5GG. Ph: 0115 9363566. Fax: 0115 9363261. E-mail: D.McCann@bgs.ac.uk.

Oct. 29. *Research in Progress/AGM.* Geochemistry Group. At CheltenHam and Gloucester College, Convenor: Dr. Hugh Rollinson. E-mail: h_rollinson@cheltenham_he.ac.uk.

Oct-Nov. *North American IM Annual Meeting.* IMIL.To be advised, USA. Sharon Thomas, Park House, Park Terrace, Worcester Park, Surrey KT4 7HY. Fax. +44 (0) 181 337 8943.

NOVEMBER

Nov. *Industrial Minerals Forum & Annual Dinner.* IMIL. London, UK. Contact: Sharon Thomas, Park House, Park Terrace, Worcester Park, Surrey KT4 7HY. Fax. +44 (0) 181 337 8943.

Nov. 2-7. *Ninth International Conference of the International Association for Computer methods and advances in Geomechanics.* Wuhan, China. Prof. Jian-Xin Yuan, Chairman of IACMAG 97, Institute of Rock and Soil Mechanics, The Chinese Academy of Sciencies, Wuhan 430 071, China. Tel. (86) (27) 788 1776. Fax (86) (27) 786 2413.

Nov. 5-7. *Problems and Pitfalls in Joint Operating Agreements,* Houston,TX. Att.: The University of Tulsa, Div. of Continuing Education, 600 S. College Ave., Tulsa, OK 74104, Ph.:918 631 3088, e-mail:conted_cee@utulsa.edu

Nov. 7. *Contaminated Sediments International Conference.* Rotterdam, Netherlands. IAWQ. Ph: 31 24 323 44 71. Fax: 31 24 360 11 59.

Nov. 8-9. *Structural Controls and Genesis of Economic Resources* (Mineraland Hydrocarbon Deposits). Joint Meeting with Tectonic Studies Group, Mineral Deposit Studies Group, Irish Association for Economic Geology Meeting. Mineral Deposit Studies Group. At Trinity College Dublin, Ireland. Convenors: Dr. Ken McCaffrey, Kingston University. Ph. 44 181 547 2000. E-mail: k.mccaffrey@kingston.ac.uk. Dr. Lidia Lonergan, Imperial College, London. Ph: 44 171 594 6465. E-mail: Llonegan@ic.ac.uk. Dr. Jamie Wilkinson, Imperial College, London. Ph: 44 171 5946415. E-mail: j.wilkinson@ic.ac,uk. Dr. Patrick Wyse Jackson, Trinity College Dublin. Ph: 353 1 608 1477. E-mail: wysjcknp@tcd.ie. Dr. Kerr Anderson, Navan Resources. Ph: 353 1 46 22363.

Nov. 10-11. *North East Atlantic Palaeoceanography and Climate Change.* Marine Studies Group. At Southampton Oceanography Centre. Convenor: Dr. Colin Summerhayes, Southampton Oceanography Centre, Empress Dock, Southampton SO14 3Zh, Ph: 01703 596020. E-mail: CPS@soc.soton.ac.uk.

Nov. 11. *Bill Bishop Research Symposium: Recognizing Responses to Environmental Change.*Joint Association for Quaternary Research. At Burlington House. Secretary: Mrs. Sheila Bishop Bsc, 4 Ashridge Gardens, Pinner, Middx, HA5 1DU. Ph: 0181 8674966

Nov. 11-14. *IV Simposio Nacional sobre Taludes y Laderas Inestables.* Granada, España. Universidad de Granada y Universitat Politècnica de Catalunya. Joaquín Pérez Romero, Dpt. de Ingeniería Civil, E.T.S. Ingenieros de Caminos, Canales y Puertos. Universidad de Granada, Colegio Máximo Cartuja, 18071 Granada. Tel. 958- 24 61 38. E-mail: joperez@platon.ugr.es. Jordi Corominas, Dpt. Ingeniería del Terreno, E.T.S. Ingenieros de Caminos, Canales y Puertos. c/ Gran Capitán s/n. Edificio D-2. 08034 Barcelona. Tel. 93- 401 68 66. Fax. 93- 401 65 04. E-mail: corominas@ctseccpb.upc.es

Nov. 12-13. *Rates and Timescales of Magmatic Processes.* Geochemistry Group. At Burlington House. Convenor: Nick Rogers, Chris Hawkesworth or Simon Kelley, Dept of Earth Sciences, The Open University, Milton Keynes MK7 6AA. E-mail: n.w.rogers@open.ac.uk or s.p.kelley@open.ac.uk.

Nov. 12-15. *International Science in Ceramic Joining,* Bled, Slovenia. Att: Dr. Alida Bellosi, CNR-IRTEC. Via Granardo, 64. 48018 Faenza, Italy. Ph: 39 546 69 97 59.

Nov. 19-20. *Quaternary of Sellafield. Edinburgh.* Att: Michael Browne, BGS, Murchison House, West Mains Road, Edinburgh EH9 3LA. Ph: 0131 650 0289. E-mail: m.browne@bgs.ac.uk, Fax: 0131 668 2683. Martin Broderick, NIREX. Ph: 01235 825323. Fax: 01235 831 239.

Nov. 27. *Seminar and GCG AGM: New Developments at the Natural History Museum.* Geological Curators Group. At Natural History Museum, London. Convenor: Andew Clark. Ph: 0171 938 9282 or Cally Hall, Ph: 0171 938 8869.

DECEMBER

Dec. 2-3. *Course 172: Stratigraphic Problem Solving. Multifaceted Techniques for Stratigraphically Problematic Plays.* Joint Association for Petroleum Exploration. Att: Mrs. Jean Drury, JAPEC Administrative Secretary, c/o Geological Society, Burlington House, Piccadilly, London W1V 0JU. Ph: 0171 4349944. Fax: 0171 4398975.

Dec. 16-17. *Periglacial Workshop: periglacial Processes and Environments.* Joint Association for Quaternary Research. At University of Wales, Cardiff. Convenors: Dr. Charles Harris(IPA) Dept of Earth Sciences, University of Cardiff. Dr. Julian Murton(QRA) School of Chemistry, Physics & Environmental Sciences, University of Sussex.

1998 MARCH

Spring. *2nd International Symposium on water resources in karstic formations.* Kermanshah, I.R. of Iran. A. Afrasiabían, P.O. Box 15875-3584 Tehran, I.R. of Iran. Tel. +98 21 7520474. Fax. +98 21 7533186.

Mar. 24-28. *CONEXPO-CON/AGG'99.* Las Vegas. Inf.: CIMA, Construction Industry Manufacturers Association. 111 E Wisconsin AVE. Milwaukee. W1 53202 4879 Las Vegas. EEUU

Mar.30-Apr. 5. *BAUMA'98. XXV Edición del Salón Mundial de Maquinaria para Obras Públicas y Materiales de Construcción.* Munich, Alemania. Messe München GmbH. Messegelände. D-80325 München, Alemania.

Mar. 31-Apr. 3. *In Sight of the Suture: The Geology of the Isle of Man in its Iapetus* Ocean Contex. Isle of Man, UK. Att: Dave Quirk, Geology & Cartography Division, Oxford Brookes University, Gipsy Lane, Oxford OX3 OBP. Fax: 01865483926. E-mail: dgquirk@brookes.ac.uk.Bill Fitches, (Aberystwyth) & Nigel Woodcock (Cambridge).

APRIL

Apr. 13-17. *15th International Sedimentologi-cal Congress.* Alicante. Spain. Departamento de Ciencias de la Tierra y Medio Ambiente. facultad de Ciencias. Campus de San Vicente de Raspeig. Universidad de Alicante. Apt. 99. 03080 Alicante.Spain. Dr.Salvador Ordóñez. Chairman. Ph: 34 65903552 Fax: 34 65903552. e-mail: ctierra@vm.cpd.ua.es

JUNE

Jun. 7-9. *International Congress on «Underground Construction in modern infrastructure».* Underground construction 98, c/o Congrex (Sweden) AB. P.O. Box 5619, S-114 86 Stockholm, Sweden. Tel. +46 8 612 69 00. Fax. +46 8 612 62 92. E-mail: Congrex @ congrex. se, Internet: http: //www.congrex.se.

Jun. 29-July 18. *International Platinum Symposium.* IAGOD/CODMUR, Johannesburg, South Africa. (C.A. Lee, Box 68108, Bryanston 2021, South Africa. Tel. 2711/4112253. Fax. 2711/6923693).

AUGUST

Aug. 9-15. *International Mineralogical Association,* mtg., Toronto.(A.J. Naldrett, Dept. of Geology, University of Toronto, Toronto, M5S 3B1. Tel. 416/978 3030. Fax. 416/978 3938. E-mail: ima98@quartz.geology.uturonto.ca).

Aug. 20-26. *16 Congrés mondial de Sciencie du sol.* Monpellier, France. CNEARC, 16 Congrés mondial de Sciencie du sol, 11 01 avenue, d'Agropolis, B.P. 50 98, 34033 Motpellier Cedex, France. Tél. 33/67 61 70 23. Fax 33/67 41 02 32.

SEPTEMBER

Sept. 1-10. **XXI Congreso Mundial de Carreteras de la AIPCR**. Kuala Lumpur, Malasia. AIPCR. La Grande Arche, Paroi Nord, Niveau 1. La Défense. 92055 Paris La Défense. Cedex 04 (Francia). Tel. +33 1/47 96 81. Fax. +33 1/49 00 02 02. Tél. 90/312 432 30 85. Fax 90/434 23 88. E-mail: jdogan@et.cc.hun.edu.tr

Please send meeting notice three months before publication date to: *The Editor,* EFG, ICOG, Av. Reina Victoria 8, 28003 Madrid, Spain, Tel: 34-1-3495778, Fax: 34-1-4426216. e-mail: mregueir@santandersupernet.com Include date, title, sponsor, place of meeting and telephone number for information.

From 20 to 24 October 1997, and organised by the Ilustre Colegio Oficial de Geólogos de España.

Course on Engineering Geology of Lineal Infrastructures

Highways • Railways • Channels • Airports • Gas-ducts

Following its continual training policy, the Ilustre Colegio Oficial de Geólogos de España (ICOG) organises from 20 to 24th October 1997 a Course on Engineering Geology of Lineal Infrastructures, dedicated to geological and geotechnical studies of roads, highways, railways, channels, airports, gas-ducts, etc.

The course will have morning general and theoretical sessions and the explanations of practical cases in evening sessions.

One day will be dedicated to European lineal infrastructures. Thus the ICOG invites European Geologists with experience in this type of works to contact the director of the course in order to program their possible participation in the course. The ICOG will provide a certain number of scholarships for EurGeol's and EFG members. If you are interested please contact Luis Suarez at the ICOG. Tel: 34 1 5532403. Fax: 34 1 5330343. E-mail icog@telprof.eurociber.es.

EUROPEAN GEOLOGIST ARTICLES

The EFG need quality articles for future issues of European Geologists. EFG members and readers are encouraged to submit articles or contact the Editor to recommend individuals who should be asked to submit articles. Submissions should be 1000 to 2000 words in length, although longer texts could be accepted. Articles submitted on diskette along with a hard copy are appreciated. The Editor uses Word 6, Word 7, WP for Windows 95, or Mac files, both preferably in 3,5 diskettes. Photographs, figures, tables, etc are welcome. Photographs enhance articles and make great EG covers. Be sure to send photographs when possible with your article, or send your favorite photograph for considerations for a future EG issue. Submission deadline is weeks preceding month of issue. 1st May for June issue and 1st November for December issue.

Photographs or graphics shorwd be sent uncompressed in optical disk, removable disk or zip (100 Megabyle) disk when in computer format. Alternatively slides or paper copies are also welcomed.

Acceptable languages will be Spanish, English and French, although for the sake of uniformity it would be desirable to have them in English. Several methods of submitting reports and articles are available. Listed below in order of preference, are the methods of submitting materials to the European Geologist magazine.

1.–Send files via e-mail to MREGUEIR@SANTANDERSUPERNET.COM and follow with a fax to 34-1-4426216 for confirmation of the text.

2.–Send an IBM or MAC compatible computer disc (3,5") in Word 6, Word 7, Wp, RFT with a printout.

EDITORIAL EMPHASIS

Professional Topics
- –Geology in EUROPE
- –Education of Geology
- –Employment
- –Ethics & Standards of Practise
- –Public perception of Geology & Geologists
- –Certification & Licensing
- –Practising Geology Internationally
- –Governments & Geologists

Euronews
- –European Parliament news. Laws
- –European Commission news. Contracts
- –CGEU news. Activities

Technical Topics
- –Mineral Resources
- –Petroleum Geology
- –Hydrogeology
- –Environmental Geology
- –Engineering Geology
- –General Geology

Opinion
- –Political Geology
- –Future trends

Geonews
- –European Geologist news
- –European Geologist Title page
  - –EUR.GEO Benefits
  - –New members. Applicants
  - –FEG news
  - –Actions, Meeting Schedule
  - –New members
  - –International contacts
- –EFG membership
  - –Statistics
- –EFG Working Groups
- –Jobs
- –Geological news
  - Mineral Industry
  - FOREGS, EuroGeosurveys
  - Public Works
  - Hydrogeology

Publications

Geo Calendar

◄ TG 30-20 DPM-DPH
DYNAMIC PENETROMETER
4x4 SELF-PROPELLED

PAGANI
PENETROMETER TG 63-100 kN ►
SELF - ANCHORING SYSTEM
STATIC - DYNAMIC - ROTARY
RUBBER TRACKED SELF-PROPELLED

PENETROMETER TG 73-200 kN
SELF-ANCHORING SYSTEM
STATIC-DYNAMIC- ROTARY
6x6 SELF-PROPELLED

PENETROMETER TG 73-200 kN
STATIC-DYNAMIC- ROTARY

PENETROMETER TG 73-200 kN
STATIC-DYNAMIC- ROTARY
WITH WORK CABIN

EUROPEAN FEDERATION OF GEOLOGISTS (EFG)

The representatives of the British, Spanish, French and Italian National Associations of Geologists met in London in 1978 in order to establish the European Federation of Geologists and outline its Statutes, the final text being drafted during the meetings that took place in Paris and Madrid in the months of March and November 1979. Belgian and Irish geologists attended those meetings as observers.

The E.F.G. was officially born in Paris en 1980 during the 26th International Congress of Geology, and was composed of Professional Associations from Spain (A.G.E.-I.C.O.G.); Italy (A.N.G.I.-O.N.G.); Portugal (A.P.G.); United Kingdom (I.G. now incorporated in the G.S.); France (U.F.G.); Belgium and Luxembourg (U.B.L.G.). In July of the same year the Statutes were presented to the European Economic Community in Brussels.

The geologists of the Federal Republic of Germany (B.D.G.) became members of the F.E.G. in 1985, Ireland (I.A.E.G.) in 1988, Finland (F.U.G.) and Sweden (S.N.) in 1989, Greece (A.G.G.) and The Netherlands (K.N.G.M.G.) in 1993.

The E.F.G. currently represents some 65.000 geologists from 13 countries.

OBJECTIVES OF THE E.F.G.

1. To represent the geological profession in Europe. The Committee of Geologists of the European Community (C.G.E.C.) of the E.F.G. is the organization authorized to make representation to the European Union and its various bodies.
2. To safeguard and promote the present and future interests of the geological profession in Europe, including:
   - To guarantee the free movement of geologist in Europe, with the mutual recognition of their academic and professional qualifications by the adoption of the title of European Geologist.
   - 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 E.F.G.
   - To provide advice and assistance to constituent members National Associations.
3. To promote a European geological policy with regard to the responsible use of the Earth's Natural Resources and in particular:
   - Energy Resources.
   - Mineral Resources.
   - Hydrogeological Resources and their pollution problems.
   - Geological problems in land development, environmental protection and the exploitation of raw materials.