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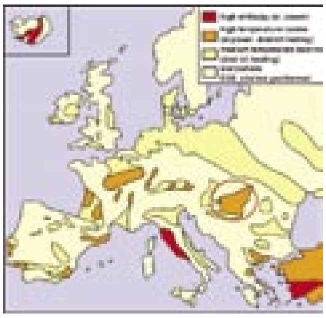

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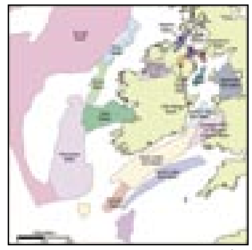

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"Welcome to the latest issue of European Geologist, and to our new and improved format for the magazine. The Editorial Board has been working hard to develop a new layout and more clearly defined sections, as well as identifying a broad theme for each issue around which articles will be based. The theme for this edition is 'Energy', and we hope you enjoy the wide variety of articles our contributors have responded with. In redesigning the magazine, we trust that we will continue to represent the interests of the various members of the Federation in an accessible way, maintaining the global outlook which has always been at the heart of the EFG's work".

The Editorial Board

Cover photos (clockwise from top)

GT Energy Ltd prospecting for deep heat on Blackrock Newcastle Fault, south side Dublin Basin, Ireland (Image: Gareth Jones)

Airtricity's Kingsmountain wind farm, Co. Sligo, Ireland

Airtricity's Bindoo wind farm, Co. Louth, Ireland

OpenHydro's impression of subsea base. Slow moving rotor minimizes rick to marine life

Wavebob image. Electricity generation from wave motion; experimental version on trial in Galway Bay, Ireland. Invented by William Dick

Photos this page (clockwise from top left)

Geothermal Europe; Sedimentary basins, Ireland; EFG Medal of Merit; Limestone cliffs of Mynydd Eglwyseg, Wales (photo: Stewart Campbell)

EURO-AGES logo; EFG Green Week logo

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Foreword

Geologists and the global crisis

by EurGeol. Manuel Regueiro, President

It has been said that we will reach the climax of the global crisis during 2009. The credit crunch and production drop affects everyone, including geologists.

In Spain, Ireland and the UK, drastic cuts in the construction industry, particularly in the housing sector, have affected the engineering geology market, with many layoffs and closures in geotechnical companies, especially in small and medium firms. Even so, geological unemployment in Spain, for example, has only risen from 2.5% to 5%, (total unemployment in Spain is today 13%).

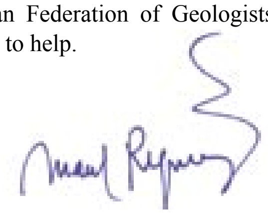
So European geologists may not yet be seriously affected by job losses, probably because the production of geologists is still very low compared with demand.

Even so, the future looks gloomy, and there is a need for a quick reaction from the professional associations. The EFG is doing its bit in several ways. First of all, by launching EU-financed Geotrainet and Euro-Ages projects; Geotrainet in the field of training of geologists in the geothermal field, and Euro-Ages to design the most adequate academic curricula for the education of geologists.

The potential job losses might mean that some geologists will change their current job, and to do that, they will need professional training. The EFG is currently drafting an agreement for its on-line training courses, and designing its first EFG Masters, probably on Mineral Resources.

But this is a global crisis, and we need a global professional response. Our current involvement with our colleagues in the United States and Canada might be the key to a cooperative effort to support our geologists on both continents. We should design coordinated employment services and a quick flow of job offers from one side to the other. Canada, in particular, has not been so badly affected by the financial crisis, and its mineral resources industry is buoyant. Canada needs more geologists because demand exceeds production. The free movement of professionals between Europe and Canada will no doubt help our European professionals, and for this the EFG has proposed an agreement for the mutual recognition of professional titles between the EFG and the Canadian Council of Professional Geoscientists (CCPG) which will help both sides to solve their current and future problems. I hope that this will finally mean another great success for the EFG and the CCPG and a brighter future for geologists in these critical times.

I am sure that we will survive this crisis, but the structural lack of geoscientists will affect recovery unless steps are taken to promote the interest of young people in Earth Sciences. The momentum gained by the International Year of Planet Earth 2007-2009 must be boosted again with a long-term plan to provide a more practical and useful view of geology to our citizens, particularly in developing countries, where our knowledge is more needed, and the European Federation of Geologists will be there to help.



 ISSN: 1028 - 267X

CO_2 capture and storage

by Wallace S. Broecker[1]

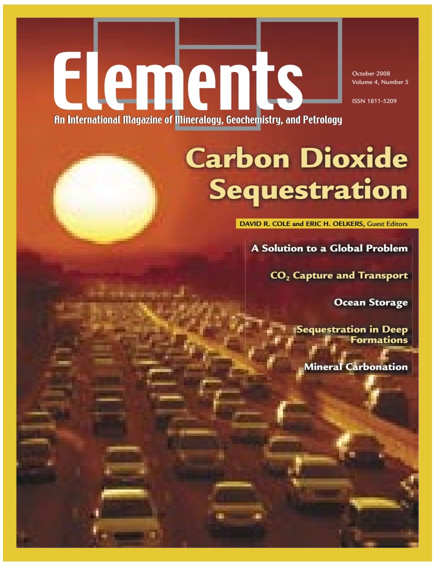
Reprinted from Elements 4, 2008

Few concerned with the need to stem the ongoing buildup of CO_2 in our atmosphere believe that this can be accomplished solely by some combination of conservation and non-fossil fuel energy sources. While both of these components are absolutely essential to any solution, even according to the most optimistic projections, they will fall short of the requirement to halt the CO_2 rise. Here, I present an objective description of solutions that have been proposed and end with my opinions, based on a long career of studying global chemical cycles.

Les quelques personnes concernées par le souci d'endiguer le développement croissant du CO_2 dans notre atmosphère croient que la solution passe par quelque combinaison associant conservation et sources d'énergie non fossiles. Tandis que ces deux paramètres restent fondamentaux dans la recherche d'une solution quelconque, selon les projections les plus optimistes, ils sont loin de satisfaire les exigences propres à stopper l'augmentation du CO_2. Cet article présente une description objective des solutions proposées et se termine par les opinions de l'auteur sur le sujet, opinions basées sur une longue carrière consacrée à l'étude des cycles chimiques dans leur ensemble.

Pocos que estén relacionados con la necesidad de detener la actual acumulación de CO_2 en nuestra atmósfera creen que esto se pueda acometer sólo por medio de la combinación de ahorro y de fuentes alternativas de energía. Si bien estos dos componentes son absolutamente esenciales para cualquier solución, incluso de acuerdo con las predicciones más optimistas, no serán capaces de reducir lo suficiente el aumento del CO_2. En este trabajo se presenta una descripción objetiva de las soluciones que se han propuesto y termina con mis opiniones personales, basadas en una larga carrera de investigación de los ciclos químicos globales.

The CO_2 rise must be halted, but the methods to accomplish this are still under debate. The facts are as follows. The growing demand for energy in developing countries certainly will far outstrip attempts at energy savings by the leading world powers. Coal will remain the cheapest source of energy for a very long time, and enough exists to fuel the planet for at least 150 years. The technology already exists to convert coal to gasoline at a cost less than what we now pay for petroleum. Thus, in the absence of some miracle that reduces the price of solar electricity or other renewable energy forms, additional options for halting the CO_2 rise will be required. These options fit into a single category: CO_2 capture and storage (IPCC 2005). If we are to halt the rise in CO_2, we will have to implement technologies to capture it at its source in electrical power plants, and also to pull it back out of the atmosphere. And, of course, means for storing or disposing of this CO_2 will also have to be developed.



Evidence from studies of ice core and sediments demonstrates that since agriculture began ~8000 years ago, the climate has remained remarkably stable (Broecker, 1997). This is in stark contrast to the preceding ~100,000 years, when there were very significant temperature fluctuations, from warm to glacial in just a few decades. Such rapid change suggests sensitivity to internal or external climate feedback. Also, the abrupt changes in palaeotemperatures and atmospheric CO_2 concentrations (e.g. Petit *et al.*, 1999) estimated from the ice and rock record may be telling us that the Earth's climate system has several distinct modes of operation and that it can jump from one mode to another in a matter of a decade or so. The only element of our climate system that has multiple modes of operation is the ocean's thermohaline circulation, which is sensitive to the freshwater budget at high latitudes (Broecker 1997). This raises the question of whether the mode shifts revealed in the climate record were initiated by the oceans, and if so, what influence would there be from a rise in temperature driven by greenhouse gases (GHG). Increased polar ice melting from GHG-induced global warming could, in turn, influence thermohaline circulation. Rather than showing a linear evolution, the climate might follow a nonlinear path with sudden and dramatic surprises when GHG levels reach an as-yet-unknown trigger point.

Overview of possibilities

Capture of CO_2 emissions from electrical power plants

Currently, roughly one-third of the CO_2 produced from fossil fuel burning in the USA is emitted from electric power plants. Retrofitting coal-fired plants currently in use for CO_2 capture is in many cases more expensive than replacing these plants with a new breed in which coal is treated with steam, thereby creating carbon monoxide

[1]Newberry Professor at Lamont-Doherty Earth Observatory of Columbia University. Internationally recognized for his research on climate change and a co-author of *Fixing Climate: What Past Climate Changes Reveal About the Current Threat – and How to Counter It*, recently published by Hill and Wang, New York.

and hydrogen. These gases would be oxidized in fuel cells, creating CO_2 and H_2O as end products. But this option currently does not cover the remaining two-thirds of American fossil fuel energy use. Hence, were there only the capture option, some means of extending its reach would have to be developed. For example, automobiles could be run on the hydrogen or the electricity generated by these plants, or gasoline and jet fuel could be manufactured by combining the hydrogen and carbon dioxide.

Capture of CO_2 directly from the atmosphere

Lackner *et al*. (1999) point out that despite the fact that air contains far less CO_2 than the gas emitted from an electric power plant, the cost of capture is dominated by the portion that represents release of the CO_2 from the capture medium. Thus, capture from air is as feasible as direct capture from a smoke stack. They also point out that a wind turbine moving at a reasonable wind velocity would only have to be two orders of magnitude larger than a collector that captures CO_2 to compensate for the emissions from a diesel engine that generates the same amount of electricity. Hence, just as wind turbines are competitive, so also should be air capture. The problem is that no one has yet demonstrated that CO_2 can be captured from air at an acceptable energy cost. To my knowledge, only one serious effort is underway to develop such a system. GRT, a company in Tucson, Arizona, USA, has been working on this problem for almost five years. They claim to have found the key and promise that by 2010 a commercial prototype will be available.

CO_2 burial in spent petroleum reservoirs

At best, only about half of the petroleum contained in oil fields comes out easily. As this resource becomes ever more scarce, hence more expensive, it will become financially favourable to implement what is known as improved (IOR), enhanced (EOR), or tertiary oil recovery (Lake, 1989). In one method, CO_2 is pumped into the reservoir, where it entrains part of the remaining petroleum, decreasing the oil's viscosity.

The CO_2 is carried back to the surface and is then separated from the petroleum and reinjected. In itself, this is not a storage solution, but because large quantities of CO_2 are needed and must be transported to the reservoir, future demand by oil companies could provide a jumpstart for the commercial implementation of CO_2 capture and transport. Also, when the enhanced recovery process has run its course, the spent reservoir can become a CO_2 storage depot.

CO_2 burial in saline aquifers

Large regions of every continent are underlain by sedimentary rocks. Below a depth of a kilometer or so, the pores in sedimentary rocks are generally filled with hypersaline water, which is of no value for agriculture. A strategy for CO_2 disposal is to drill into these aquifers and pump in liquid CO_2, displacing the resident water. The Norwegian company Statoil is already successfully disposing of CO_2 separated from natural gas in such an aquifer beneath the North Sea (Torp and Gale, 2004).

CO_2 disposal in the deep sea

The ultimate fate of the majority of fossil fuel CO_2 is dissolution in sea water. There, it is neutralized to HCO_3^- by reacting with carbonate and borate and with the $CaCO_3$-rich sediment that covers much of the deep sea floor. However, the deep sea is ventilated on a time scale of many centuries, so little of the excess CO_2 produced during this century would be neutralized in this way. However, an option to short-circuit the slow delivery pathways is to pump liquid CO_2 down into the deep sea. CO_2 delivered to depths exceeding 3.5 km is denser than seawater and would sink to even greater depths (IPCC, 2005). Further, it rapidly reacts with seawater to form an even more dense clathrate slush, which would accumulate on the ocean floor and then gradually dissolve and disperse.

CO_2 disposal in basalt

Layered basalt provinces, such as the Columbia River sequence in the USA, the Deccan Traps in India, the Siberian Basalts in Russia, and many more, offer not only storage depots for captured CO_2 but, more importantly, a means of low-temperature mineralization. Water charged with abundant CO_2 reacts with basalt, releasing Mg bound in pyroxene and olivine, which then combines with carbonate to form highly stable $MgCO_3$ (magnesite). Water with lower quantities of CO_2 reacts with plagioclase, releasing Ca which forms $CaCO_3$ (calcite). While these reactions have been carried out in the laboratory and are known to occur in nature, many questions still exist about their kinetics and by-products (McGrail *et al*., 2006; Matter *et al*., 2007). What fraction of the CO_2 injected into basalts can react before it finds its way back to the surface? Do the carbonate minerals so formed clog the plumbing? Will alteration by-products (silica, clay minerals, zeolite, etc.) coat the surfaces, slowing the reaction between the CO_2-charged water and the rock? Clearly, experiments must be conducted to answer these and other questions.

Disposal in lakes beneath ice caps

Although very likely unacceptable from an environmental perspective, disposal of CO_2 in lakes beneath the Antarctic ice cap is certainly a geochemically sound storage option. At the temperatures and pressures prevailing in that environment, CO_2 would form a clathrate that would settle to the rock floor beneath the lake. Unlike disposal in the deep sea, the clathrates would not dissolve because, in the closed system of the lake, the overlying water would quickly become saturated in CO_2 gas. Although the formation of clathrates ($6H_2O$-$1CO_2$)

would remove CO_2 from the lake's water, the heat released during their formation would melt a nearly equivalent amount of ice from the lake's roof.

Mineralization of magnesium-rich rocks

In the long term, it might turn out that the best option is to mine ultramafic rock (i.e. rock made almost entirely of magnesium and silicon oxides), grind it in a processing plant, and react it with captured CO_2 to form $MgCO_3$ (magnesite) (Seifritz, 1990; Lackner *et al*., 1995). The products would be stored in the pits created by the mining. The main obstacle is to find a means to do it economically in terms of both money and energy costs (IPCC, 2005).

Seafloor disposal

Going a step beyond storage in the deep sea, it has been proposed that CO_2 be injected into the basalts that line the mid-ocean ridge crest or in $CaCO_3$-rich sedimentary sequences (House *et al*., 2006; Levine *et al*., 2007).

A few words in perspective

After this brief, objective summary of capture and storage options, I now add my own opinions. These are based on a long career, much of it spent studying global geochemical cycles.

With regard to capture, I strongly favour direct capture from the atmosphere. For a number of reasons, I consider it an absolutely essential component of any strategy designed to stem the buildup of CO_2:

- Because facilities for such capture are not linked to the energy grid, they can be located anywhere on the planet
- As envisioned by Global Research Technologies, GRT, the company in Texas developing this technology, the individual units will be "Toyota"-sized (each capable of capturing one ton of CO_2 per day), as opposed to "battleship"-sized coal-gasification facilities. As a result, they could be mass produced and more easily distributed. As is the case of automobiles, the design could be continually upgraded, making them ever more durable, efficient, and economical
- Once the rise in CO_2 has been stemmed, air capture can be used to bring the CO_2 content of the atmosphere back to an acceptable level
- Because some sort of international agreement regarding the distribution of future CO_2emission rights will eventually have to be negotiated, as a bargaining chip, the rich nations could offer to remove a portion of the CO_2 released during the preceding decades. In this way the playing field can be levelled.

With regard to disposal, I lean toward the deep ocean as the most favourable early-stage option. However, in response to the strong Greenpeace stand against what they refer to as ocean "point pollution," little is being done to explore either the costs or the environmental consequences of this option. Their stand includes a threat to disrupt any attempt to conduct pilot experiments, so in a sense, they hold a pocket veto. I consider this to be an extremely unfortunate circumstance, and I have initiated a campaign aimed at convincing them to abandon such aggressive tactics.

I am also convinced that, in the long term, we must turn to solutions that involve chemical neutralization (immobilization) of CO_2, as opposed to simply storing it in gaseous form. Hence, I consider petroleum reservoirs and saline aquifers as interim storage solutions.

Ultimately, we must learn to economically bind CO_2 with the magnesium and calcium contained in silicate rocks, whether it be under *in situ* or *ex situ* conditions. As a participant in the basalt storage project currently underway in Iceland, I have become aware of the complexity of the required research.

Looming in the wings is yet another technological fix designed to deal with the rise in greenhouse gases. It involves purposely altering our planet's albedo by delivering large quantities of SO_2 to the stratosphere (Wigley, 2006). Once there, it would be oxidized to form H_2SO_4 aerosols. These aerosols would reflect sunlight away, thereby countering greenhouse warming. I do not consider this to be a solution, but rather an insurance policy against a bad CO_2 trip. As we have assumed the role of planetary stewards, we must strive to clean up our waste products, rather than treat them with Band-Aids!

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Geological storage of CO_2 in the island of Ireland: a review

by Dr. Deirdre Lewis[1]

SLR Consulting Ireland, with partners, carried out an assessment of the potential for geological storage of carbon dioxide (CO_2) on the island of Ireland. The study commenced with a preliminary geological assessment of likely storage structures, followed by in-depth assessment of identified structures/basins, to quantify potential storage sites. A potential geological storage capacity of 93,000Mt was quantified, but the lack of deep geological data for many basins is the main constraint to a full assessment of geological storage potential in Ireland. Complementary economic analysis suggests that CCS may be viable, following further research.

La Compagnie SLR Consulting Ireland et ses partenaires ont effectué une évaluation du potentiel de stockage géologique du dioxyde de carbone (CO_2) sur le territoire irlandais. L'étude a commencé par une évaluation géologique préliminaire des structures de stockage a priori favorables, suivie par une évaluation détaillée des structures identifiées (bassins), pour quantifier les capacités de stockage. Une capacité de stockage potentiel de 93 000 Mt a été chiffrée mais le manque de données sur la géologie profonde de beaucoup de bassins représente la principale contrainte pour obtenir une pleine évaluation des capacités de stockage du CO2 en Irlande. Une analyse économique additionnelle suggère que le stockage pourrait être viable, à l'issue d'un complément de recherches.

La empresa SLR Consulting Ireland, en colaboración con diversos socios, ha realizado una evaluación del potencial de almacenamiento de dióxido de carbono (CO_2) de Irlanda. El estudio comenzó con una evaluación geológica preliminar de potenciales estructuras de almacenamiento, seguido de una evaluación en profundidad de las estructuras/cuencas identificadas, para cuantificar los potenciales lugares de almacenamiento. Se ha estimado un potencial de almacenamiento de 93,000Mt, pero la falta de datos geológicos profundos en muchas cuencas es la principal limitación para conseguir una evaluación completa del potencial de almacenamiento de Irlanda. Análisis económicos complementarios sugieren que el almacenamiento de dióxido de carbono podría ser viable, si se realizan estudios adicionales.

International response to climate change has assumed a greater urgency since the publication of the International Panel on Climate Change (IPCC)'s Fourth Assessment Report in late 2007 and governments globally are seeking ways in which to reduce anthropogenic greenhouse gas emissions. Since mid-2007, carbon capture, transport and storage (CCS) has moved up the political agenda in Ireland and is now regarded as being potentially a major component of carbon abatement strategies, as early stage research suggests that it may be both technically and commercially viable.

SLR Consulting Ireland (previously CSA Group (Holdings) Ltd) was commissioned, with partners Byrne O'Cléirigh, British Geological Survey and CO2CRC Australia, to undertake an assessment of the potential for geological storage of carbon dioxide (CO_2) on the island of Ireland (both jurisdictions) by Sustainable Energy Ireland (SEI) and the Environmental Protection Agency (EPA), with technical direction provided by the Petroleum Affairs Division, Geological Survey of Ireland and Geological Survey of Northern Ireland (Lewis *et al*., 2007). The study commenced with extensive data gathering from variable sources and compilation to GIS to provide a preliminary geological assessment of likely storage basins and structures, both onshore and offshore , followed by in-depth geological assessment of each identified structure, to quantify potential for storage of CO_2. Although geological assessment confirmed that there are significant data gaps, the study arrived at a reasoned, quantified assessment of Ireland's geological storage potential. The paucity of deep geological data for many basins, particularly the offshore western basins, is the overriding constraint to a full assessment of geological storage potential for CO_2.

The all-island energy policy environment, security of energy supply and power generation mix, were used to provide an economic analysis of the most suitable technologies to capture, transport and store carbon, by modelling the likely prices of coal and carbon to 2020 and beyond.

The critical factor for the advancement of CCS on the island of Ireland is the geological viability of injection and storage in a suitable location on or offshore. The depleting Kinsale Head gas field in the North Celtic Sea (Fig. 2) presents the best short term (<10 years) option, subject to further geological analysis and full reservoir simulation. Critically, there would be no logic in investing in expensive carbon capture technologies unless a proven geological storage site within acceptable socio-environmental risk parameters were to be available to take the captured CO_2 into safe, long-term storage.

Geological assessment of storage capacity

An integrated assessment of the geological storage capacity of Ireland was carried out for suitable geological basins and structures (Table 1 & Fig. 2). Potential storage may exist in deep sedimentary basins in depleted gas fields or saline aquifers, in which CO_2 could be stored below 750 m and where suitable sealants are present.

Each basin was assessed according to its geological characteristics, available data and literature review. The data available for each basin are highly variable, thus each basin estimate was classified according to a techno-economic resource pyramid recommended by the Carbon

[1]SLR Consulting Ireland

Sequestration Leadership Forum (Bachu *et al*., 2007). In many cases, insufficient data were currently available to make a quantified assessment of storage capacity, but that does not exclude the possibility that new geological information may provide additional storage capacity in the future.

Selected basins were examined by BGS using digitized top depth structure maps (where available) to determine potential host rocks below 750 m and to identify closed structures, which may have the potential to store CO_2. Well data and published information were used to identify the geological characteristics of potential reservoir/seal pairs and available storage where feasible.

The study estimated, using the CSLF techno-economic resource pyramid, that the island has a total storage capacity of 93,115 Mt (Fig. 1).

This storage volume may be subdivided as follows:

- Total quantified capacity = 93,115 Mt
- Practical Capacity = 1,505 Mt
- Effective Capacity = 3,507 Mt

of which 667 Mt is a subset of theoretical capacity

of which 2,840 Mt is additional to theoretical capacity

- Theoretical Capacity = 88,770 Mt

Basin	Structure Type	Capacity Classification	Storage Capacity Mt	Quantified Storage Capacity Mt
Kinsale	Gas Field	**Effective/ Practical**	**330**	**1505**
South West Kinsale	Gas Field		**5**	
Spanish Point	Gas Field		**120**	
East Irish Sea	Oil & Gas Field		**1050**	
Portpatrick Basin	Sherwood Sandstone selected structures	**Effective** *(subset of theoretical capacity)*	**37**	*(667)*
Central Irish Sea	Sherwood Sandstone structures		**630**	
Lough Neagh Basin	Enler Group selected structures	**Effective** *(additional to theoretical capacity)*	**1940**	**2840**
Kish Bank Basin	Sherwood sandstone structures		**270**	
East Irish Sea Basin	Ormskirk structures		**630**	
Celtic Sea -	1 structure in the Cretaceous A sand	**Theoretical**	**40**	**88770**
Portpatrick Basin/ Larne	whole basin		**2700**	
Peel Basin	Sherwood Sandstone whole basin		**68000**	
NWICB Dowra Basin	whole basin		**730**	
Central Irish Sea	whole basin		**17300**	
Kish Bank Basin	Carboniferous sandstone and coal	**Theoretical / un-quantified**		
Rathlin Basin	Sherwood Sandstone, Permian and Carboniferous			
Celtic Sea	Cretaceous A sand			
Porcupine Basin				
Slyne/Erris Basins				
Clare Basin				
Rockall Trough				
Gas prospects				
Other onshore basins				
TOTAL (PRACTICAL/ EFFECTIVE/ THEORETICAL)			**Mt**	**93,115**

Table 1. All-island Ireland: quantified geological storage capacity for CO_2 (2008)

In the geological assessment, only theoretical, effective and limited practical capacities (Table 1) can be calculated due to limitations in deep geological data. To move these estimates up to the apex of the pyramid would require further geological and engineering studies for each structure.

Assessment of Ireland's emissions

The Island's major 'point source' emissions of 28.8 Mt CO_2 per annum are derived from the power, alumina and cement industries. If CCS is to be viable then it must be proven to be economic at the largest point sources to take advantage of economies of scale.

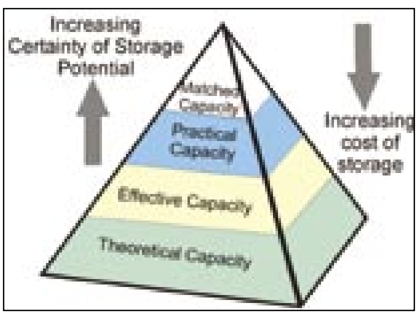

Figure 1. Techno Economic Resource Pyramid (CSLF 2007)

This suggests that the power sector is the primary target for CCS, centred on two key generators at Moneypoint (Republic of Ireland) and Kilroot (Northern Ireland), with current emissions of 5.0 Mt and 2.4 Mt CO_2 respectively from their coal-fired power plants. Planned combined cycle gas turbine (CCGT) power generating capacity in the Cork Harbour area, as well as proximity to the Kinsale storage site, suggested that Cork could be considered as a potential capture point.

Three main technologies exist for capture of CO_2: post-combustion, pre-combustion and oxy-firing. Currently, the most technically proven is post combustion capture using solvent absorption as a means of separation, which was chosen for the study. The three priority sites identified for detailed economic analysis were Moneypoint, Kilroot and Cork, because of possible economies of scale. Base cases were taken for each site with variable coal and gas fuel sources, while sensitivity analyses were applied to arrive at multiple cost comparative scenarios.

Transport for CCS

Transport options for Moneypoint to Cork-Kinsale, Cork to Kinsale and Kilroot to Portpatrick were considered. International pipeline specifications (steel grade, pipe diameters, materials, pressures) for transport of CO_2 were assessed and applied using variable economic scenarios. Shipping of CO_2 offshore to the east coast UK was considered to be sub-economic given the short distances involved.

Potential CO_2 storage sites

A number of sites were identified for potential geological storage of CO_2 including the Kinsale Head depleting gas field in the North Celtic Sea Basin, the Portpatrick Basin in the North Channel and potentially the Clare Basin off the west coast. Significantly, the analysis indicates that the depleting Kinsale gas field with 330 Mt of effective storage capacity, could provide a sink for a clean coal power station (sited at Moneypoint or Cork) theoretically for 50 years. In exploration terms, the Kinsale gas field is low risk with proven reservoir potential, but in CO_2 storage terms the key risk applies to containment. Drilling of two exploration wells from the existing platforms would provide sufficient geological data to conduct reservoir simulations, to model the effect of injecting CO_2 on the stress regime and to identify potential

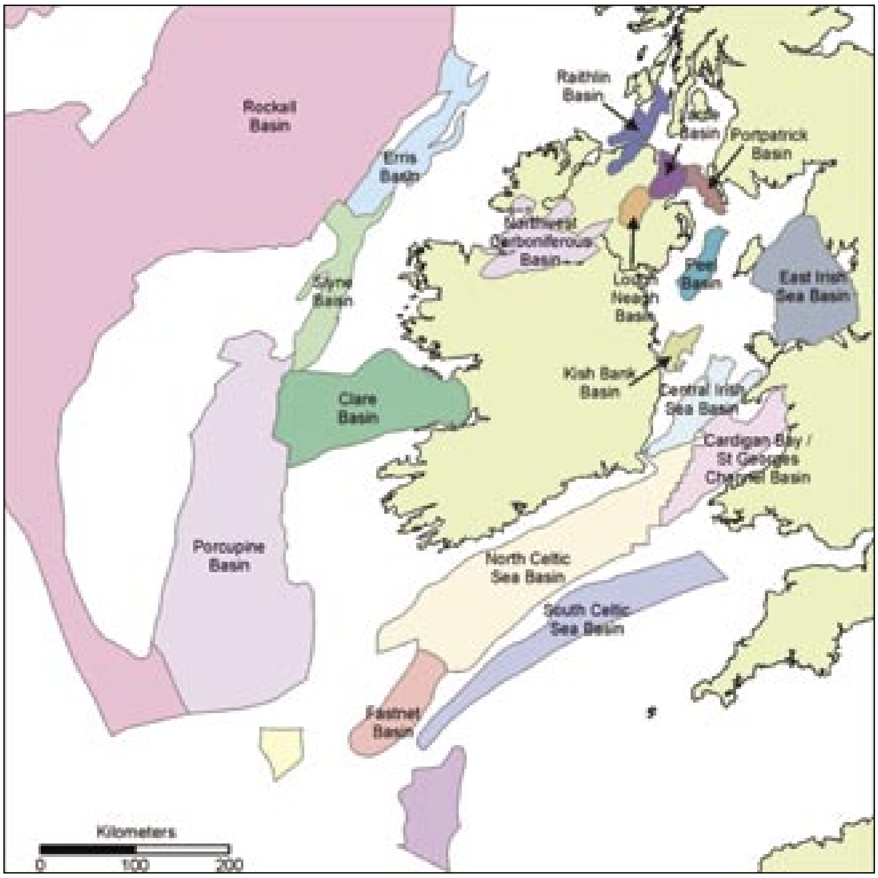

Figure 2. Key sedimentary basins assessed in study, all-island Ireland

leakage points. The highest risk of leakage may be through existing production wells; however, this could be remedied through recompletions with appropriate cement barriers to flow of CO_2.

The Portpatrick saline aquifer in the favourable Sherwood Sandstone Group offers 37 Mt of effective storage capacity in closed geological structures and a further 2200 Mt of theoretical storage capacity, and could service a clean coal power station at Kilroot theoretically for 10 years in the closed structures or for 58 years if 10% of the theoretical storage capacity were proven up.

Saline aquifer storage in the Peel Basin (68,000 Mt theoretical) and other offshore basins could offer enormous storage capacity in the longer term, but will require significant and costly proving up. The East Irish Sea Basin may offer a very significant sink (1060 Mt effective/practical capacity in depleted gas reservoirs), but would require a collaborative approach with the UK Government.

If such capacities can be proven up to offer 'matched capacity' storage, then the island of Ireland could significantly reduce its contribution to atmospheric carbon emissions.

Risk assessment of storage sites

The risk of leakage of CO_2 from a deep storage structure decreases up the resource pyramid with increasing certainty of storage potential. The lowest risk basin identified was that of the gas field at Kinsale in the North Celtic Sea, lying in the 'practical capacity' field.

Risks were considered for Kinsale using FEPs analysis (frequency, events, processes - Maul & Savage, 2004) and although issues such as seal efficacy, faulting, gas chimneys, CO_2:host rock interaction and injectivity require to be modelled in detail, the structure offers an attractive storage site.

Due to the sum of its production history and known geological characteristics, as well as hydrodynamic and risk modelling carried out in this study, it is likely that there are no major barriers to safe storage. The study suggests that Kinsale currently has a 70% probability of providing a 'matched capacity' storage site. To move the Kinsale field towards matched capacity for CO_2 injection and storage, the study estimated that for a costed study of €15 million, to include injectivity and reservoir simulation, the basin could be moved to a 90% probability of safe containment within two years of study commencement. However, further reservoir simulation, injectivity testing, fault seal analysis, new seismic acquisition and more extensive drilling may be required to fully confirm the suitability of the Kinsale Head Field and to confirm the hydraulic integrity of the reservoir seal.

Portpatrick was also risk assessed, but at present is significantly less well understood than Kinsale and its associated risks of ineffective containment are therefore considerably higher.

Economics of Carbon Capture & Storage

An economic analysis to evaluate the technologies and costs involved in building a complete CCS infrastructural chain was undertaken. A standardized International Energy Agency (IEA) economic approach, using standard coal LHV, standard discount rates, etc. was utilized. A baseline coal price of US$90 was employed, lying in the mid range between what IEA used as the long term coal price and the $120 per tonne that both Kilroot and Moneypoint were paying at the time of study. Due to volatile oil and coal prices, sensitivity analysis over a wide range $60 to $175 for coal price was employed. The economic evaluation examined whether the Governments should consider CCS as a valid part of future climate change strategy.

The comparative cost of electricity (COE) including the cost of carbon credits, with and without CCS, for seven model cases was examined, where a carbon credit price of €35/t was assumed. The incremental effect of CCS-based COE with no carbon price ranges from €17 - €54/ MWh, but with a carbon price of €35/t CO_2, lies in the range of -€5 to +€20/ MWh.

These figures are significant and could mean that CCS, with the correct pricing incentives, could be an attractive option for the island of Ireland.

The economics appear robust and suggest that CCS may well be more economic in an Irish context than in some other economies. In this case there is a strong case to pursue the research into the geological and technical viability in further phases.

However, in the case of all the geological basins examined, the data available on priority storage sites is insufficient to provide definitive matched storage capacity. Kinsale is an attractive option, but will require detailed geological studies and reservoir simulation in order to guarantee the technical feasibility of a CCS project in the short term. The economic analysis suggests that while €15 million may increase the probability of Kinsale offering a 'matched capacity' storage site to 90%, up to €80 million may be required to provide sufficient confidence in Kinsale as a long term geological storage option. A figure of €100 million has been modelled to bring Portpatrick to a sufficient level of geological confidence in its storage capacity.

It is very likely that by 2015 it would be possible to purchase power station technology fitted with CO_2 capture and compression equipment with a high certainty that the technology will function. However, there would be no logic in investing in this technology unless a proven geological storage site within acceptable risk parameters was available on or near the Island to take the CO_2 into safe, long term storage.

Conclusions

The following conclusions were reached:

- 93,000 Mt of potential geological storage capacity for CO_2 on the island of Ireland have been quantified. However, due to a paucity of deep geological data for many basins and structures, particularly in the western offshore, only theoretical, effective and limited practical capacities can be calculated
- Questions of injectivity rates sufficient to meet the storage requirements of large, clean coal power generators and reservoir pressure stability remain to be tested conclusively. Other geological issues such as occlusion of porosity and permeability by CO_2:host rock interaction or the long term migration of CO_2 plumes, have not been explored and would require long term modelling and monitoring at injection sites
- The cost of a clean coal power plant exporting 900 MWe to the grid and including carbon capture, compression, pipelining, injection and storage may cost up to €3 billion. The capital cost of power plant, capture and compression comprise the most costly part of the system (~ 70%), while transportation/storage and monitoring chain can comprise up to 30% when owners' costs and contingencies are applied. However, a window of opportunity linked to the cessation of natural gas production at Kinsale within the next decade could be optimized to demonstrate that basin's CO_2 storage capacity in the shorter (<10 years) term
- The comparative analysis indicates that a power plant with CCS, which includes the cost of carbon pricing at €35/t CO_2, with correct pricing incentives, could be highly competitive in the all-island Ireland energy market place
- The success of CCS projects will hinge on (currently) unknown factors including the role of self-propagating, feedback mechanisms during CO_2 flow which may amplify leakage risks and potential explosive discharges. The issue of long term environmental integrity will be a key determinant as to whether CCS will be adopted by the Irish and Northern Irish governments as a mitigative option in the effort to reduce the island's carbon emissions. Adherence to emerging international monitoring and reporting EU and IEA Guidelines was proposed
- The economics outlined appear robust and suggest that CCS may well be more economic in an Irish context than in some other economies. In this case there is a strong case to pursue research into the geological and technical viability of carbon capture and storage in future research.

Acknowledgements

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Sir Mark Moody-Stuart[1] shares his views on peak oil with Sarah Day[2]

Peak oil is a strange concept. Although it's fairly easy to produce a straightforward definition – the point at which oil production begins to decline - there seems to be almost no agreement about when this point will be reached, if it hasn't already happened. Various analysts have come up with their own scenarios, ranging from the catastrophic (peak oil has already happened and supplies are in rapid decline) to the more optimistic (the global decline will begin at around 2020, by which time there will have been major investments in alternative forms of energy).

Few are better placed to offer an opinion than Sir Mark Moody-Stuart, former chairman of Shell. As well as having held that position for three years, he has been chairman of mining company Anglo-American for the past eight, and is well aware of how thinking about peak oil has been changing. The idea began with geoscientist Dr Marion King Hubbert, who came up with Hubbert peak theory, a basic component of the peak oil theory.

'That was the original definition of Peak oil, saying that these are finite resources and production will decline slowly at some point. King Hubbert, who also worked for Shell, produced a curve in the 50s which accurately predicted a US peak in the 70s and he thought the global peak would be round 1995 or 2000'

Since then, many theorists have developed more alarming predictions.

'People now talk about production collapses…that there will be a more or less catastrophic reduction in the world's ability to produce oil, and that this is somewhere pretty close'

Others take a less alarmist stance, believing that oil production is more likely to reach a ceiling and then plateau, a model Sir Mark agrees with.

'For many years, I've said that I suspect we will never produce the last barrel of oil, just as we'll never shovel the last ton of coal, because we'll have found more convenient methods of energy production before that. I still believe that'

Whatever form these more convenient methods will take,

'We have coal, gas, oil, nuclear, wind, hydro, biomass, solar, wave, geothermal, a huge variety'

finding alternatives to oil will never be enough by itself. However much additional energy we produce, our usage is continually creeping up, and it is curbing this trend which will be the greatest challenge.

'The difficulty is that you're dealing with two factors: the rate at which energy use grows, and then the methods by which we meet that energy need'

He recalls a discovery made whilst researching for a talk given to the IGC in August, in which he came across predictions made by Greenpeace for what proportion of energy production would be supplied by renewables in 2030, and compared the figures with Shell's own prediction.

'I was quite struck by the fact that…you came out with very different shares of different fuels, so in the Greenpeace one there's a much higher proportion of renewables'

Despite this, he says, both Greenpeace and Shell produced very similar forecasts for the actual amount of energy which would be produced by renewables:

'They were actually within about 4% of each other. The difference was entirely due to their assumptions of the rate of growth of energy use in the world. Greenpeace somewhat optimistically assumed that energy use would not grow'

Reducing the growth of our energy use is, in many ways, a much greater challenge than finding alternative energy resources. It's not enough, claims Sir Mark, to expect people to make environmentally friendly choices out of a sense of duty or rationality.

'In my Shell days I used to say, we always assume that the consumer is rational. I lived in Holland, a completely paved country. Walking to work I noted that about one in ten vehicles was a four wheel drive, often driven by a young woman alone, very often smoking a cigarette. A set of completely irrational choices. What drives consumer choice isn't rational economics, it's something far more complex. If we want to really change the mix and drive energy efficiency I think we need regulatory frameworks, things which drive the efficiency of lighting, of thermal insulation, of construction of houses, of vehicle efficiency, and so on. The markets through individual choice will not deliver those'

So, for example, rather than persuading everyone that energy efficient light bulbs are a more environmentally friendly

[1]Chairman of mining company Anglo-American
[2]Earth Science Communicator, Geological Society

option, Sir Mark's suggestion is that there be a regulation placed on every light bulb manufactured, with a minimum level of efficiency based on lumens per watt.

> ***'Once you've done that, the market will create bulbs that are the most attractive, give the best light, are the cheapest, and so on. You need this combination of the regulatory framework driving the absolute magic of the market'***

It's a difficult time to attempt to introduce such legislation. In general, it results in rising costs which consumers can ill afford at the moment. But Sir Mark maintains that the economic downturn need not stall our efforts to conserve energy resources.

> ***'In general if you talk to people the concern hasn't gone away - people don't suddenly say, well I'm not worried about climate any more. The negative effect is that capital in industry is very constrained. Even if we use energy very efficiently, we still need a lot of energy to live. The problem is to deliver it in lower carbon ways, which requires significant capital expenditure, and capital is constrained at the moment'***

In the face of such a complex and imminent problem, the traditional image of major energy companies as profiteering bullies seems rather naïve. If positive action is to be taken, it will be by energy companies and other organisations cooperating with one another rather than fighting over the moral high ground. Sir Mark is a perfect example of such a pragmatic approach, with seemingly contradictory alliances. At the same time as being Chairman of Anglo American, a worldwide group of companies which has been accused of profiting from the abuse of local communities and for carrying out practises damaging to the environment, he is on the board of the UN Global Compact, a UN initiative to encourage businesses worldwide to adopt socially responsible and sustainable practises. Many of his ideas are not what you might expect from a chairman of Anglo American, or an ex-chairman of a major oil company. He admits himself that his position has not always been a very common one.

> ***'If you go back to the year of Kyoto, 1997, it was a bit unusual for energy companies to be thinking about climate and to be talking about conserving energy, but both Shell and BP were'***

Nevertheless, he dismisses the idea that major energy companies would prefer the issue of efficiency to be overlooked as 'demonstrably untrue'.

> ***'For a long time, fuel companies have had campaigns on how to use their fuel more efficiently, what you should do, the fact that their fuel delivers more miles and so on, things which are of interest to the customer. The best way of selling to someone is to deliver things in a way that they find convenient, which suits them, which addresses their concerns'***

Recently, a CBI taskforce brought together representatives from across industry to discuss the challenges of climate change and energy conservation, something which Sir Mark pinpoints as an example of their willingness to engage with the issues. Suspicion remains, however.

> ***'Where in my opinion the CBI taskforce would have benefitted would have been by the inclusion of some major civil society environmental groups, because that would have increased the trust in the outcome. If a group of companies says something, inevitably, even if it's something really sensible, people will say they've probably got some special axe to grind. The best solutions I think are reached by people with different backgrounds and different interests getting together, wanting to get to the same place and then talking to each other about how most sensibly to get there'***

Those who hope for such positive collaboration, as well as the kind of regulation which Sir Mark favours, have been encouraged by the recent election in America which have fuelled a new feeling of optimism, particularly amongst environmentalists.

> ***'As I understand it, one of the President's new advisors is a great enthusiast for these sorts of regulation, which is surprising in the United States, as well as for the application of sound science. I think there's going to be a big change'***

If change is to happen, though, it needs to come from individuals as well as those making policy decisions. To those who question how much of an impact we can have by making small changes to our everyday lives, Sir Mark is quick to respond.

> ***'I was just in South Africa visiting a mine. As Chairman of the company I've been banging on about energy efficiency and setting the proper targets and meeting our targets, and it has had a limited effect. Because there was an energy crisis in SA and the electricity utility failed to deliver energy, this focused everyone's minds. I was in a major mine talking to someone about this, and I said, "you've made fantastic progress on reducing energy", and we went into why, and she said one of the amazing things is, we actually started a campaign getting people to turn things off when they're not using them. She said, "I've always thought the effect would be quite small. It's not small at all - if you do this on an industrial scale, its remarkable! Several per cent of our ten per cent reduction has just come from that". That's amazing, and of course if we did it in society at large, well…'***

Geothermal Energy in Hungary: potentials and barriers

by János Szanyi[1], Balázs Kovács[2] and EurGeol. Péter Scharek[3]

After Italy and Iceland, Hungary is one of the best places for geothermal energy in Europe, since the Earth's crust is significantly thinner beneath Hungary than elsewhere. Geothermal energy is used mostly for heating and supplying baths with thermal water. Up to now there has been no electric power plant established on geothermal resources and the number of installed geothermal heat pumps is lower than in the neighbouring countries. The geothermal community of Hungary has to solve the main legislative barriers with special regard to the planned increase of geothermal energy use from 4 PJ to 35 PJ until 2020 in the country.

Après l'Italie et l'Islande, la Hongrie est l'un des pays d'Europe les plus favorisés du point de vue énergie géothermique car la croûte terrestre y est sensiblement plus mince qu'ailleurs. L'énergie géothermique est surtout utilisée comme source d'alimentation et de chauffage de l'eau des bains. Jusqu'à présent, il n'a pas été construit de centrale électrique d'origine géothermique et le nombre de pompes à chaleur d'origine géothermique est inférieur à celui des pays voisins. La communauté hongroise en charge de l'énergie géothermique doit ouvrir les barrières d'ordre législatif en portant une attention particulière à l'accroissement de l'utilisation de cette énergie, prévue passer, dans le pays, de 4PJ à 35 PJ, à l'horizon 2020.

Después de Italia e Islandia, Hungría es una de las mejores zonas de Europa para la obtención de energía geotérmica, debido a que en Hungría la corteza terrestre es mucho más delgada que en otros lugares. La energía geotérmica se utiliza fundamentalmente para calefacción y para el suministro de aguas termales a los baños. Hasta ahora no había ninguna planta de generación de electricidad basada en los recursos geotérmicos y el número de bombas de calor geotérmicas es más bajo que en los países vecinos. La comunidad geotérmica de Hungría tiene que resolver las principales trabas legislativas especialmente con relación al aumento del uso de la energía geotérmica de 4 PJ a 35 PJ previsto en el país hasta el año 2020.

Hungary is located in Mid-East Europe, in the Carpathian Basin. It lies on a characteristic positive geothermal anomaly (Fig.1). The area discussed is on the contact of the African and European tectonic plates, and this is the reason for its special geothermal potential.

Due to late plate tectonic events, a rapid, in geological time, subsidence of the surface occurred creating a large deep-sea sedimentary basin (the Pannonian-sea), which became shallower and brackish as it filled. Subsequently, the sea became isolated from the ocean (Pannonian inland lake) and dried out completely, resulting in an up to 6-7000 m-thick sedimentary sequence (s.c. Pannonian-basin) (Figs 2-3).

In comparison with the other parts of the continent, the Earth crust is much thinner in Hungary (22-26 km) and this thick sedimentary series of low heat conductance forming on it leads to a positive anomaly in geothermal gradient of c. 50 °C/km, while high porosity, groundwater-bearing formations fill the basin (Dövényi *et al.*, 1988).

In the basin there are two existing flow regimes: an upper, gravity driven flow system and a deeper, (over)pressure driven system concerning essentially the finer deep sea sediments and underlying formations. The cause of the high overpressure (up to some 10 MPa above the hydrostatic pressure) is until now scientifically unknown, but the most probable origin of it can be the tectonic compression of the formations, whereas gas formation during the maturation process of the sediments can also be a factor.

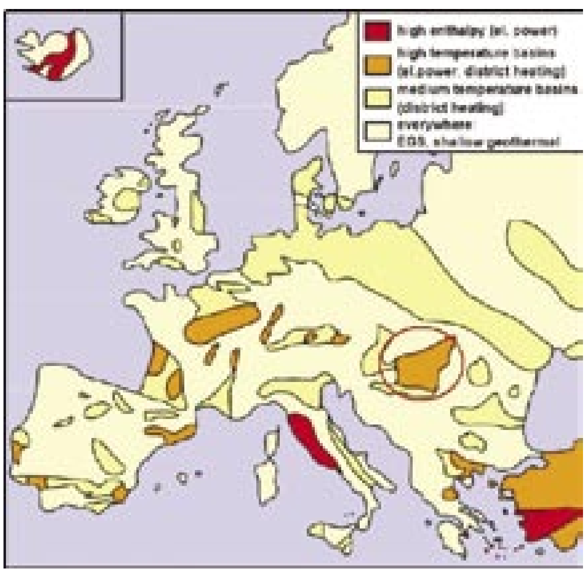

Figure 1. Geothermal thematic map of Europe with positive anomaly in Hungary (based on B. Sanner, EGEC, 2008)

At the base of the basin, different metamorphic and carbonaceous rock bodies are located where there are also possibilities of geothermal use.

The geological and hydrogeological conditions make the Pannonian basin favourable for geothermal use: a positive geothermal anomaly occurs with high geothermal gradient, including porous formations containing water up to 130-150 °C, but in the basement there are also some

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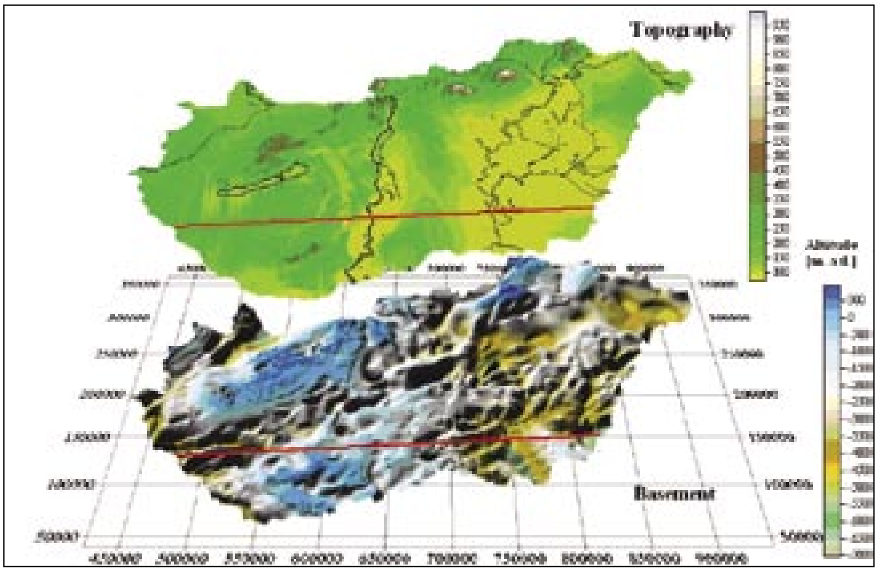

Figure 2. The topography and 3D presentation of the Pannonian Basement with the cross section line (Based on P. Scharek et al., MÁFI, 2004)

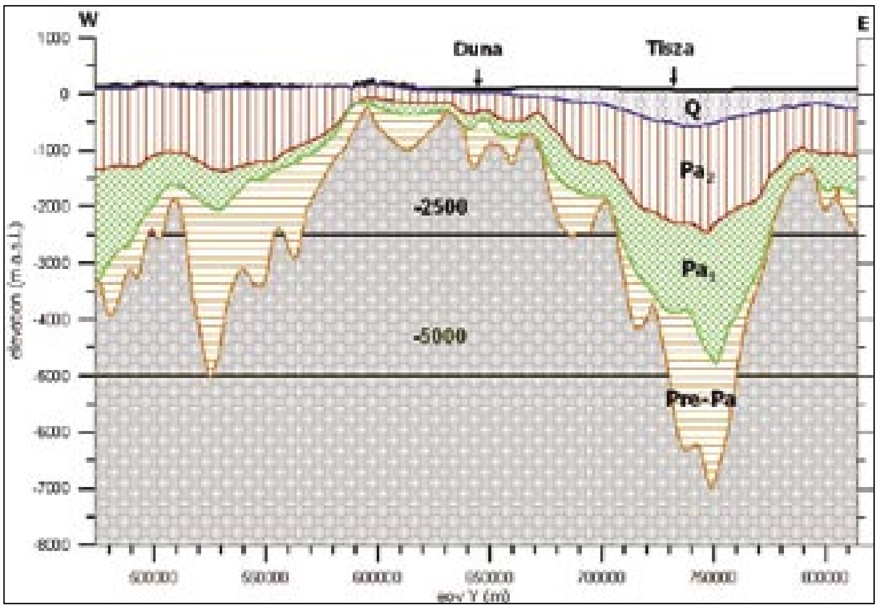

Figure 3. A WE cross section through South Hungary (Q=Quaternary Pa_2=Upper Pannonian (Pliocene) Pa1=Lower Pannonian (Upper Miocene) Pre-Pa=Prepannonian Cainozoic Formations)

geological units with karstic and fractured carbonaceous aquifers with much higher temperature that makes the area suitable for establishing medium and high enthalpy geothermal systems (Fig. 4).

Geothermal facilities past and present

The very first thermal well in Hungary for a shallow uplifted limestone reservoir was drilled in 1865 in Harkány, and the first real deep drilling was made in 1868-1878 in Budapest by a mining engineer, Vilmos Zsigmondy, where a borehole of 970 m depth discovered 73.8 °C thermal water. The well's yield was 1200 m^3/d at that time. The balneological use of the Pannonian sandy thermal aquifers began in 1925, when a 1091 m-deep well in Hajdúszoboszló discovered 70 °C thermal water. Afterwards, several drillings for this thermal aquifer were also made in other places in the SE part of Hungary (Szeged, Karcag, etc.). In 1958, the agricultural use of thermal water in the Szentes area began, where besides greenhouse heating, the thermal water was used for district heating purposes. There are around 40 wells in this region nowadays. The cascade system for direct heat use in Hódmezővásárhely started in 1998. Now this system is one of the most complex in Hungary. Both balneological and district heating use of the thermal water is rapidly growing in the SE part of the Great Hungarian Plain (Kistelek, Mórahalom, Makó).

There are more than 1400 deep wells in Hungary (Fig. 5) that have discovered warm and hot thermal water, but only 950 are in production at present.

Some of them are abandoned CH drillings but there are also boreholes and wells made for thermal water exploitation purposes. Around 220 wells are used for balneology and there are another 200 wells with water above 30 °C used for public water supply. There are also approx. 200 wells used for agricultural purposes and a half of them produce water at more than 70°C. Unfortunately there are only about 20 reinjection wells, showing that the direct use of water without reinjection is the current standard. Due to new legislation, a new system of reinjection must be established, and only waters used for balneotherapy are allowed into surface waters due to their high salinity.

It follows that geothermal energy is mainly used for district heating at present. In some locations where the water chemistry is favourable it is also used for public warm water supply, agricultural (green houses) and balneological purposes as well as in swimming pools.

The estimated total production rate of the thermal wells is 120 million m^3/year, the exploited heat content is 15.2 PJ/year. Most of the wells (172) are located in SE Hungary, in Csongrád County, where the estimated thermal water production is above 20 million m^3/year. Before 1990, the thermal water production reached 180 million m^3/year but due to the high charge for groundwater use it was decreased to two thirds of its original value (Rezessy *et al.,* 2005)

As a consequence of the high thermal water production, the hydraulic head of the aquifers decreased by 50-70 m but due to the mentioned decrease of thermal water production an increase of 5-10 m was observed in the last decade. Most of the wells were free flow up to 50 m in primer state, but now continuous pumping of the wells is needed. There has been no decrease of water temperatures observed in the bottom of the boreholes so far but it should be mentioned that there has been only negligible reinjection up to now.

To assure the sustainable use of thermal water, reinjection of thermal waters into the same aquifers is required by Hungarian legislation.

Up to now there has been no electric power plant established on geothermal resources, though several Hungarian and foreign investors are very interested in prospecting for high enthalpy geothermal reservoirs for electric power generation despite legislative problems that add to existing geological risk.

Legislative barriers

The GeoThermal Regulation - Heat project (GTR-H http://www.gtrh.eu) summarizes the problems concerning the legislation:

" ... in Hungary the exclusive usage of the permit field is not guaranteed. The exclusive usage of the applied water reservoir of the applicant is not secured by the law. Therefore the consequences from the point of view of project development and project related risk management are:

- *reservoir can be used by several competitors or projects*
- *investments are not secured long term (possible project period of up to 50 years)*
- *loss of possible revenues if e.g. reservoir temperature is lowered too fast or flow rate declines.*

.... Another legal barrier concerns the fixed feeding-in tariff, because the period of its validity is not determined in the act. In this manner, there is a significant risk that an amendment could reduce the feeding-in tariff. ... The security of a long-term fixed feeding-in tariff is especially important since already the project preparation phase (time till commissioning) could last up to three years. A related issue is that there are no tariff differences between renewable energies (wind, solar, geothermal energy, etc.) with different general attributes."

GTR-H concludes and summarizes the legislative problems as follows:

Hungarian legislation relevant to geothermal energy is spread throughout mining, water environment, energy fields.

- financial burden of geothermal projects is multiple, and likely greater than in other EU Member States
- the long-term safety interest of investors is not satisfactory (neither from legal nor financial point of view)
- regulatory authority framework has become simple due to public administration reform of 2006 but many criticize the long licensing period
- near future improvements in legislation are foreseen (e.g. amendment of the Mining Act) but no new economic incentives predicted.

In spite of the unfavourable legal conditions, there are some initiatives to establish geothermal power plants in the country.

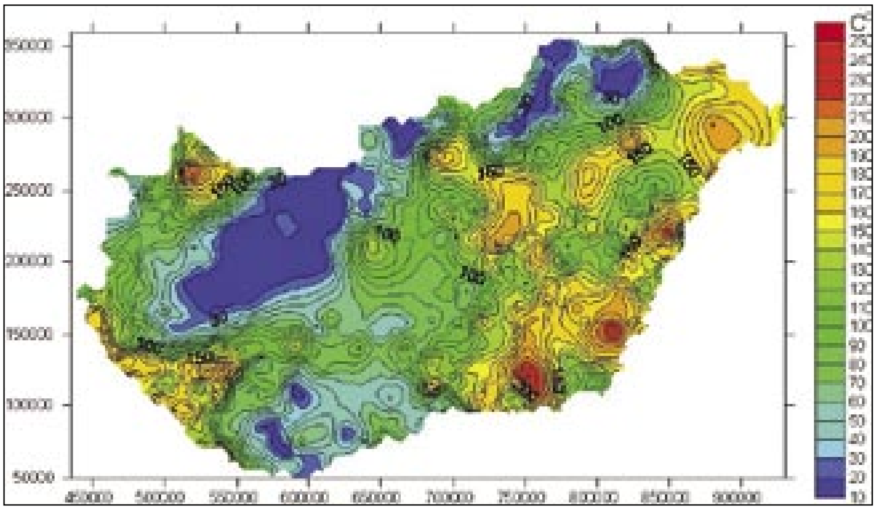

Figure 4. Temperature distribution at the basement of the Pannonian basin

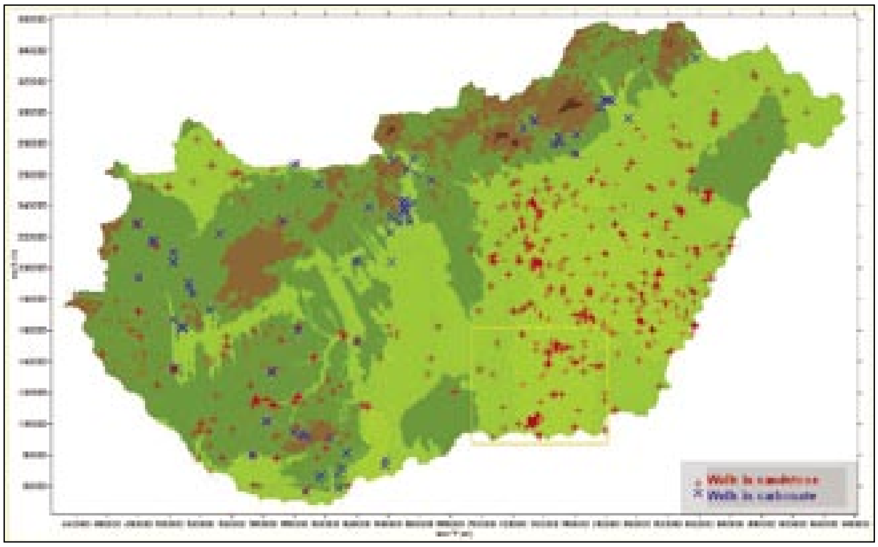

Figure 5. Location of thermal wells in Hungary, rectangle shows Csongrád County

The very first initiative using abandoned CH wells was not successful, for the yield of the wells and the productivity of the aquifer stayed below the acceptance limit. Some new projects are now planned and in the geological, hydrogeological and geophysical prospecting phase so that a geothermal power plant will very likely also be established in the near future.

Targets for Hungary

The following targets aim at an increased geothermal exploitation in Hungary:

- a) extensive use of heat pumps, improving efficiency by supervising the old systems
- b) increasing the number of production-reinjection well-pairs (well-triples)
- c) constructing geothermal power plants for electricity production with attached heat energy production (with heat utilization)
- d) improvement of the legislative, regulatory environment and establishment of an individual renewable energy law.

a) If only the utilization of the omnipresent heat of the soil by heat pumps is considered, based on the present trend, the exploited energy might well attain 3-5 PJ/year by 2020 as a result of the increasing number of heat pumps. The latter also enable the use of heat that comes from subsurface and thermal waters as well as springs to the surface but that is at present left unused. The combined exploitation of the heat of thermal waters and soils as well as other industrial and agricultural waste would result in an energy production of 10 PJ/year by 2020 that, apart from decreasing primary investment costs and environmental risks, would reduce thermal water production and it would mean the most efficient application of heat pumps.

b) In parts of Hungary rich in thermal water, more water has to be exploited to produce more heat. Nevertheless, the resources of the county's thermal water reservoirs are not unlimited. Production can be increased only by reinjecting the cooled water back into the reservoir, where it warms up at depth and can be exploited again. By reinjection, the direct utilization of geothermal energy can substantially be increased attaining 15 PJ/year by 2020. It would enable substitution of imported hydrocarbons first of all in district heating, heating of communal and industrial institutions and hot water supply with an estimated ten-year return.

c) The geological setting of the country facilitates the establishment of power plants for electricity production capable of providing as much as around 4-8 MWt heat while generating 1 MWe electricity. By 2020, the involvement of private capital and available state subsidies would provide a real opportunity for the establishment of power plant blocks of 60 MWe + 240 MWt (under optimal circumstances even +480 MWt) capacity and thermal heat delivery with about 10 year return and 9 PJ/year energy production. Thermal water reservoirs of more than 120 ^{o}C suitable for electricity production are located deep under the surface. In Hungary the target interval of exploration is between 2000 and 4000 m requiring considerable investment for drilling activities.

d) It is necessary to supervise and simplify the legislative and regulatory environment as well as to reconsider the related costs. In compliance with the approved directive on sustainable energy, the elaboration of a transparent, system concerning the utilization of geothermal energy including administrative licensing, supervisory aspects, etc. and supporting the development of the applications cannot further be delayed.

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Geothermal energy in the Netherlands

by Leslie Kramers[1]

Driven by concerns about the sustainability of our environment and the security of our energy supply, interest in renewable energy is growing. Roughly 40% of Dutch energy demand is consumed in the form of 'low-temperature' power for heating homes and offices (at the municipal level) and industrial greenhouses. This demand for low-temperature power could easily be supplied by geothermal energy in its various forms. Studies show that deep geothermal energy is highly competitive with other forms of energy. Moreover, geothermal energy can be used to produce electricity when the temperature of the aquifer is above 120 °C. With its low rates of greenhouse-gas emissions, geothermal energy would help reduce CO_2 emissions.

Lié à la motivation touchant le caractère durable de notre environnement et la sécurité de notre approvisionnement énergétique, l'intérêt porté à l'énergie renouvelable va croissant. A peu près 40% de la demande hollandaise en énergie est consommée sous la forme d'énergie basse température pour le chauffage domestique et des bureaux (au niveau municipal) et les serres industrielles. Cette demande pour une énergie basse température pourrait être satisfaite facilement par l'énergie géothermique sous ses différentes formes. Cependant, l'énergie géothermique peut être utilisée pour produire de l'électricité quand la température de l'aquifère est supérieure à 120°. Avec son bas niveau d'émission de gaz à effet de serre, l'énergie géothermique serait une aide à la réduction des émissions de CO_2.

El interés por las energías renovables está creciendo debido a la preocupación por la sostenibilidad de nuestro medio ambiente y la seguridad del suministro de energía. Aproximadamente el 40% de la demanda energética holandesa se cubre con energía de "baja temperatura" para calentar casas y oficinas (a nivel municipal) e invernaderos industriales. Esta demanda de energía de baja temperatura podría fácilmente ser satisfecha utilizando energía geotérmica en sus diversas modalidades. Las investigaciones realizadas demuestran que la energía geotérmica profunda es muy competitiva frente a otras fuentes de energía. Además la energía geotérmica se puede utilizar para producir electricidad, si la temperatura del acuífero supera los 120 ºC. Debido a su baja tasa de emisiones de gases de efecto invernadero, la energía geotérmica se podría utilizar para reducir las emisiones de CO_2.

There has been a resurgence of interest in the use of deep geothermal heat in the Netherlands in recent years. The causes of this are manifold, one of which is the 1997 Kyoto Protocol that encourages governments to explore the use of renewables. Moreover, it is expected that the gas and oil prices will rise sharply again after the recent crisis comes to an end, which will force private enterprises to consider the use of alternative energy sources.

Geothermal energy

To extract geothermal energy, two geological prerequisites have to be met: the temperature of the formation water has to be sufficiently high and it should be possible to extract a sufficiently large amount of water. Concerning the first prerequisite, a distinction has to be made between shallow and deep aquifers. The water temperatures in deep aquifers may be 70 °C or higher, whereas the water temperatures in shallow aquifers are around 45 °C.

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To meet the second prerequisite, the transmissivity (product of thickness and permeability) of an aquifer should be sufficiently large to permit a production of several thousand cubic metres a day. This transmissivity is the main risk factor. In practice, therefore, only thick or very permeable sandstones are prospective.

Large parts of the Netherlands have considerable geothermal potential: there are several sandstone units at depths of over 1500 m at which the prevailing temperatures are most favourable, marked by a geothermal gradient of 30 °C/km or higher. Figure 1 visualizes potential aquifers at a depth of 1500 m or more. Large parts of these units, which have been extensively explored by the E&P industry, are water-bearing aquifers, including Rotliegend, Triassic and Lower Cretaceous, making them interesting targets for geothermal energy.

The geothermal energy potential for the Netherlands has been calculated by determining the Heat In Place (HIP) of the most interesting aquifers. A HIP calculation takes into account the average thickness of a sandstone layer, the average difference between aquifer temperature and surface temperature, and the lateral extent of the reservoir. Moreover, it also involves the heat capacities of the rock matrix and the pore water, which are calculated separately on the basis of the average reservoir porosity. In total, approximately 90×10^{18} Joule of HIP may be present in the Netherlands in the three specific stratigraphic intervals mentioned above, which might be suitable for the extraction of geothermal energy. The amount of geothermal energy that may eventually be produced successfully, however, also depends on location-specific reservoirs properties.

Geothermal heat

The use of direct geothermal heat currently has a lot of interest from private greenhouse enterprises and from various city councils, housing co-operations and private town development companies. It is expected that within the next few decades several tens of geothermal doublets will be developed for greenhouse and/or district heating purposes in the Netherlands. Expected capacities might range from 3 - 10 MW per doublet (around 50000 -

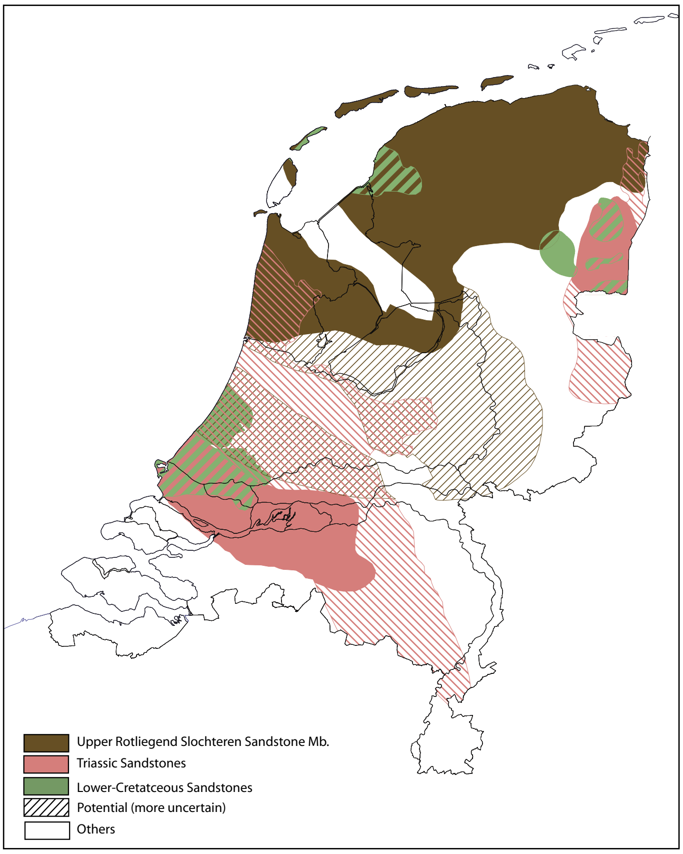

Figure 1. Dutch aquifers from 1500 m depth with geothermal potential

150000 GJ per year, based on 4000 running hours per year). In recent years, a Dutch horticultural firm in the greenhouse area in Bleiswijk, near The Hague, has developed the first geothermal heating plant in the Netherlands from a sandstone unit at 1,700 m depth. After drilling the two wells (Fig. 2), this geothermal doublet (60°, 160 m^3/hr) functions above expectation. It will eventually heat around 10 ha of tomato greenhouses. In 2009, the first geothermal district heating grid is expected to be built, in the South-West of The Hague. This doublet will serve around 4000 dwellings.

Geothermal electricity (Enhanced Geothermal Systems)

Besides district heating purposes, geothermal heat can be used to produce electricity when the temperature is above approximately 120 °C, commonly measured in stratigraphic units below 3500 m depth. Producing electricity from high-temperature steam reservoirs in volcanic environments already takes place in countries like Iceland and Italy, but in other European countries like the Netherlands such environments do not exist. An interesting option is producing electricity from Enhanced Geothermal Systems (EGS), also called engineered geothermal systems, which extract heat by creating a subsurface fracture system to which water can be added through injection wells (Fig. 2). An EGS is defined by improving the natural resource by, for instance, hydraulic fracturing. Hydraulic fracturing is a method used to create fractures that extend from a borehole into rock formations which are typically maintained by a proppant, a material such as grains of sand or other material which prevent the fractures from closing

In contrast to the conventional high-temperature steam reservoirs in volcanic environments, EGS resources are more difficult to localize and to assess. While volcanic resources are clearly indicated by obvious effects at the surface (e.g. geysers, fumaroles, etc.), EGS resources commonly have indirect traces (e.g. increased surface heat flow at faults). Usually, they are water-dominated systems and characterized by a wide range of production temperatures. Notwithstanding, commercial projects are currently either operational or under development in Australia, the United States, and Germany (see this issue).

In the near future, the deep-lying volcanic rocks and moderate to low-permeability clastic rocks of the Rotliegend of the North Eastern Netherlands and Triassic aquifers in the Roer Valley Graben at a depth of at least 3500 m, or maybe even Lower Carboniferous limestones might be feasible targets for application of Enhanced Geothermal Systems in the Netherlands.

Legislation

In the Netherlands, geothermal exploration and production from depths over 500 m is regulated by the Dutch Mining Act (2003) for which the Ministry of Economic Affairs is the Permitting Authority. Permits/licenses are required for exploration for terrestrial heat, production of terrestrial heat and the operational plan during the total chain of geothermal mining activities. Both the exploration and production permits have a geographical extent and specific time domain. Geothermal applications shallower than 500 m have to meet the criteria as defined in the Groundwater Act, which is governed by the 12 provinces.

Furthermore, exploitation of both deep and shallow geothermal energy has to meet the regulations within the Environmental Management Act (e.g. Environmental

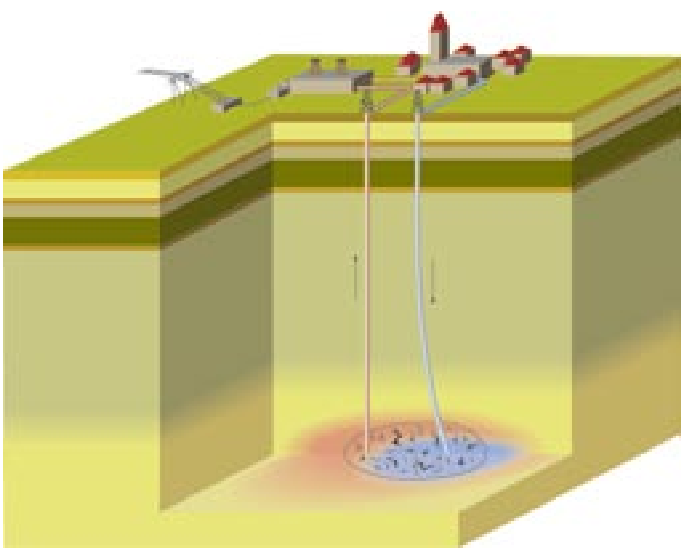

Figure 2. Cartoon of an Enhanced Geothermal System. A production well (red) and injection well (blue) are drilled into an aquifer. Fractures created by hydrofraccing increase the permeability to extract more water

Impact Assessment). This Act regulates emissions to air, water and soil as well as objectives in the domain of energy efficiency and sustainable energy systems.

For 2009, over 17 exploration licenses have been issued in the Netherlands. The proliferation of interest in geothermal applications takes advantage of the well-defined legal framework for exploration and production, which has been in place for decades for oil and gas operations. However, given the relatively small operations and fierce local competition compared to oil and gas, E&P adaptation of existing rules and associated guidelines to geothermal is of high priority.

ThermoGIS and techno-economic performance assessment

Governmental bodies, such as geological surveys, experience a major challenge in supplying the geothermal community with relevant data and derived subsurface and flow models and facilitating quantitative assessment of geothermal potential of targeted areas, for heat and electricity production.

In order to face this challenge, the Ministry of Economic Affairs has commissioned TNO to take up this task. TNO developed a public web-based 3D information system connected to a geothermal performance assessment tool. This public information system (ThermoGIS) includes high resolution 3D geological models covering the complete onshore of the Netherlands, outlining key geothermal reservoirs and allowing assess to relevant parameters and underlying uncertainties therein. State-of-the-art 3D modelling techniques have been used and developed to obtain the reservoir structures, flow properties and temperatures, using constraints from over a thousand deep wells, and detailed subsurface mapping from 3D and 2D seismic. Users can obtain key reservoir parameters, and underlying uncertainties at any location and for any reservoir. In an automated workflow, these parameters are fed into the performance assessment tool, in order to assess the probability of success to meet minimum requirements on key performance indicators such as Coefficient of Performance (COP), power produced, and Unit Technical Cost (UTC).

Furthermore, there exists a techno-economic performance assessment model for deep geothermal projects. The model Dedicated Decision Support (DSS) model is a public deliverable of the European project Enhanced Geothermal Innovative Network for Europe (ENGINE, www.engine.brgm.fr), which was completed in Spring 2008. The models have been implemented in EXCEL and as part of a dedicated decision support system, using best practices for asset evaluation from the Oil & Gas industry. This approach takes into account natural uncertainties and decision trees to evaluate sensitivities and define different scenarios

In the model approach, fast model calculations for a techno-economic evaluation are used to calculate the performance of the geothermal systems. Performance sensitivities are investigated due to natural uncertainties (e.g. flow characteristics, subsurface temperatures), engineering options (bore layout and surface facilities options) and economic uncertainties (e.g. electricity price, tax regimes). Models for the temperature evolution of the water in the well and fractures are based on so-called fast analytical solutions, based on streamline approximations. This allows calculation of the performance and its sensitivity to uncertainties and the effect of various engineering options in a matter of seconds.

Russian energy: an overview

by Sergei Matveichuk[1] and Dmitry Zheldakov[2]

The article is an overview of the Russian energy complex, which is a very complicated system incorporating various fuel and energy industries, such as the electric power industry, including the thermal power sector fueled by oil, gas and coal sectors; the hydro power sector; and the nuclear power sector fueled by the uranium industry. The history of the complex and major landmarks of its development are described. The authors also acquaint the readership with the future plans for Russian energy development.

L'article correspond à un panorama du système énergétique russe qui représente un système très complexe, incluant les différentes industries, celles liées ou non au pétrole telles que l'industrie électrique, l'industrie du secteur thermique alimentée par le pétrole, le gaz et le charbon ; également le secteur hydroélectrique et l'industrie nucléaire développée à partir de l'uranium. L'article décrit l'histoire et les étapes dominantes et complexes du développement énergétique. Les auteurs mettent aussi les lecteurs au courant des futurs plans de développement du secteur énergétique russe.

El artículo es un repaso al sistema energético Ruso, que es un sistema muy complicado que incluye diversas industrias de combustibles y de energía, tales como la industria eléctrica, incluyendo el sector de las centrales térmicas que emplean petróleo, gas y carbón, el sector hidroeléctrico y el sector de la energía atómica, impulsado por la industria del uranio. Se describe en este trabajo la historia del sistema y los principales hitos de su desarrollo. El autor también explica al lector los futuros planes del desarrollo energéticos en Rusia.

The energy complex of the Russian Federation (RF) is a very complicated system incorporating various fuel and energy industries. Historically, the thermal power sector has been the most important part of the Russian economy. In the 1920-1930s, this sector got an impetus for development due to the implementation of a large-scale thermal power plant construction programme as well as large hydraulic power plant construction plans. In the 1950s, the progress of the USSR energy complex was spurred by nuclear research and NPP construction. In the subsequent years, the country focused on the development of such energy sources as water energy from Siberian rivers, as well as fossil hydrocarbon resources in Western Siberia.

Electric power industry

This is the basis of the country's economy. Electricity is an integral part of life in the Russian Federation. It is indispensable to other industries, commercial establishments, homes, and even most recreational facilities. In terms of electricity generation per capita Russia is at the level of Germany and Denmark, which have lower transmission losses and heating expenses. After the economic recession of 1990-1998 the country's electricity demand grew continuously. In 2007, the total output of all power plants of the United Energy System reached 997.3 billion KW·h. However, the top index for the year 1990 - 1,082 billion KW·h - has not been reached yet.

In 2007, the structure of electricity demand by consumer in the Russian Federation was as follows: industry - 61.7%; agriculture - 1.8%; transport - 6.4%; population - 9.3%; other - 20.8%. Significant grid losses, which may reach 11.5%, negatively affect the sector performance.

In 2003, Russia launched the reform of its electric power industry. Major landmarks of this process are as follows: formation of new market players, transition to new regulations of wholesale and retail electricity markets, decision on the acceleration of electricity market liberalization rates, initial public offering and secondary placement of equities of power generating companies on stock markets.

Since late 2007, E.ON (Germany), ENEL (Italy) and Fortum (Finland) have been major foreign players of the Russian electric power industry.

The development of the traditional electric power industry in the nearest future will be based on the application of more efficient and flexible combined-cycle power plants and enhancement of the coal share in the fuel mix (Fig. 1).

Thermal power sector

The country's thermal power sector incorporates fossil fuel mining, processing and fuel sale segments, such as, coal, gas, oil, peat, oil-shale and uranium mining industries.

Oil and gas industry

This is the basis of the thermal power sector of Russia. It possesses vast well-investigated reserves and resources. A significant share of oil and gas production is provided due to the development of some of the largest fields: old Urengoi and Yamburg gas fields, new promising Bovanenkovskoe and Zapolyarnoe gas fields; Samotlor, Priobskoe, Russkoe oil fields in Western Siberia, and Romashkinskoe oil field in Tatarstan. In 2008, the country's gas output reached 665 billion m^3, the domestic demand - 386 billion m^3 (more than a half of the country's demand in energy sources), natural gas exports amounted to 203 billion m^3. In 2007, the country's oil output amounted to 491 million tonnes, and oil exports to 330 million tonnes.

Presently, 41 large oil refineries are in operation in Russia with a total annual capacity of nearly 300 million tonnes. In 2006, their operating capacity was 255 million tonnes. In 2007, nearly 32 million tonnes of diesel fuel, 29 million tonnes of petrol, and 7 million tonnes of kerosene were supplied to the domestic market.

A major share (93%) of liquid hydrocarbon transport is provided by the state-owned Transneft Company, which operates the main oil pipelines.

Coal industry

In terms of prognostic resources estimated at $3.8 \cdot 10^{12}$ tonnes, Russia ranks as the world's second, following China; in terms

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of explored reserves estimated at 192.3 billion tonnes it ranks second following the USA (Fig. 2). Over a half (52.9%) of steam coal reserves are brown coals, while the share of coking coals accounts for 24.6% of the total coal reserves. Russian coals are mainly high-grade coals: ash content of more than a half of explored coal reserves does not exceed 15%, while their sulphur content is less than 1%.

In recent years the total coal output of the country grew at higher rates exceeding those of gas output growth. Surface coal mining is developing at increasing rates; its share in the total coal output has reached 64.9%. Coking coal output progress is held back by insufficient domestic market demand: major growth of the total coal output is attributed to hard coal, while that of brown coal is kept back by the lack of demand (Fig. 3).

Peat industry

Before the 1990s, the peat industry had played a significant role in the thermal power sector. In the latest 20 years, however, peat lost its importance as an energy source. In the mid-1970s, the annual peat output reached 90 million tonnes, while today it does not exceed 5 million tonnes. In Russia the explored peat reserves (with 40% moisture content) exceed 150 billion tonnes with an annual formation of up to 1 billion tonnes of new peat. Major reserves are concentrated in Western Siberia and in the northwest of European Russia. Nearly all peat deposits are located in remote areas.

Hydropower sector

The theoretical potential of the Russian hydropower sector is estimated at approximately 2,295 billion KW·h/year, of which 852 billion KW·h/year are economically feasible. A major part of the potential is concentrated at a remote distance from main electricity consumers, namely in Central and Eastern Siberia and in the Far East; its realization depends on the industrial development of these regions. Full advantage has not yet been taken of the river energy potential in Ural, Kola Peninsular and Kamchatka; it is also true for the potential of mountain rivers in the Caucasus.

In 2007, Russian hydropower plants generated 177.7 billion KW·h, i.e., 17.8% of the total country's power output. Future development of the hydropower sector will be based on the river energy of the Northern Caucasus and Siberia. Expansion of the capacity of some operating HPPs and the launching of new HPP construction projects

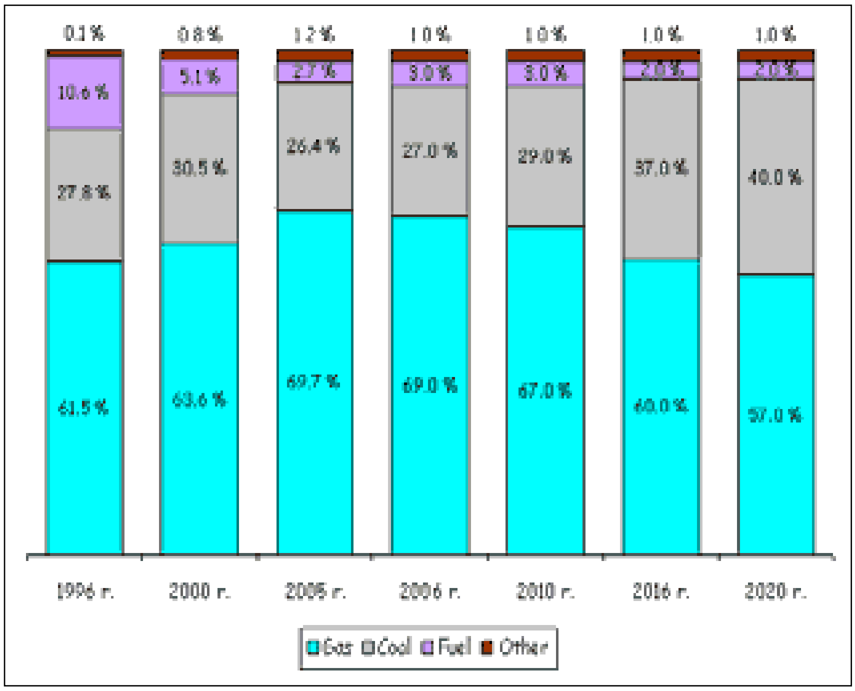

Figure 1. Fuel mix of thermal power plants in Russia by year

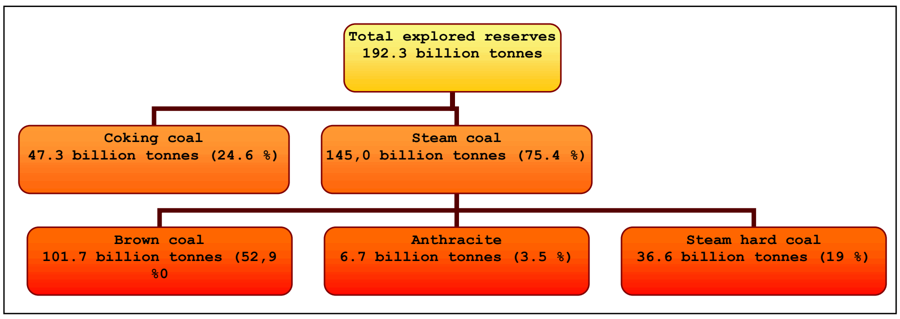

Figure 2. Explored coal reserves of Russia by type (source: Ministry of Energy of the Russian Federation)

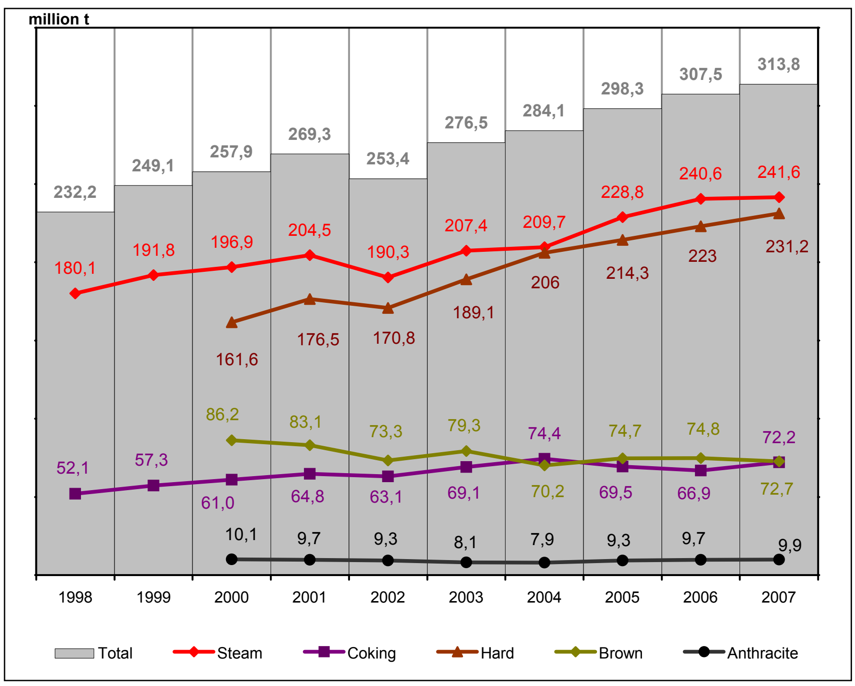

Figure 3. Coal output in Russia by type and year

are planned for Central and Northern European Russia, and the Volga River area.

Great energy opportunities can be also provided by gulfs with high (up to 10 m) tides. In Kislaya Bay on the Barents Sea shore a 0.4 MW pilot tidal power plant has been in operation since 1968.

Nuclear power sector

Russia possesses full nuclear fuel cycle technologies - from uranium ore mining to electricity generation. In 2006, the Russian Federation with its 8% share ranked the world's fifth in terms of uranium ore mining and uranium concentrate output.

All Russian uranium mining companies are incorporated by the state-owned OAO TVEL Corporation. The nuclear fuel output of TVEL fully meets the country's demand. TVEL also exports fuel elements to 13 European and Asian countries where Russian-designed reactors are in operation. The Corporation supplies fuel for 73 power and 30 research reactors, i.e., for every sixth nuclear reactor worldwide.

Explored uranium reserves and opportunities for the application of advanced nuclear technologies are not so great as those of natural gas. Russia's total annual uranium demand, including domestic demand and export commitments, amounts to nearly 20,000 tonnes.

Most NPPs operate in the northwest of European Russia, providing 42% of the country's total electricity generated by the nuclear power sector. In 2007, the total power output of all Russian NPPs reached an all time high point of 158.3 billion KW·h, or 15.9% of the total electricity generated by the United Energy System of Russia.

The nuclear power sector of Russia is now entering a new stage of development. To meet Russia's growing demand for clean, affordable domestic energy, the Government has launched an ambitious nuclear renaissance programme that calls for the construction of 26 new reactors and raising the share of nuclear power in the country's total energy consumption from the current 16-17 % to 20-25 % by 2020.

Renewable energy sources

In contrast to major industrially developed countries, Russia does not use renewable energy sources on a broad scale. Poor infrastructure and low population density in some of the Russian regions, as well as relatively low natural gas prices of the domestic market are the factors preventing the country from a broad-scale use of renewable energy sources.

Bioenergy

Wood is the most popular bioenergy source in Russia. Firewood is used for house heating, cooking and water heating in remote agricultural areas with no access to main gas pipelines and high coal transportation costs, being blessed, however, with significant wood resources. However the efficiency of firewood as a fossil fuel alternative is by far lower than the negative environmental effect of deforestation, and the use of this fuel can be viewed only as a least-evil temporary solution.

Geothermal power

The reserves of geothermal energy in Russia are extremely great: according to some estimates, they exceed 10-15-fold the reserves of organic fuels. Geothermal heat sources with a temperature ranging from 30 to 200 °C can be found in nearly all the country's regions. However, until recently the scale of geothermal energy use was rather small. As of the end of 2005, the total installed capacity in terms of direct heat utilization was 307 MW.

In 2006, 56 geothermal water fields with a daily output of more than 300,000 m³ were explored. Today, 20 of them are being developed on a commercial scale. In Western Siberia there is an underground lake, 3 million m² in area where water temperature is 70-90 °C.

Mutnovskoe geothermal water field in Kamchatka is well explored and promising. Its prognostic reserves are estimated at 312 MW in terms of heat output.

In Russia there are three geothermal power plants in operation, all located in Kamchatka. The total electric power potential of steam-water termae is estimated at 1 GW of operating electrical capacity; however only 76.5 MW of installed capacity (2004) are used with an annual power output of 420 million KW·h.

A 34.5 MW geothermal power plant project (Iturup Island, Kurile Archipelago) with an annual power output of 107 million KW·h is open for investors and equipment suppliers.

*Wind powe*r

The theoretical potential of wind power in Russia is estimated at over $50 \cdot 10^{12}$ KW·h, while its annual economic potential at nearly 260 billion KW·h, is nearly 30% of the total electricity generated today by all Russian power plants.

Great wind power capability is characteristic of the Pacific and Arctic shores, mountainous areas of the Caucasus, Ural, Altai, and Sayan. The areas located closer to consumers and having a well-developed infrastructure are suitable for the construction of large wind farms. These areas are: the Kola Peninsular shoreline, Primorsky Krai, shorelines of the Caspian and Azov Seas.

In 2007, the installed capacity of wind power plants in the country reached 16.5 MW and their total annual power output, 25 million KW·h.

Solar power

This is at the earliest stage of development in the country.

Renewable energy in Russia still lacks its regulatory framework and legal environment. However, some entities of the Russian Federation have regional laws supporting the development of renewable energy. These are Krasnodar Krai, Amur Oblast, Aginsky Okrug in Buryat Republic. For instance, in Krasnodar Krai, the Renewable Energy Development Fund has been established to finance renewable energy projects.

Conclusions

For the reliable long-term supply of all kinds of energy for the economy and population of the Russian Federation, a scientifically grounded, socially and institutionally acceptable long-term energy strategy is of great importance. Presently, the government energy policy is based on the Energy Strategy of Russia for the period up to 2020. This document, adopted by the Russian Government in 2003 (Decree of the RF Government No 1234-p dated 28 August 2005), aims at the identification of ways and methods for qualitative improvement of the fuel and energy complex, enhancement of competitive advantages of its products and services in the world market based on the most efficient use of its potential; identifying top-priority areas of the fuel and energy complex development, elaboration of measures and mechanisms of the state energy policy with due account for predictable results of its implementation. It is also important to note that recently, the Ministry of Energy has completed the work on the Energy Strategy of Russia for the period up to 2030. Fifteen groups of experts representing government agencies, research establishments and the business community of the country were involved in this work. Shortly, this document will be submitted to the respective ministries for examination and then sent to the RF Government for approval.

Geothermal energy in Germany

by Detlev Doherr[1]

Geothermal energy is a domestic energy resource in Germany, which is used for electricity production, industrial heating processes, and efficient home heating and cooling. The potential of electricity production from geothermal sources is estimated at 150 TWh, but the present installed capacity is only around 400 MWh. Non-electric generation of geothermal energy is in the range of 2,3 TWh. The main regions in Germany with the highest potentials for hydrogeothermal energy are the sedimentary basins in the north ('Norddeutsches Becken'), the Upper Rhine Valley, and the 'Molasse Becken' in Bavaria near the northern rim of the Alps. The number of heat pumps and earth pipes increased by 85000 units between 2005 and 2008, worth 850 Mio Euro per year.

En Allemagne, l'énergie géothermique représente une ressource domestique, utilisée pour la production d'électricité, le chauffage industriel et le chauffage ou refroidissement efficace des habitations. Le potentiel de production électrique à partir des ressources géothermiques est estimé à 150 TWh mais la production actuelle n'atteint environ que 400 MWh. L'énergie géothermique non consacrée à la production d'électricité est voisine de 2,3 TWh. Les principales régions en Allemagne qui offrent un maximum de potentialités en énergie hydro géothermique correspondent aux bassins sédimentaires du Nord (Norddeutsches Becken), la haute vallée du Rhin et la Molasse Becken, en Bavière, près de la partie nord de l'arc alpin. Le nombre de pompes à chaleur et de tubes pour échange de chaleur a augmenté de 85000 unités entre 2005 et 2008 pour un montant de 850 millions d'euro par an.

La energía geotérmica es una fuente local de energía en Alemania, que se emplea para la producción de electricidad, en procesos de calefacción industrial y en la eficiente calefacción y refrigeración de viviendas. El potencial de producción de electricidad de fuentes geotérmicas se estima en 150 TWh, pero la capacidad actualmente instalada es sólo de alrededor de 400 MWh. La generación de energía geotérmica no eléctrica está en el entorno de los 2,3 TWh. Las regiones de Alemania con el mayor potencial de energía hidrogeotérmica son las cuencas sedimentarias del norte ('Norddeutsches Becken'), el Alto Valle el Rhin y la 'Molasse Becken' de Bavaria, cerca del borde septentrional de los Alpes. El número de bombas de calor y redes de tuberías aumentó en 85000 unidades entre 2005 y 2008, por un valor de 850 M€ al año.

Geothermal heat provides continuous and clean energy production. It is an essential part of sustainable energy supply in Germany. It is considered a renewable resource because the heat emanating from the interior of the Earth is essentially limitless. Geothermal energy is a domestic energy resource which requires heat, permeability of the subsurface, and water. It can be used for electricity production, industrial heating processes, as well as efficient home heating and cooling through geothermal heat pumps. Therefore, it can displace coal, natural oil and gas in the electric power sector.

Germany has an enormously growing market of renewable energy production with heat and power supply. The electricity production from geothermal sources is less than 1%, but is expected to increase mainly because of a renewable energy law which benefits the production of geothermal electricity with a guaranteed feed-in tariff of €0.15 per KWh. The German Federal Ministry of Environment (BMU) aims for an overall potential of electricity capacity of 25000 MW and production of 150 TWh per year [1]. It seems to be an ambitious target, taking into consideration the actual production of primary energy supply in 2007 was around 400 MWh.

The non-electric generating potential of geothermal energy is estimated to be more than 330 TWh [1]. Actually the geothermal production of heat energy was 2,3 TWh in 2007, which is less than 1 % of the 1350 TWh heat energy that Germany needs.

[1]Univ. of Applied Sciences, Offenburg, Germany

Geothermal potential in Germany

There are three geothermal energy options developed in Germany, depending on the depth of the wells and the kind of heat transport from underground to the surface as well as the use of the heat by heat pumps or plants.

Almost everywhere, the upper few meters of the Earth's surface maintain a nearly constant temperature between 10 - 15 °C. So a geothermal *heat pump system* can take advantage of the subsurface temperature, using pipes buried horizontally or vertically at shallow depth near a building, a heat exchanger, and ductwork into the building. Water or other fluids circulate through the system and can reduce electricity use by 50% compared with traditional heating and cooling. The heat pumps are mainly used for private facilities to reduce costs of heat and warm water supply, using the nearly constant temperatures of groundwater at depths greater than 3 m. Those wells have a typical depth between 10 - 100 m. All over Germany there are many examples of economic use of heat pumps, independent from those hydrothermal areas.

Hydrogeothermal resources depend on subsurface structures and the geothermal gradient. To calculate the potential of a geothermal project, one has to consider the situation shown in Figure 1. This presents the three areas of higher hydrogeothermal potential in Germany, the 'Norddeutsches Becken' in the north, the Upper Rhine valley in the southwest and the 'Molasse Becken' in the south of Germany, close to the rim of the Alps. Those structures are sedimentary basins with hot water in the subsurface with temperatures ranging from 60 °C to more than 100 °C depending on (or relative to) the depths, typically 2000 - 3000m. The required flood rates are pretty high to reach an economic production. Therefore, deep aquifers in permeable sediments, like sandstones and carbonates, are exploration targets .

Enhanced geothermal systems run with deep drillings of 4000 - 5000 m into the hot and dry basement, injecting water into the hot rocks. The natural fractures and pores in deeper rocks do not provide adequate flow rates. Hence, the permeability can be stimulated by pumping water into the

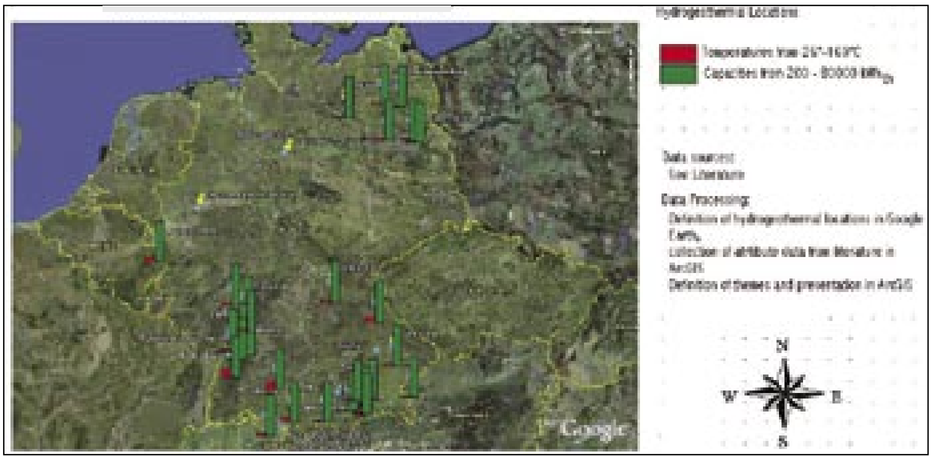

Figure 1. Hydrogeothermal resources in Germany with regions and locations of geothermal plants representing the three main regions of exploration: the "Norddeutsche Tiefebene" in the north, the Upper Rhine Valley in the southwest, and the "Molasse Becken" in the south. The capacities range from 200 KWh to 80000 KWh (green). The temperatures of the geothermal reservoirs are in the range 26-160 °C (red).

borehole to produce artificial fractures. This process causes fissures and cracks allowing an economic water flow from the injecting well to another well, where the hot water is extracted (doublet system).

Geothermal projects

The first geothermal electricity plant was started in Neustadt-Glewe, in the northern part of Germany, in 2003. The geothermal reservoir is a permeable sandstone 2300 m in depth with brine at 100°C temperature and a salinity of 227 g/l [3]. There was a thermal capacity of about 10 MW_{th}, producing 1400 - 1600 MWh_{el} electricity per year [3]. This binary system was one of the first operating with the Organic Rankine Cycle (ORC)-technology at a lower temperature level. As a result this project proved that the production of electricity from hydrogeothermal sources on low temperature levels of about 100 °C is possible in Germany, and it was concluded that Germany's geothermal resources could be used to supply the entire base load of the country.

In addition to the existing geothermal plant in Neustadt-Glewe, two new projects in Unterhaching (Bayern) and Landau (Rheinland-Pfalz) were started in 2007 with the goal of electricity production.

All locations are listed in Figure 2, where electricity was or is generated by geothermal energy.

The pumping rates of hot water and the temperatures are basic parameters for the capacity of the plant. The high pumping rates of the locations in the 'Molasse Becken', in the southern part of Germany, are economic factors for the development of geothermal plants, whereas the higher geothermal gradient is important in the Upper Rhine Valley.

The depths of the hydrothermal drillings for the listed projects in Figure 2 are all in the range 2500 - 5000 m.

Research on geothermal energy is supported by the German Federal Ministry of Environment (BMU), while the development of smaller-scale projects, such as as earth pipes and heat pumps, are supported by the German Federal Ministry of Economics (BMWi).

Germany reached about 14 % of gross electricity consumption from renewable energy sources in 2007 [6]. This was reached by continuous developments of domestic geothermal energy resources and technical research. Currently, there are about 30 locations with hydrogeothermal energy production as heat or power supply.

Neustadt- Glewe was the first electricity plant in 2003 [3]. In 2007, the plants in Landau (Rheinland-Pfalz) and Unterhaching (Bayern) were developed, and Bruchsal (Baden-Württemberg) finally started production.

Ongoing research on hydrogeothermal energy and hot dry rock technology focuses on technological innovation to minimize the costs and risks of geothermal exploration. The volume of financial support in 2006 was in the range of 23,7 Mio €, but increased to 8,1 Mio € in 2007.

Financial support was given for specific projects. Some are listed here:

- Online information system named "GEOTIS"

The Geothermal Information System (GeotIS) is a database containing aquifer data and information about geothermal energy potentials in Germany. It presents its data in the form of a geothermal atlas. It was created to minimize the risks in the exploration of geothermal locations.

- Power production in Landau (Rheinland-Pfalz: 2,1 Mio €)

Landau is located in the Upper Rhine Graben, which shows a higher geothermal gradient than in other areas of Germany. The gradient is 47 °C/1000 m, reaching temperatures of 100 °C at a depth of only 1200 m. So, the hydrothermal energy project runs with thermal water temperatures of 160°C at depths of 3300 m and flow rates of 50 - 80 l/s, which is used for electricity generation. After that process, the water is cooled down to 70 - 80 °C, which is enough to heat surrounding facilities. To protect the environment and the system, the water finally will be reinjected to the reservoir through a second well. The electrical capacity reaches 3 MW_{el} and the thermal capacity 6 MW_{th} [3]. This is the first industrial plant for generation of electricity

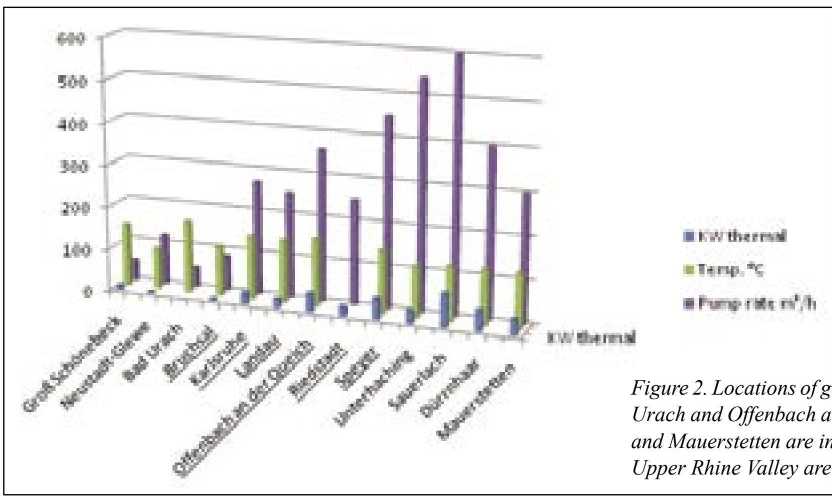

Figure 2. Locations of geothermal electricity plants (Karlsruhe excluded). Bad Urach and Offenbach are no longer operating; Speyer, Sauerlach, Dürrnhaar and Mauerstetten are in development or still to start. Locations in or near the Upper Rhine Valley are underlined. Data comes from [5]

and heat utilization with year-round availability [6].

- Unterhaching (Bayern: 1,2 Mio €)

One of the deepest geothermal wells has been developed in Unterhaching (Bayern). It reaches a depth of 3400 m and exploits about 150 l of thermal water with temperatures of 122 - 130 °C. The plant has a capacity of 38 MW_{th} and 3,4 MW_{el}, independent of time and seasons [3]. The power station is based on a Kalina cycle system, using an ammonia-water working fluid for high efficiency. The Kalina cycle is one of the potential fluid approaches to possibly achieving greater heat transfer efficiency for electricity production.

- Hydrogeothermal project Groß Schönebeck

The GeoforschungsZentrum (GFZ) Potsdam is developing a power plant in Groß Schönebeck. They are using an older exploration well for natural gas at 4300 m depth to explore the geothermal capacity in the "Norddeutsches Becke". The doublet system with a second deep well was developed in permeable sandstone to create a heat exchanger. This will be used to build a power plant from Vattenfall Europe AG[4]. The project is supported with 14 Mio € from BMU.

- Soultz-Sous-Forets (France) in cooperation with a European consortium [4]

This is an EU research project in cooperation with France, started in 1986 with the purpose of developing a hot dry rock technology. The permeability of the rocks at 5000 m depth was stimulated in 2006 with acid, with the result that water flow was enormously improved. A power plant based on the Organic Rankine Cycle (ORC) with 1,5 MW capacity was ordered. The BMU supported it with 6,4 Mio €.

Two projects called GeneSys and Prometheus are dealing with stimulation technologies in the deeper underground. GeneSys is located at the GeoZentrum in Hannover, and is expected to supply the office buildings with heat [4]. The key question is the stimulation of semipermeable sediments with hydraulic pressure to produce microcracks and fissures, to reach adequate flow rates between a doublet well.

The project Prometheus of the Ruhr-University Bochum will use the Hot Dry Rock technology under conditions of typical geothermal gradients in Mid Europe as 3 °C/100 m depth. There is an exploration well down to 4000 m depth to analyze the geological situation. The heat capacity will be used to supply the University with heat and hot water.

Pipes and heat pumps

The use of earth pipes and heat pumps to use geothermal energy increased to more than 1000 MW_{th} in 2007. More than 50,000 new heat pumps were installed in 2006 and 2007 to supply private homes [1]. This trend continued in 2008, where 35,000 units were sold, an increase of about 30%, with a value of around 850 Mio € [2].

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[4] Agentur für erneuerbare Energien: Geothermie- Forschungsschwerpunkte in Deutschland (*http://www.unendlich-viel-energie.de/*).

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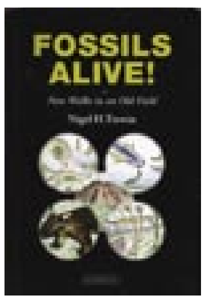
A bus tour with a difference: Geological excursions in deep time

Book review by David A.T. Harper[1]

Fossils Alive! Or New Walks in an Old Field.
by Nigel H. Trewin

Published by Dunedin Academic Press Ltd.
ISBN: 978-1-903765-88-3
Date: 2008, 211 pages
Price: 19.95 stg.



Geologists have tried to recreate past environments and their inhabitants, through nearly 4 billion years of Earth history. But try as we may we cannot lie in a meadow of the first land plants, stroll together with a herd of dinosaurs or swim with shoals of ammonites. Nigel Trewin has developed the next best thing. In a series of field excursions, Trewin takes us back to look at the evolution of Scotland's rich geological past, not with a Tardis but with a time-travelling bus and some friends and colleagues. Here we can visit the Devonian, paddling with primitive fishes and sea scorpions in Forfar Lake, experience one of the earliest land ecosystems cradled amongst the hot springs at Rhynie, fish for giant placoderms and osteichtheyans at Achanarras and witness the mass mortality of fishes at Dura Den; in the Carboniferous we follow the busy life of a trilobite, Mrs Phillips, as she flits across the seafloor evading the attentions of cephalopods and experience the incredible coal swamps with giant dragonflies and millipedes together with a new cast of amphibians. Around Elgin the Permian desert was inhabited by herds of pig-like dicynodonts avoiding the occasional carnivore whereas the Jurassic of Skye, not unlike western Australia today, was home to *Plateosaurus*-like dinosaurs navigating a vegetation of cycads, tailed by predators. In seas around Broadford and Trotternish, ammonites and belemnites swarmed observed by ichthyosaurs, plesiosaurs and large sharks, making scuba diving hazardous. Finally participants can experience an ancient Tsunami during the late Jurassic, transporting Jurassic life seaward into the Helmsdale Boulder Beds.

This is a lucid guide to Scotland's unique fossil heritage, illustrated by a series of vivid, reconstructions of habitats, complemented by many fine illustrations of the key fossils from each site. Sadly, we can no longer visit these sites except in our imagination, but Nigel Trewin in this lively book has provided the next best thing.

[1]David Harper is Professor of Palaeontology and Head of Geology in the Natural History Museum of Denmark, University of Copenhagen

A World Federation of Professional Geologists: why the world needs one

The idea of a WFPG was originally presented by me at the 1st International Professional Conference in Alicante in 2000, and again at the 32nd International Geological Congress in Florence in 2004. But so far it is just that: *an idea*.

Today scientists worldwide discuss the probable effects and potential solutions for Global Warming, and debate how science can help to prevent and solve the dilemma of living everyday in an apparently dangerous planet. There are more than 20 international scientific organizations that can handle those debates (IUGS, IAEG, IAG, IAH, IGCP, IUGG, to cite just a few acronyms).In the world of professional organizations, we also have our discussions on scientific matters, but we mostly concentrate on how to; remove barriers to mobility of professionals; certify qualifications; attain decent salaries and behave ethically in this evolving and harsh scientific/professional environment where opinions can represent major expenditure in the wrong or the right way. But in spite of the importance that all this might have, the fact is that today there is not a single worldwide organization of professional geologists. This is clearly a handicap that affects our image and also our impact in a global society.

Geoscientists and geo-professionals are sometimes the same, but their opinions might not be so. But both our judgments are needed.

It is in this framework of an evolving science and professionalism to a more global view of the Earth Sciences' involvement with society, in the framework of the EFG policy of "Geology at the service of the citizens" and the International Year of Planet Earth, that it seems that an idea must become a reality *now*.

In 1999, after Katrina and its catastrophic results, it was clear that the geological profession had to do more than just register and document the phenomenon; our ethical guidelines could not and should not make us look another way. That ethical engine drove to the creation of the first geological NGO: World Geologists. Today that idea is up and running and the organization is operating in Central and South America and in Africa, developing hydrogeological and geological hazards protection projects, has a budget of over 1 M€ and has employed, since its creation, more than 100 geologists. If that idea has been so successful, why not try now a world professional organization?

But what would that new entity do? It would of course represent professional geologists in all international forums, but specifically in international organizations such as the UN, ICOGS, UNESCO, IUGS, etc, it could promote and encourage the use of geological knowledge on a worldwide basis; to improve human welfare in the context of sustainable development; promote the integration of geology in society to provide quick response to all its needs; produce geologically educated citizens; improve the quality of geological professionals through continual professional development on a global scale; disseminate the practical use of geological knowledge at all levels, particularly employing new modern technologies; develop a global code of ethics and enforce its use worldwide, and promote global policies with regard to environmental geology, land-planning and use of natural resources, to name a few.

Representatives of National Professional Associations, Regional Professional Associations, Federations of Professional Associations, Scientific and Technical Associations, Earth Sciences' NGOs as well as Institutions, organizations and companies interested in supporting the activities of the WFPG for the advancement of professional geology, could join efforts in this new but necessary view from within the profession, providing the citizens of the world with the geosciences advice they need.

Draft statutes for this new entity were presented during the council meeting of the EFG in December 2007. During the 3rd International Professional Geology Conference, held in Flagstaff in September 2008, the presidents of the European Federation of Geologists (EFG), the Canadian Council of Professional Geoscientist (CCPG) and the American Institute of Professional Geologists (AIPG) signed the Flagstaff Agreement (see European Geologist 26). This represents the latest step towards a World Federation of Professional Geologists. I hope this initiative will finally be successful during this last year of the International Year of Planet Earth 2007-2009.

Manuel Regueiro y González-Barros
President of EFG

EFG Medal of Merit

The title of Honorary European Geologist was created in 2002 in Alicante. This was to be awarded to those who had made a significant contribution to professional geology in Europe. It was replaced in Berne in 2002 by the EFG Medal of Merit to avoid confusion with the professional title.

Medals have been awarded to nine people.

1. John Shanklin UK 2002
2. Eric Groessens Belgium 2003
3. Richard Fox UK 2004
4. Renzo Zia Italy 2005
5. Gerard Clement France 2005
6. Manuel Regueiro Spain 2005
7. Pietro de Paola Italy 2005
8. Pieter Laga Belgium2007
9. John Clifford Ireland 2008

Citations and reports were published for John Shanklin and Eric Groessens in the EFG Pictorial History (2005), and for them and for Richard Fox, Manuel Regueiro, Pietro de Paola and Gerald Clement in European Geologist magazines 15, 18, 21 and 23.

We note the further recipients here, with edited citations.

4. Renzo Zia (in Memory)

Renzo Zia was born in Livorno (Italy) in 1929 and died in December 1996. He graduated with full marks in Geological Sciences at Pisa University in 1954. He was a researcher at CNR Study Centre for Geology of the Apennines and an Associate Professor of Geology and Lithology at Pisa University. For several years he has worked as an independent professional in environmental and applied geology, geotechnics and hydrogeology.

Renzo ZIA was a member of many associations and committees, consultant to Development Agencies and adviser to Public Bodies. He worked abroad, as FAO expert and U.N.I.D.O. adviser in hydrogeology in Africa and the Middle East.

Since the date of the EFG's foundation in 1980, Renzo ZIA was a Member of the Council and was one of EFG's early Presidents, from 1983 to 1986. He also has served on the Editorial Committee of "The Geologist" Magazine. He was a Member of the Board of ONGI (now CNG) from 1975 to 1985, and President from 1979 to 1985.

Proposers: Floriano Villa and Carlo Enrico Bravi

Seconder: Pietro De Paola

8. Pieter Laga

Brussels, November 2007

Dirk de Coster cited

We note that as Director of the Geological

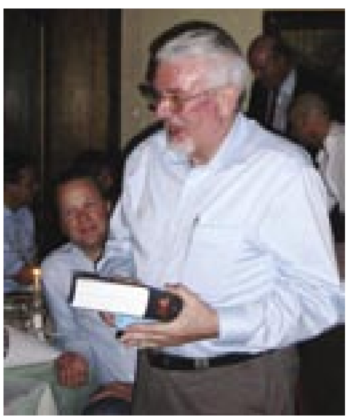
Survey of Belgium, Pieter Laga was instrumental in welcoming the EFG to its current office on the fourth floor of the GSB building in rue Jenner in Brussels. He has gone out of his way to make sure that our occupancy was as pleasant and as free from bureaucracy as possible. Whenever there have been problems he has sought to minimize them and to solve them. We are indebted to him for his positive approach to our relationship.

9. John A Clifford, IGI
John Clifford was the EU Delegate on the EFG Board from 2002 to 2005 and made great strides in helping the EFG Brussels Office in its development in those years, especially since he works for a private company. Even from the far distance of South America, John has always fulfilled his duties, and this has always been done well over the requirements and commitments of the EFG.

For many years now John Clifford has been a moving force in bringing standardization to areas of professional reporting. His impressive work on his subject of reference: "mineral resources and mineral reserves classification" representing the EFG, is one of his multiple achievements. With his international contacts he has been a driving force from within and outside the following bodies: Committee for Mineral Reserves International Reporting Standards (CRIRSCO); United Nations - Economic Commission for Europe (UN-ECE) Ad Hoc Group of Experts Meeting; UN-ECE's United Nations Framework Classification (UNFC); International Council of Mining and Minerals (ICMM); Society of Petroleum Engineers (SPE); International Accounting Standards Board (IASB) Extractive Industry Working Group; Australasian Joint Ore Reserves Committee (JORC); South Africa SAMVAL SAMREC; SME Guidelines; Pan European Resource/Reserve Committee (PERC). As you can see, John is also a fluent speaker of acronymish.

John Clifford is and has always been a strong defendant of the EurGeol. title, not only on his own behalf, but also on the EFG's behalf. Above all, John is a good representative of the geological profession, both personally and professionally.
Proposer Istvan Berczi
Seconder Manuel Regueiro

EFG Award to Peer Anderson
Brussels, November 2007
For work on EFG Website. For many years Peer carried out important work on the EFG website without recompense and with little public acknowledgement. We were delighted to recognise his support for the EFG with the presentation of a music encyclopedia.
Proposer: Gareth Ll. Jones
Gareth Ll. Jones



Figures 1-4 (above from top). Renzo Zia; Pieter Laga receives his medal from Dirk de Coster; John Clifford; Peer Anderson

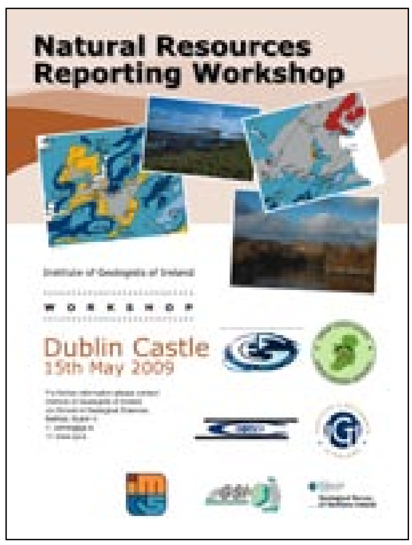
Natural Resources Reporting Workshop, Dublin, May 15 2009.

The Workshop
Reporting standards are now more important than ever in a changed world where credibility and reliability have been severely challenged, particularly in the banking and financial markets. Trust and belief in the accuracy and reliability in mineral resources and mineral reserves is now fundamental to continued investment in the natural resource sector. This Workshop provides a forum to review the current reporting codes and their inter-relationships and to identify ways in how the codes can be strengthened and made more consistent.

Keynote papers will be presented, highlighting the importance of a vibrant natural resource sector for European society and the role that resource reporting has in its sustainable development. The CRIRSCO family of reporting codes will be described, with emphasis on the PERC Code, and their relationship to the Russian system explained.

The importance of high standards of resource reporting for financing resource development in today's difficult financial markets will be discussed, as will the relationship with the recently enacted EU Mine Waste Directive.

Case studies will also be presented on the implementation of resource reporting codes within different sectors of the resource industry. In addition to the mining sector, representatives from the petroleum and aggregate sectors will outline the resource reporting standards presently applied in those industries.
EurGeol Kevin T. Cullen PGeo.



Only one Earth, don´t waste it!

The European Federation of Geologists in collaboration with International Year of Planet Earth and EuroGeoSurveys participated in the European Commission's Green Week 2008 (June 3-6) exhibition: "Changing our behaviour".

This year the theme of the annual event was "Only one Earth, don't waste it!", focused on the sustainable use of natural resources, especially waste management and sustainable consumption and production.

Green Week brought together some 3,000-4,000 representatives from different levels of government, international institutions, business, non-governmental organizations and the scientific and academic communities. The ultimate objective was to find the most effective ways to protect and improve Europe's environment, now and for the future.

Debates, presentations and stands reviewed actions in environmental topics. The EFG stand was focused on Sustainable Use of Natural Resources. The objective was to present the role of geology in the management of natural resources: use and storage of Energy, Water and Minerals.

We distributed information about the EFG: EFG leaflet (below), EFG Members, EFG Manifestos and European Geologist Magazine. We also distributed a document and a leaflet from the French Union of Geologists which supported us during the exhibition: *Les Géosciences au service de l´Humanité. Géologue: acteur-clef de la planète; Les Géosciences au service de l´Humanité. Anée Internationale de la Planète terre 2007-2008-2009.*

In conclusion of the EFG's performance in Green Week 2008, a leaflet presenting the use of these resources, their pollution and waste management was prepared, as well as a Power Point presentation, which showed in more detail these three subjects.

EFG in collaboration with the International Year of Planet Earth and EurGeoSurveys organized a Session and a debate: "European geology in the International Year of Planet Earth" which took place on 5 June, 2008.

Dr. Werner Janoschek, the Goodwill Ambassador of IYPE, gave a presentation under the title "The International Year of Planet Earth, a contribution to Sustainable Resource Management". Dr Janoschek presented the two main objectives of IYPE: to demonstrate the great potential of the Earth Sciences in the building of a safer, healthier and wealthier Society, and to encourage Society to apply this potential more effectively. The presentation gave a global vision of how the IYPE is being taken into account, relevant events, global organization, etc. The presentation described the science themes for the IYPE: groundwater, hazards, Earth & health, climate, resources, megacities, deep Earth, oceans, soils, Earth and life. Finally, Dr Janoschek focused on Resources Management, Mineral Resources, Industrial Minerals, Construction Material, Energy Resources and Groundwater, with quantitative information on a worldwide-level. The problem in the Mineral Resources Management was presented with some examples in Austria.

Dr. Pierre Andrieux, Vice President UFG, Professor emeritus University Pierre & Marie Curie gave another presentation under the title "Geology at the service of the citizens" which was based on the report "Les Géosciences au service de l´Humanité. Géologue: acteur-clef de la planète", UFG report for the IYPE. Dr. Pierre Andrieux presented a lot of reasons for young people to be interested on the geologist's profession. The presentation

Figure 1. EFG Stand with some members of the three collaborating associations

was focused on Energy, Mineral Resources, Water, Environment and Development.

To conclude the session, Dr. Patrice Christmann, EuroGeoSurveys Secretary General gave a presentation named "Natural resources challenges for the XXIst century: the mineral resources example". With this presentation, Dr. Christmann explained to the European Institutions some reasons why we should use the third dimension below the soil's surface. The relation between Economy and Well-being are complemented with minerals, water, energy and soils resources. Finally, the presentation focused on minerals, explaining the general use of mineral resources and the European dependency on foreign countries. The real situation of the mining exploitation in Europe was presented, including the problems of resources accessibility and the environmental impact assessment during the transport of minerals around the world. The last part of the presentation dealt with research on new technologies for exploitation.

Dr Christmann recommended the development of a European mineral resources policy based on five pillars

- Increase the supply of raw materials from European sources on a sustainable basis
- Ensure sustainable and a more transparent supply from third countries
- Encourage capacity building in developing countries
- Encourage greater efficiency in the use of resources
- Establish an adequate EU knowledge base on raw materials.

Adela Aparicio, Assistant, Panels of experts and ILB
Jorge García, Assistant, Communication
Isabel Fernandéz, EFG Office Director

Comments and letters to the editor

11 March 2009
Comments on Kevin Cullen and Fionnuala Collins, Guidelines for quarry developments in Ireland, European Geologist Magazine, December 2008

Dear Editor,
I read with interest the subject article, as I have worked in and around aggregate-rock and dimension-stone quarries throughout much of the United States, and more recently in Afghanistan, Nepal, and Pakistan. While the U.S. has hundreds of quarries, Afghanistan has several score, Nepal has only several, and Pakistan has several dozen. The most profitable rock quarries in Afghanistan, Nepal, and Pakistan, as in the U.S., are for marble dimension rock. Some of spent U.S. quarries have been converted to artificial lakes, fishing and hunting recreational areas, and commercial fish farms. Unfortunately, prior to promulgation of the U.S. Resource Conservation and Recovery Act (RCRA) in 1976 - regulates hazardous waste from cradle to grave, landfills, underground storage tanks, and treatment-storage-disposal facilities - and its expansion as the *Hazardous and Solid Waste Amendments of 1984 (HSWA)*, many spent U.S. quarries were converted to raw dumps for municipal and industrial waste. Many of these old quarries, now dump sites, became the focus of the U.S. Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA, aka "Superfund") and its enhanced Superfund Amendments Reauthorization Act of 1986 (SARA), and Emergency Planning and Community Right-to-Know Act of 1986 (EPCRA) - which primarily regulates abandoned hazardous waste sites, environ mental releases, and the public rights to know.

One of the very positive aspects of U.S. quarries speaks to the American entrepreneurial spirit. In general, where the rock material is a carbonate, the quarry is associated with a cement kiln industry to produce cement for concrete, and in some cases a calcium carbonate processor for chalk, industrial chemicals, and pharmaceuticals. In addition, many U.S. dimension-stone quarries recover waste rock to make stone aggregate and other commercial rock and crushed stone products where feasible. And of course, for several decades, dimension-rock quarries more often use electrical or diesel operated diamond-tip saws rather than suffer the rock-quality damages inherent in blasting.

In contrast to these US common practices, dimension-stone quarries in Afghanistan, Nepal, and Pakistan typically are not associated with cement production, and typically excavate by blasting which leaves a 60 - 75 % rock waste by volume in the quarry yard. And, unfortunately, the waste rock is not systematically recovered for any beneficial use, such as aggregate-rock use. Moreover, each future delivery of blast-rock quarry dimension-rock billets or masses to the mill or shop typically arrive in worse condition and poorer quality because of blast-induced fractures.

In the mill or shop - which converts the incoming dimension-rock billets from the quarry to rock slabs or dimension stone by sawing - waste rock can be a commercial resource for tile, ceramic, castings, mosaics, and calcium carbonate source material. If the billets arrive with significant cracks and holes from blasting, much of the rock will be unsuitable for large slabs, and some will need to be injected with silicaceous gels or plasticizers at a cost to produce a commercial product, even a less valuable product than if the billet is solid. The volume of waste rock from cracked or hollow billets may be as high as 50 - 60 % at the shop floor. This waste, which would be more likely reprocessed in the US for any of several commercial products from tiles, ceramics, castings, mosaics, and calcium carbonate source, is more likely to be dumped or discarded without commercial recovery in Afghanistan, Nepal, and Pakistan. When the shop-floor waste is factored over the blast dimension-rock quarry rock waste, the overall waste percentage varies from approximately 80 - 90 %, generally un-recovered as a resource. This enormous wastage contributes to air pollution, ecological stress, water contamination, and increased downstream sedimentation and flooding.

Consequently, there is little export volume or revenue from these countries, though they do have some really lovely natural rock, which, if managed appropriately and entrepreneurially with commensurate capital investment, working capital, operations and maintenance, infrastructure, and marketing, would be a significant source of sustainable jobs and wealth generation. Afghanistan's Chesht and Khogiani marbles have been favourably compared to Carrara marble, an Italian marble recognized to be one of the finest in the world (Embassy of Afghanistan, 2007). Nepal's Godavari marble is locally mined and consumed (Tumbahangphey, 2001). Pakistan's Boticenaa and Onyx (Green), and Malagori (white) marbles are also prized for sculpture (Wikipedia, 2009).

For comparative purposes, consider that Afghanistan is slightly smaller than the size of France in area, with slightly less than twice the population of France. Nepal is slightly larger than twice the size of Poland in area, with slightly more than three times the population of Poland. Pakistan is slightly smaller than France and Germany combined in area, with the population of slightly less than the combined population of France, Germany, Belgium, and Netherlands.

Best wishes,

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Report on CRIRSCO Meeting Santiago, Chile, November 2008

CRIRSCO held its annual meeting in Santiago on 24-27 November 2008, hosted by Chilean members and SONOMI (National Mining Society of Chile).

CRIRSCO International Reporting Template
The core definitions of the Template are derived from the Denver Accord of 1997. It is recognised that various National definitions have 'drifted' from the original Denver Accord versions and the Committee agreed that, while such changes may not have been significant, there was a need to work towards a single agreed set of International definitions again. This was seen as particularly important when dealing with external international organizations. It was agreed that CRIRSCO would develop a protocol for changing the core definitions and that an exercise would be carried out to examine the current definitions in all member countries to see where differences existed and identify a means of removing these.

Various members of CRIRSCO are leading efforts to align the reporting systems of other non-member countries with the International Reporting Template. Important recent developments include:

- The signing of a Protocol of Intentions with the Russian State Commission on Reserves (GKZ) to be followed by a joint mapping exercise
- Engagement with the Chinese Government, which is in the process of updating the country's minerals classification and reporting system
- Providing support to Mongolia by CRIRSCO members, including visits

- to Mongolia to outline the principles of Western reporting and hosting visits to US mines for Mongolian delegates
- Preliminary discussions with Indonesia on Code development and international reciprocity.

United Nations Framework Classification Revision Task Force (UNFC)
CRIRSCO continues to participate in the UNFC through regular teleconferences and occasional face to face meetings. The proposed revised UNFC, which is a high-level system of definition that can be supported by both industry sectors without compromising the individual classifications that are in practical use throughout these industries, has been published for comment and was presented to the Geneva meeting of the UN Ad Hoc Group of Experts for approval in March 2009.

International Accounting Standards Board (IASB)
The IASB research initiative looking at valuation of Mineral Reserves for financial reporting is proceeding slowly. CRIRSCO is maintaining a close relationship with the IASB and other interested parties as this project develops. The Working Group is now preparing to engage with the IASB on the broader issue of international accounting.

CRIRSCO strategy on the SEC
The USA situation remains still problematic with the US Securities and Exchange Commission still not recognising the SME Guide for reporting. Recent changes to SEC requirements for oil and gas reporting have given some encouragement and CRIRSCO's US members will prepare a strategy document in anticipation of a similar exercise being instigated by the SEC in due course.

Hot Topics
Various members have schemes whereby foreign Competent Persons can be recognised for reporting purposes in their countries. This often raises issues on which organization is responsible for disciplining Competent or Qualified Persons for non-compliance with reporting codes. Members agreed that there was a need to clarify how the systems worked in each member country with a view to creating a more easily understood international format.

The definition of Inferred Resources is one that tends to create more issues than other classes as it is often the point at which resources are first declared, and where confidence in the estimate is most difficult to quantify.

Exploration targets are noted in several member Codes but not currently in the Template. While these can be regarded as a sub-set of Exploration Results and reported on accordingly with appropriate Competent Person sign-off, the Committee considered the more general issue of how to report mineralization that does not fall into a resource class. While it is recognised that some stakeholders such as governments may have a need to quantify mineralization beyond Inferred resources, and that companies will commonly maintain an internal inventory of such mineralization, the Committee did not feel that this warranted extending the Template definitions.

Various member codes refer to Pre-Feasibility as the minimum level of study before reserves can be publicly declared, but this is not universal and others leave the decision to the Competent Person to specify Feasibility as a minimum. The Committee agreed that this was an issue of concern and that some clarification is needed. An exercise will be conducted to compare current rules across member NROs with a view to reaching an agreed standard position for CRIRSCO.

CRIRSCO Administration
CRIRSCO's role as a Task Force of the International Council for Mining and Metals was discussed. The trial period for this arrangement ends in May 2009 and members discussed their views on the arrangement and whether changes were necessary. In general the relationship was seen as positive and had been of great assistance to CRIRSCO.

It was noted that representation of PERC might need to be increased to adequately cover the large UK and Western Europe constituency. It was also noted that Russia will now have direct involvement in CRIRSCO from May 2009. Grigoriy Malukin, one of the Russian delegates to the EFG Council and one of the EFG's representative on the Pan-European Reserves Committee, has been nominated to CRIRSCO to replace John Clifford who retires from the post in May 2009.

The Committee discussed the possibility that other countries would seek to join CRIRSCO over time and how this could be handled without compromising the aims and objectives of CRIRSCO, but at the same time encourage such membership. It was agreed that a fundamental principle for membership is the subscription to a reporting standard that is compliant with the Template and which contains the various governance safeguards provided by current member Codes.

Niall Weatherstone will step down as Chairman in June 2009 to be replaced by Roger Dixon for a two-year term.

Launch of the Chilean Code and Registry of Competent Persons
CRIRSCO participated in the launch of the Chilean Comisión Minera at a public event attended by around 200 people. All CRIRSCO members gave a presentation on reporting standards in their jurisdictions. Representatives from the ASX and TSX also made presentations.
John Clifford

Press Release. Reporting of Reserves and Resources in Russia: Agreement between GKZ and CRIRSCO

At a meeting in Moscow on 21-22 October 2008 between the FGU "State Commission on Mineral Reserves" (GKZ) and the Committee for Mineral Reserves and International Reporting Standards (CRIRSCO), a breakthrough agreement was reached on alignment of the two reporting systems. Key points of this agreement include the following:-

- a basis for mutual recognition of Competent Persons
- a set of guidelines for conversion of reporting categories for resources and for reserves, which will be developed fully in a handbook to be issued jointly by GKZ and CRIRSCO before the end of 2009
- a commitment to coordination of future efforts in standardization of reporting
- an immediate invitation to the Russian Association of Mineral Resource Experts (OERN) to nominate a representative as a member of PERC (the Pan-European Reserves & Resources Reporting Committee), whose new CRIRSCO-compliant minerals reporting code is to be published within the next few weeks.

In parallel, the European Federation of Geologists (EFG) has also invited its Russian member organization OERN to nomi-

Left to right. Yuri Podturkin, Chairman GKZ and Niall Weatherstone, Chairman, CRIRSCO nate the next PERC representative to sit on the CRIRSCO committee.

Following the signing of the Protocol of Intentions on 22nd October, Mr Yuri Podturkin, General Director of GKZ, said that we are of the opinion that international geologists understand each other, and it is necessary that, by our joint efforts, international investors and financial institutions see the transparency and adaptability of the Russian system of recording and assessing mineral reserves and resources. We are going together with CRIRSCO to achieve this objective. Mr Niall Weatherstone, chairman of CRIRSCO, said that this agreement recognises the importance of Russia as both a producer of minerals and an international partner in many mining ventures. Mutual recognition of minerals reporting systems and greater integration with the well established CRIRSCO reporting methodologies will assist industry practitioners, regulators, and the financial community in the future.

Further information from:

Dr S. Henley, secretary, CRIRSCO-GKZ Working Group, stephen.henley@resourcescomputing.com

Web Links: both English and Russian texts of the Protocol can be found on the web sites of GKZ (*www.gkz-rf.ru*) and CRIRSCO (*www.crirsco.com*).

John Clifford

News from the Netherlands

On 20 November 2008, the Royal Geological and Mining Society of the Netherlands (KNGMG) organized a successful conference in Amsterdam, under the title: Climate change: Facts, Uncertainties and Myths. Seven speakers of different professions (geologist, geophysicist, biologist, climatologist, astronomer, physicist and philosopher) gave a fascinating insight into the diverse problems of climate prediction. One very remarkable contribution came from the astronomer, Professor Kees de Jager, whose findings were compressed in a press release that, in summary, stated;

"Different from the traditional thoughts so far, periods of extreme sun activity are predictable. The number of explosions of energy on the sun will decrease as from 2014. and this will last during the entire 21st century. According to Professor de Jager this decreasing activity will have implications for the climate on Planet Earth. Better insight into the origin of the sun activity has made it possible to establish the degree to which our climate depends on the Sun. This appears to be more than thought so far. The present warming period will probably change into a relative cooling, when, as predicted the activity of the sun decreases further". The meeting drew over 400 participants.

Peter de Ruiter, President of the Royal Geological and Mining Society of the Netherlands (KNGMG)

Geologos sin Fronteras (GsF). The Togo project (west Africa) 2009

The Water Supply Project in Togo started with a GsF preliminary mission in March 2007, during the accomplishment of a similar project carried out in Mali, which was finished and delivered to the beneficiaries in January 2008.

A second Mission in Togo (April-May 2008) has given the opportunity for a detailed hydrogeological investigation, the exact drawing of the project and the survey of a map of the area involved, at a scale of 1:5.000.

Six Villages, Agbatitoe, Avovo, Simbao, Tchadome', Koledjikope/Fadakope and Yava will benefit from the project, with a total population of around 4,000 (60% children).

Field work started in February 2009. At present, the project operations have been concentrated in the central/northern area (Koledjikope/Fadakope and Yava).

Two water retention basins measuring 50 x 30 X 2,70 m have been excavated ; these will provide the necessary amount of water for agricultural purposes. Drinking water is now assured by two water wells that have been drilled in the basement rock (granite), up to depths of 80 and 98 m. Good water has been found in granite fractures at depths of, respectively, 57 and 88 m. Both wells have been equipped with solar electric pumps and solar panels (Fluxinos Srl - Grosseto-Italy), each producing a water yield of 9,5 m^3/day.

Simple water distribution systems have been put in place.

The Project is in full development. Four more water wells have to be drilled and equipped with solar pumping systems.

The whole Project is scheduled to be accomplished and handed to the beneficiaries by end of May 2010.

Carlo Enrico Bravi

International Year of Planet Earth

In proclaiming the International Year of Planet Earth in 2005, the United Nations General Assembly recognised the global nature of the challenges faced by the Earth Sciences and by society, and the need to promote public awareness of the importance of geological knowledge, regardless of culture, language or international borders. The inception of the year, however, goes back much further. A review by the International Union of Geological Sciences (IUGS) in 2000 showed that there was a major discrepancy between our current knowledge about Planet Earth, and its application in daily life. The responses to natural disasters such as the 2004 Indian Ocean tsunami and the 2005 Katrina hurricane only reinforced this impression. Our knowledge about natural disasters, though extensive, was not being used to its full potential to help vulnerable societies.

Along with other observations, including the progressively fewer number of university entrants in geoscience subjects, these conclusions prompted the IUGS to explore ways in which the public and its leaders could be persuaded of the importance of reversing these trends. The idea of the IYPE was generated, with the aim of capturing people's imagination about exciting knowledge we possess about the natural world, and the ways in which it can be used to improve and enrich our lives. Shortly after the IYPE's inception, UNESCO's (former) Earth Science Division joined, followed by 26 Associate Partners and 12 Founding Partners.

We are now in the third year of the International Year of Planet Earth, with 2008, the UN year, already behind us. Some of the aims and ambitions have already been realised, but many others are still underway. Among the highlights was the official global launch of the IYPE at the headquarters of UNESCO in Paris on 12 and 13 February 2008. Hosted by UNESCO's Director General Koïchiro Matsuura, the audience included 200 invited students from around the globe, chosen for their responses to an international student competition. Entrants aged 18-22 were invited to approach one of a list of Earth Science topics in a creative way, and responded in a wide variety of forms, including essays, poems, artwork. The launch event also included discussions of a variety of challenges faced in the Earth Sciences by leading scientists, figures from industry and politicians.

As well as the global launch, national launch events were held around the world. In the UK, the national launch took place on 10 January 2007, and coincided with the opening of a year of events commemorating the bicentennial of the Geological Society of London. Celebrating both its own 200th birthday, and the 4567 millionth birthday of Planet Earth, 4567 biodegradable balloons were released to mark the occasion. In Africa, the official launch took place on 8 and 9 May 2008 in Tanzania, in the city of Arusha at the foothills of Mount Kilimanjaro. Hosted by the President of Tanzania, Jakaya M. Kikwete, the launch featured talks by scientists of many African nations, and was witnessed by an audience of 300 from 20 different nations, among whom were many invited students from African countries.

The IYPE was organised with both scientific and outreach activities in mind. The flagship science project was OneGeology – an international initiative of the geological surveys of the world, spearheaded by the British Geological Survey. The aim of the project is to develop a geological equivalent of Google Earth, by making dynamic geological map data available on the internet. Earth and computer scientists from 79 are working together to deliver the project, with the hope that it will enable all nations, regardless of their economic status, to have access to information which is crucial to the development of engineering projects, waste management and many other vital initiatives.

The success of OneGeology was not always matched by other scientific projects. There was disappointment when fundraising did not quite meet expectations, which limited the extent of scientific research which could be carried out. More successful was the science programme's development of a series of brochures based around the themes of the IYPE. These have attracted great interest, and have already been translated into several languages, with plans to produce a similar series of books which will serve as a legacy to IYPE already underway.

The real success of the IYPE has been its outreach activities, which have produced a number of unanticipated results. Of particular note has been the establishment of a large number of National Committees, set up around the world to administer outreach activities and apply the IYPE's global ambitions on a regional scale. The organization of National Committees was undertaken by many more nations than had been expected, with numbers growing all the time. By the end of 2008, geoscience communities had established committees in 76 countries and regions across the world.

One of the most positive outcomes of the year has been the emphasis on young people in the Earth sciences. This engagement began with the attendance of invited students at the launch events, which provided a wonderful opportunity for students from all over the world to meet and discuss their ideas and concerns. Since then, young people's engagement with the aims of the IYPE has continued, precipitating the formation of Young Earth Scientists for Society, which will hold its first conference in October 2009 in Beijing. Formed as a direct result of the IYPE, the YES network is composed primarily of scientists under 35 years of age, to provide links between those who will provide the future generation of Earth scientists.

With the future of the Earth becoming increasingly uncertain, the engagement of young people in the earth sciences was always one of the IYPE's primary aims. It is hugely encouraging that it is in this area that the IYPE has been most successful, suggesting there are many reasons to be optimistic about the future of Earth sciences, and of the planet.

Sarah Day, Geological Society of London

News from NGO Geólogos del Mundo (World Geologists)

Activities in 2008

- Publication of the Annual Report 2006-2007 (Fig. 1)
- Co-organization of the concert of the International Year of Planet Earth, jointly with the Spanish Official Association of Professional Geologists (ICOG) and the Geological Survey of Spain. The event was held in the Symphonic Hall of the National Musical Auditorium (Fig. 2), and played by the Chamartin Symphonic Orchestra and the Talia Chorus, directed by Silvia Sanz as in previous years. The novelty was the premier of the Water Cantata written by A.Vivas Puig. Three other compositions related to Planet Earth were also played
- WG received the "Excellence Woody Cone" awarded by the municipality of Siguatepeque (Honduras) in recognition of the underground water supply projects carried out in four communities and the collaboration of WG staff in the emergency resulting from the October 2008 floods
- New web page currently being translated to English
- Creation of the Delegations in Castile-La Mancha and the Basque Country.

Projects finished in 2008

- "Strengthening the environmental management of the municipalities of the Fonseca Gulf. El Salvador". Financed by the Spanish Agency of International Cooperation. Budget: 199.999 euros
- "Public supply of drinking water to the Colony Noé Cruz Villena in the municipality of Siguatepeque. Dpt of Comayagua. Honduras". Financed by the Oviedo Municipality. Budget: 45.000 euros
- "Socioeconomic study for the Sustainable Development of the Back-up Lake. Nicaragua". Financed by the Biodiversity Foundation. Budget: 79.969 euros
- "Implementation of EHIS (Environmental and Hazards Information System). El Salvador" Financed by the Spanish Agency of International Cooperation. Budget: 226.011 euros
- "Borehole drilling and supply of equipment for an underground water well to supply the San José de Tapi quarters. Riobamba Municipality. Chimborazo Province. Ecuador." Financed by the Provincial Government of Saragossa, the Provincial Government of Huesca and the Municipality of Saragossa. Budget: 90.049 euros
- "Recovery and maintenance of wells as a tool to strengthen sustainable management

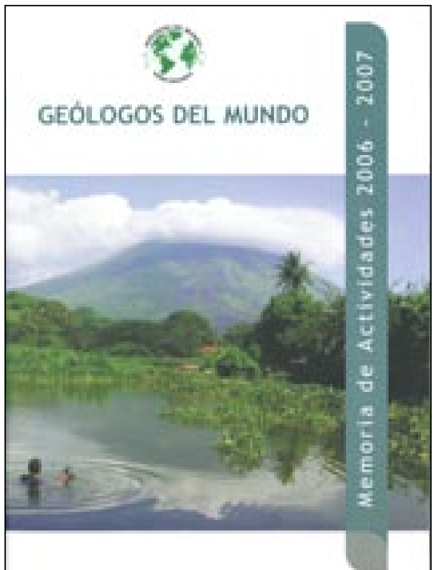

Figure 1. Annual report

of water resources. Phase I. Burkina Faso". Financed by the Agency of International Cooperation of Cataluña. Budget: 110.000 euros

- "Borehole drilling and supply of equipment for an underground water well to supply the Monseñor Sthele quarters. La Concordia village, Esmeraldas Canton. Ecuador." Financed by the County Community of Calatayud (Saragossa) and the village of La Concordia. Budget: 18.545 euros
- "Installation of a sucking pump in the borehole La Lolita de Riobamba. Chimborazo province. Ecuador." Financed by the Provincial Government of Saragossa and the Riobamba municipality.

  Budget: 19.762 euros.

Other activities

Several conferences throughout the country, diffusing geology and the NGO. Appearances in the media (TV, radio and newspapers) both in Spain and in El Salvador. WG has carried out so far more than 70 projects, mainly in Central America and Western Africa, with the collaboration of more than 60 expatriate geologists and a huge number of local technicians, and has given special attention to the signing of agreements with our local counterparts.

Ángel Carbayo Olivares
President

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A rock star, inspired in Wales

An abridged feature from the Countryside Council for Wales to celebrate the bicentenary of Charles Darwin's birth on 12 February 1809

It's one of those common pub-quiz questions! Who "discovered" evolution? Your mind goes blank! But when you hear the answer, you recall that name. Charles Darwin. An old man with a long white beard; something about a Beagle and a voyage around the world an age ago.

Darwin was trained as a geologist and, as a fit young man in his early twenties, he learnt an awful lot of his skills observing what was in the natural world around him while he tramped over the hills and mountains of North Wales.

But there's more. This was the mid 19th century when many geologists thought that the Biblical Flood - the one that Noah made the ark to survive - had shaped much of the landscape they saw around them, the deep valleys, huge boulders scattered across the land and much else. This was also a time when divine creation explained the huge diversity of life on Earth.

Spending time in Cwm Idwal (today a National Nature Reserve) beneath the towering Glyderau peaks in Snowdonia, Darwin became convinced that massive glaciers had carved out the cwm and left their evidence for all to see. He was to be proved right.

About 20,000 years ago, a glacier flowed out of the cwm and into Nant Ffrancon, smoothing and abrading the rocks in its path. The glacier formed part of a huge ice sheet that covered most of Wales. Even more recently, between about 13,000 and 11,500 years ago, a smaller glacier reoccupied the cwm, bulldozing rock debris in its path leaving the spectacular ridges or 'moraines' seen around the lake today.

Charles Robert Darwin was born on the 12th of February, 1809 at The Mount, a grand house in Shrewsbury where he grew up amongst wealth, comfort and country sports. He toyed with becoming a physician like his father, or a clergyman. But it was the natural world that fascinated the young Darwin, the colours and shapes of rocks and the variety of plants and insects he collected.

After losing interest in a medical course at Edinburgh, he studied theology at Cambridge, graduating early in 1831. Restless throughout his university years to learn more about nature, he volunteered in August 1831 to assist Adam Sedgwick on a geological tour of North Wales.

Sedgwick was one of the most famous geologists of his day and Darwin, with time on his hands - and no need to work because he had private means - was more than eager to learn. "I am now mad about geology", he wrote at the time in one of his many notebooks.

Sedgwick was looking for evidence of older rocks underneath the limestone that crops out across several parts of North Wales. They visited the ruins of Castell Dinas Bran and the limestone cliffs of Mynydd Eglwyseg near Llangollen; the Vale of Clwyd; and St Asaph where in the nearby Cefn Caves they found a fossilized rhinoceros tooth.

From there they travelled by horse-drawn gig to Conwy and the west side of the Conwy valley where they examined igneous rocks. After a visit to the quarries at Bethesda to see slate, they travelled on to Anglesey.

Returning to Bangor several days later, Darwin visited the impressive giant bowl-shape of Cwm Idwal while Sedgwick went elsewhere. Still on a huge learning curve, it's rather reassuring for today's young students to know that the evolution pioneer didn't recognise any of the glacier-carved features which he did eleven years later on a return visit. And he mis-identified several rock types too!

"His trip with Sedgwick scarcely advanced geology but it was vital for developing his craft", comments Rev. Michael Roberts, Vicar of Cockerham in Lancashire, a geologist and an expert on Darwin. "Sedgwick introduced him to careful note-taking in Wales and he learnt the basics of geology. It would be hard to devise a better three week trip for any trainee geologist. It was his apprenticeship".

"This field experience in North Wales helped him understand how volcanic islands like the Cape Verde Islands off West Africa were formed when he went on his five year voyage on HMS Beagle later in 1831. He'd seen volcanic rocks with Sedgwick. And he correctly identified St Paul's Rocks out in the mid Atlantic Ocean as serpentine, which he had seen on Anglesey", adds Roberts.

Darwin's learning worked the other way round too. He saw huge active glaciers carving rock at Tierra del Fuego at the southern tip of South America. Combined with then controversial theories about glaciation he had heard expounded by other geologists before he left on his momentous voyage, he returned to Cwm Idwal in 1842.

Commenting on his previous visit, Darwin, unassuming as always, wrote:

"Neither of us saw a trace of the wonderful glacial phenomena all around us; we did not notice the plainly scored rocks, the perched boulders and the moraines. Yet these phenomena are so conspicuous that a house burnt down by fire did not tell its story more plainly than did this valley".

Charles Darwin was a kind, pleasant man, unassuming and modest, characteristics ill-suited to the hornet's nest of argument with the establishment of his day, on publication of 'On the Origin of Species' in 1859 and 'The Descent of Man' in 1871. But he stuck with his theories which are widely accepted today.

Sandra Herbert, Professor of History at The University of Maryland, argues in her highly acclaimed book, 'Charles Darwin, Geologist' (Cornell university Press, 2005), that Darwin's developing ideas about geology were the crucial driving force for his insights into the evolution of species for which he is famed. And it was those formative field trips across North Wales where he learnt so much of his geology that make him our very own rock star.

Embargo: 11 February 2009

Dr Malcolm Smith is a freelance writer on wildlife, environment and travel. Until 2004, he was Chief Scientist and Deputy Chief Executive at the Countryside Council for Wales

The European Accredited Geological Study Programmes Project (EURO-AGES)

by EurGeol. Dr Isabel Fernandez Fuentes[1] and Adela Aparicio[2]

The project aims at developing Europe-wide applicable quality standards and criteria for the assessment of higher education programmes in geology in the context of the Bologna Process. In the next two years, framework standards will be developed and tested for their validity and applicability through discussion with stakeholders and related networks. The project aims at reaching the largest possible consensus among the relevant stakeholders. It aims to; support improvement of the quality of higher education in geology; facilitate mutual recognition by programme validation and certification; facilitate recognition of accredited degrees in geology higher education in accordance with EU directives and other agreements; support academic as well as professional mobility of geology graduates and establish a relationship with the qualification profile required by the EurGeol. title.

Dans le cadre du processus de Bologne, le projet vise à élaborer des standards et des critères de qualité applicables au niveau européen pour l'évaluation des programmes de l'enseignement universitaire en géologie. Dans les deux prochaines années, la validité et l'applicabilité des normes-cadres seront développées et testées par un débat entre toutes les personnes concernées et les réseaux professionnels. Le projet vise à atteindre le consensus le plus large possible parmi les personnes concernées. Il vise à soutenir l'amélioration de la qualité de l'enseignement supérieur dans le domaine des sciences de la Terre; faciliter la reconnaissance mutuelle par la validation et la certification des programmes; faciliter la reconnaissance des diplômes délivrés dans l'Enseignement supérieur en géologie, conformément aux directives de l'UE et à d'autres accords associés; favoriser la mobilité des géologues diplômés, que ce soit dans le secteur académique ou professionnel, et établir une connexion avec le profil de qualification requis pour l'obtention du titre de Géologue Européen, EurGeol.

En el contexto del proceso de Bolonia, el proyecto trata de desarrollar en toda Europa normas de calidad y criterios para la evaluación de los programas de educación superior de geología. Durante los próximos dos años, la validez y aplicación de las normas-marco serán desarrolladas y probadas a través de la discusión con las partes interesadas y las redes implicadas. El proyecto desea llegar al mayor consenso posible entre las personal ¿?? interesadas. Los objetivos del proyecto son apoyar la mejora de la calidad de la educación superior en la geología, facilitar el reconocimiento mutuo por el programa de validación y certificación, facilitar el reconocimiento de los títulos acreditados en geología de educación superior de acuerdo con las directivas de la UE y otros acuerdos, apoyo académico, así como la movilidad profesional de los graduados en geología, y establecer la relación existente con el nivel de cualificación requerido para obtener el título de Geólogo Europeo, Eur-Geol.

EURO-AGES is an EU-funded project. The EFG, in collaboration with ASIIN Consult (accreditation agency specialized in accrediting degree programmes in the fields of engineering, informatics/computer science, the natural sciences and mathematics, Germany), ICOG (Official Spanish Association of Professional geologists), MFT (Hungarian Geological Society) and SN (Swedish Natural Scientists Association) has made a successful application to the European Commission, Lifelong Learning Programme (DG Education and Culture) for a grant to run a pilot project on European Qualifications Framework (EQF).

EQF is a common European reference framework which links countries' qualifications systems together, acting as a

[1] EFG Office Director
[2] EFG Office

translation device to make qualifications more readable. It has two principal aims: to promote citizens' mobility between countries and to facilitate their lifelong learning. The EQF was formally adopted by the European Council on 14 February 2008, following its adoption in October 2007 by the European Parliament (*http://ec.europa.eu/education/policies/educ/eqf/index_en.html*). Shifting the focus to learning outcomes:

- Supports a better match between the needs of the labour market (for knowledge, skills and competences) and education and training provisions
- Facilitates the validation of non-formal and informal learning
- Facilitates the transfer and use of qualifications across different countries and education and training systems.

The EQF foresees that Member States relate their national qualifications systems to the EQF by 2010 and that their qualifications contain a reference to the EQF by 2012.

A call for proposals for a pilot project on this topic was launched in May 2008, with an August deadline to present the project. EFG Office informed the EFG Council about this proposal at the Athens Council Meeting. Following this action EFG Office prepared a proposal for ther project in collaboration with ASIIN Consult.

One of the EFG objectives with the project is to promote best practice standards and mobility by the award of the professional title of European Geologist (EurGeol.) to geologists who have reached a high level of training and experience.

The EFG Office invited EFG Bologna Working Group members to participate as partners on this project. We received a letter of interest from: ICOG, Spain; MFT, Hungary and SN, Sweden. In August 2008, EFG, with its four partners presented EURO-AGES, which was accepted and which started in February 2009. The duration is two years.

EURO-AGES aims at developing a qualification framework for geology based on learning outcomes rather than input factors on the European level, thereby increasing transparency of Earth Sciences qualifications and ultimately facilitating academic and professional mobility across Europe while at the same time stimulating students and graduates in the field of geology as well as professional geologists to pursue Life Long Learning. The project will also allow a structured exchange of best practices, expertise and country characteristics of professional practices in geology in the different European countries. It will, moreover, provide important reference points for quality assurance and related recognition issues focused on learning outcomes as well as adding value to the implementation of the 2005 Directive on recognition of qualifications.

At the same time, this pan-European set of outcome descriptors for the EQF level 7 ("Bachelor/1st cycle"), and 8 ("Masters/2nd cycle") will serve as a reference framework for programme development by individual higher education institutions, for the establishment of national sectoral qualifications frameworks in geology and for the development of a sectoral qualification framework for geology encompassing all levels of the EQF. The persistent lack of comparable subject-specific tools for assessing and enhancing the quality of geology degree programmes on a national or transnational level in the past has proven to be a potential obstacle to the mobility of geologists and geology students and graduates.

In response to this need - and in line with previous efforts undertaken by EU-supported projects such as "EUR-ACE - Accreditation of European Engineering Programmes", "Eurobachelor and masters in Chemistry Education" and the "Euro-Informatics project" - we propose a joint project carried by and involving the major stakeholders in the field of higher education in geology in order to develop a Europe-wide applicable qualifications framework for geology degree programmes and procedural guidelines for the assessment of geology degree programmes.

The project will be developed in five stages:

Phase 1, survey of the already existing learning outcome descriptors in the First Cycle and Second Cycle Level and sectoral qualification frameworks for geology in Europe, followed by a publication of the Status Quo as a starting point for the discussion and further refinement in later stages of the project.

In Phase 2 this learning outcome will be mirrored by the experiences of the members in the 22 member organizations of the EFG, taking into account the feedback of the alumni and also the holders of the EurGeol. title. To put it differently: at this point the practitioners and the employment side come into play by giving their opinions and advice on the suitability of the existing systems and the viability of the learning outcomes in place. By the same token, the current exigencies and requirements for the EurGeol. register will be fed into the analysis.

Phase 3 will be a dissemination phase, in the course of which the members of the consortium will present and discuss these preliminary results with a wide array of stakeholders, such as the higher education community, the deans of geology as well as many member organizations of the project partners.

In Phase 4 there will be as a milestone an interim workshop by the project partners, in which all of this feedback will be assembled, discussed and evaluated. At the end of this process there will be a new set of refined learning outcomes, which will serve as the basis for future activities. In a number of trial accreditations these learning outcomes will also serve as points of reference for the evaluation and accreditation of geology modules and programmes.

In Phase 5 a set of recommendations will be elaborated with the following goals:

- As reference points for the conceptualization, development and improvement of Geology programmes in Europe (not in the sense of defining a precise curriculum, but by elaborating an agreed set of skills graduates need to be successful in the labour market)
- To define minimum standards in the discipline, against which geology programmes are evaluated/accredited in internal and external qualification procedures
- As a reference point for the EurGeol. register of the European Federation of Geologists.

Throughout the project there will continuous monitoring of the work and its results. An International Advisory Board will be established, which will regularly be invited to the meeting of the project board, and will also comment on the progress reports. The results of this project will not only be documented by an interim and a final report and the other aforementioned publications, but also by the establishment of a dedicated website where the progress of the project will be document for a wider European public.

Mineral resource and mineral reserve reporting

by EurGeol. John A Clifford[1]

The background to the current developments in the public reporting of mineral resources is described from the "nickel boom" in the 1960s to the present time, when over 90% of publicly quoted resource companies use the CRIRSCO family of codes. These codes have common definitions and principles. The relationship between the CRIRSCO family of codes and other systems, including the UNFC and the SEC Industry Guide 7, is also discussed. The role of the Competent Person in ensuring that proper standards of estimation and reporting are adhered to is stressed. However, the critical key to ensuring a properly regulated reporting climate requires the close co-operation of professional bodies and company regulators. The EFG, through its membership of PERC and CRIRSCO, is striving to make that a reality.

La base des développements actuels dans la diffusion publique des rapports concernant les ressources minérales est décrite dans cet article, depuis le boom du nickel des années 1960 jusqu'à aujourd'hui, lorsque plus de 90% des Compagnies minières cotées au marché utilisent le système de codes CRIRSCO. Ces codes présentent des définitions et principes communs. Les relations entre le système de codes CRIRSCO et d'autres systèmes, comprenant l'UNFC et le Guide 7 industriel SEC sont également étudiées. Une emphase est mise sur le rôle de la Personne Compétente en s'assurant que les règles de base en matière de ressources minérales, concernant l'évaluation et le rapport, sont appliquées correctement. Cependant, le paramètre critique pour garantir un climat de confiance dans une communication selon les règles requiert une étroite coopération entre les Corps professionnels et les organismes régulateurs. La FEG, en tant que Membre des Systèmes PERC et CRIRSCO se bat pour que ce climat de confiance soit une réalité.

Se describen los antecedentes del actual desarrollo en la información pública sobre reservas y recursos minerales desde el "boom del níquel" de los 60 a la actualidad, cuando más del 90% de las empresas mineras cotizadas utilizan la familia de códigos CRIRSCO. Estos códigos tienen principios y definiciones comunes. También se debate la relación entre la familia de códigos CRIRSCO y otros sistemas, incluido el UNFC y la Guía SEC nº 7 para la Industria. Se destaca el papel de la Persona Competente para asegurar que se siguen normas adecuadas en la estimación de reservas y recursos y en la divulgación de dicha información. Sin embargo, la clave fundamental para asegurar un clima adecuado para la emisión de informes de reservas y recursos mineros, está en una colaboración más cercana entre las organizaciones profesionales y los reguladores de las empresas. La FEG por medio de su pertenecía a PERC y a CRIRSCO, pretende hacer eso una realidad.

The nickel "boom and bust" in Western Australia in the late 1960s made millionaires of some, paupers of others, and caused the Australian mineral resource professionals to come together to draft a code for the reporting of mineral exploration results, mineral resources and mineral reserves. The result was the 1st (1989) Edition of the JORC Code (Joint Ore Reserve Committee, a committee established by the Australasian Institute of Mining and Metallurgy, the Australian Institute of Geoscientists and the Mining Council of Australia). Recognizing the benefits of having an agreed industry standard, the Australian Securities Exchange (ASX) almost immediately incorporated the Code into their regulations. Since then the JORC Committee and the ASX have worked closely together, with JORC updating the Code at regular intervals, the most recent in 2004, and the ASX issuing guidance notes and actively monitoring reports that are submitted.

Internationally, code developments were also in progress, particularly in the United Kingdom (1991) and United States (1992).

It quickly became apparent however that, due to increasing globalization of the resource industry, the codes needed to be based on common principles if companies were to report the same estimates in different

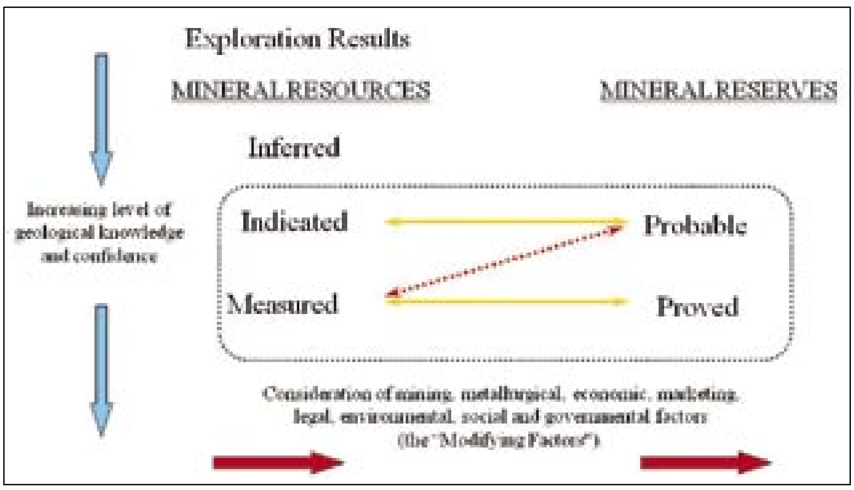

Figure 1. Relationship between mineral resources and mineral reserves

[1]PGeo, FIMMM, FAusIMM, CEng (UK). CRIRSCO board member

reporting jurisdictions.

The first step to achieving that objective was reached in Denver in 1997 when a resource classification system and common definitions were agreed by the principal mining professional institutions for the then dominant resource-producing and financing areas of the World – Australia, Canada, South Africa, United Kingdom and United States. Each has since published their own editions of a reporting code, modified to meet local practice and legal requirements, but operating to the common principles.

In order to further facilitate closer co-operation between the different jurisdictions, a loose committee was established with membership from each of the major national reporting organizations. This has since become more formalized as the Committee for Mineral Reserves International Reporting Standards (CRIRSCO; www.crirsco.com), under the umbrella of the International Council on Mining and Metals (ICMM; www.icmm.org), and has been expanded to include representatives from Chile and Ireland/Western Europe. Russia will have involvement in CRIRSCO from May 2009 when a Russian member of the European Federation of Geologists joins the Committee as a representative of the Pan-European Reserve Reporting Committee (PERC).

One of the principal tasks of CRIRSCO has been to draft a generic reporting template incorporating the common principles. This Template has been used in Peru (2006) and the Philippines (2007) to draft their reporting standards for their national stock exchanges.

The principles of the codes

All of the CRIRSCO Family of codes have the same resource classification system and use common principles.

The classification system recognizes, for reporting purposes, that there are three basic categories. These categories mirror the exploration process (Fig. 1).

They start with the reporting of mineral exploration results – these could be the outcome of geological, geochemical, geophysical, trenching or drilling programmes.

Once there is sufficient confidence to be able to assume continuity between the data points of the geology, and of the assay values, a mineral resource estimation can be completed.

Once a resource has been estimated, it is then assessed, not just on the basis of its economics, mining and metallurgical characteristics, but also taking social, environmental, legal, permitting and marketing issues into considerations. A positive result from that technical and economic analysis allows the publication of a mineral reserve estimate.

All of the codes require that the reports prepared to publicize the results must be written in a way that is clear and unambiguous, must include all the relevant information required for an investor to make an informed decision, must be impartial, and must be based on the work of a competent person.

CRIRSCO and other codes

There are other codes in common use in other parts of the World. In the USA, the Securities and Exchange Commission (SEC) requires companies to report in accordance with Industry Guide 7.

The UN Economic Commission for Europe (UN-ECE) also has a system, the Framework Classification (UNFC). This system is being implemented in a number of countries, but has not gained acceptance within either the resource or financial industry sectors.

A comparison between the CRIRSCO family of codes, Industry Guide 7 and the UNFC is shown in the Table below. This highlights the degree of convergence within the CRIRSCO family.

Russia and China both have well-established codes, which differ from CRIRSCO. They are unlikely to fundamentally change their systems, although China is currently

Criteria	Australasia	Canada	South Africa	UK/W Europe	Chile	Peru	USA – SME	USA - SEC	UNFC
Adoption of CRIRSCO-type standard	√	√	√	√	√	√	√	X	X
Reporting standard recognised by national regulator	√	√	√	√	√	√	X	√	X
Competent Person requirement	√	√	√	√	√	√	√	X	X
Reporting of Mineral Resources allowed	√	√	√	√	√	√	√	X*	√
Inferred Resources allowed in economic studies	√	X*	√	√	√	√	√	X	√
Level of study required for Mineral Reserves	1	2	1	2	2	1	1	3	3**
Commodity price process specified by regulator	X	X	X	X	X	X	X	√	X
ROPO-type reciprocal system	√	√	√	√	X	X	√	X	X

Notes: Level of study:		
	1	= appropriate assessments and studies as determined by Competent Person
	2	= pre-feasibility study - expected (UK/W Europe) or required (Canada, Chile)
	3	= feasibility study for new projects
	3**	= feasibility study for Proved Reserves, pre-feasibility study for Probable Reserves
ROPO		= Recognized Overseas Professional Organisation
X*		= Allowed in certain restricted circumstances

Table 1. Comparison of CRIRSCO Style Standards, Industry Guide 7 and UNFC. (From: Developments in International Mineral Resource and Reserve Reporting, Stephenson & Weatherstone, International Mine Management 2006 Conference, AusIMM 2006)

reviewing its reporting standard. However, the principles of mineral exploration and mining, and the nature of mineral deposits, are no different in Russia and China. Recognizing that fact, CRIRSCO has engaged with the relevant authorities in both countries to compare CRIRSCO to each. The objective is to identify the similarities and differences, so that each understands the other, without necessarily changing either.

The Competent Person

The assumption of competency is a fundamental underpinning of the reporting process, and is the primary responsibility of the Competent Person. A Competent Person is defined in all of the codes as a person holding an appropriate degree qualification, with at least five years experience in the activity or type of deposit being reported on, and to be a member of a recognized professional mining or geological institution that has both a code of ethics and disciplinary powers.

The Competent Person must sign the report, agree to its publication, and take responsibility for its contents. It is thus incumbent on the Competent Person to ensure that the results being reported are based on studies conducted to an acceptable standard and that all of the interpretation and assumptions can be defended. Failure to do this leaves the Competent Person open to civil liability and subject to discipline by the professional institution.

An international professional passport

It is recognized that we live in a global village with resource professionals operating internationally. It is unreasonable to expect that each Competent Person would hold multiple memberships to allow recognition in each securities exchange. Instead, the professional institutions sponsoring each of the CRIRSCO family of codes recognize each other's professional titles using the so-called ROPO system (Recognized Overseas Professional Organization). This professional passport, of which the European Geologist title is one, allows members to sign-off on reports submitted to all of the major international securities exchanges, providing they meet the specific requirements for relevant experience and expertise set out in the code.

Resource reporting codes and company financial reporting

The International Accountancy Standards Board (IASB) is currently drafting International Financial Reporting Standards (IFRS) for extractive activities.

The principal assets of companies in the extractive sector are their raw material resources. If resource companies' balance sheets are to be comparable globally then they must be based on a common system of resource estimation and reporting. If not, companies run the risk of having to prepare two reports - one for public reporting of resource and another for accounting purposes. This would be an obviously ludicrous situation.

To facilitate the needs of the IASB, CRIRSCO and the Society of Petroleum Engineers (SPE), who have developed the classification system in use in the hydrocarbon sector, and the UN-ECE jointly prepared a report for the IASB correlating the minerals and hydrocarbon resource classification systems. They correlate well at a high level. It now appears likely that the IASB will recommend adoption of the mapped CRIRSCO and SPE definitions in the IFRS.

The European code

In 1991, the then Institution of Mining and Metallurgy (IMM) issued a reporting code. This became the standard for the London stock exchanges.

That code was rewritten in 2001, adopting the CRIRSCO format and incorporating issues addressed in earlier editions of the Australian, Canadian, South African and the United States reporting codes. In addition to including these issues, greater emphasis was placed on the estimation and reporting of industrial minerals and aggregates, a very important industry in Europe, and incorporated a generic code of ethics. This new edition of the code was adopted by the IOM3, successor to the IMM, the European Federation of Geologists, the Geological Society of London, and the Institute of Geologists of Ireland, and became binding on their members.

Continued updating of the codes in Australia and South Africa meant that it was timely in 2006 to consider a European update. This work was undertaken by a joint committee of the four sponsoring organizations, expanded to include representatives from the financial resource community. Given its European-wide representation, this committee was named the Pan-European Reserve Reporting Committee or PERC for short. A further broadening of its European representation was recently gained when the Russian professional association joined the membership.

Following almost two years in the making, the up-dated code was launched in draft form in July 2008 and formally released in January 2009 (www.percreserves.com).

A common question is - why do we need another code? The simple answer is that it is not another code. As explained above, it is a member of a family of codes with common definitions and principles. However, each of these reflects the industry practices and legal reporting requirements for each of their regions.

The role of the stock exchange

A reporting code on its own has little value. To gain value, or teeth, it needs to be recognized and adopted by the stock exchange regulators.

This distinction is often not clearly understood. The JORC code is incorporated into the ASX regulations, and the SAMREC Code in South Africa by the JSE Limited in its regulations. In Canada, National Instrument 43-101, which regulates the public reporting by listed companies there, developed out of the BreX fraud. It incorporates the CIM Definitions, which are part of the CRIRSCO family.

In each of these jurisdictions, the regulators have established a monitoring mechanism to ensure that listed companies' public reports adhere to the code, and to the regulations.

This is the key to ensuring a properly regulated market. On the one hand, industry professionals drafting standards to the international norm, promulgating to the profession, and then adhering to them in their professional practice. On the other hand, stock exchange regulators working to ensure that the public reports published by their listed companies meet the minimum standards.

This requires a linkage between the professional bodies and the securities exchange regulators. Such a linkage between code developers and securities exchanges is well established in Australia, Canada and South Africa. They have learned the lesson the hard way.

In the UK and Europe, the links between code developers and security exchange regulators is much weaker. However, progress is being made. Given the central role that London plays in international mining finance - mining industry capitalization on the LSE represented 41% of the world total at the end of 2007 - it is essential that the linkage between code developers and stock securities exchange regulators be established as soon as possible.

Gold standards

by Sarah Day[1]

On March 19, 1997, a body was found in the Indonesian jungle. Investigators struggled to identify the remains, which were unrecognisable, but eventually used finger print s and molars to conclude that the body was that of Michael de Guzman, a Filipino geologist working for Bre-X, a Canadian mining company whose stock had soared in the preceding two years.

What followed was the unraveling of the largest mining scandal in history. Following the advice of geologist John Felderhof, Bre-X's founder David Walsh had bought land in the middle of the jungle in Borneo, which his project manager Michael de Guzman estimated was sitting on around 2 million ounces of gold. The find came shortly after more than a dozen mining companies had dismissed the property as worthless. Estimates rose and rose, until in 1997 the figure was 70 million ounces, with Bre-X's stock price rising to $280 per share.

Following the discovery of de Guzman, who had apparently jumped from a helicopter on his way to a meeting with US officials who had doubts about the site, the fraud was rapidly exposed. Freeport-McMoRan, the company he had been on his way to meet, had conducted their own core samples which showed 'insignificant amounts of gold'. An independent analysis showed that Bre-X's samples had been salted with gold dust, tests from one hole demonstrating that the gold had been shaved from jewellery.

The fall-out from the scam was colossal. The effects are still being felt on the Canadian stock exchange, and doubtlessly by many individual investors as well. Aside from the ramifications for the business world, the mine's 400 workers were primarily recruited from the native Dayak people. Bre-X took over a village of around 2,000 inhabitants during operations, providing electricity, new homes, kindergartens, sewing classes for local women, and even engineering scholarships. No doubt they believed they were participating in a historical undertaking. Today the area has been abandoned by investors. Buildings and clearings have been rapidly reclaimed by the jungle. Isolated from the complexities of stock markets and business deals, some locals are at a loss as to why the fraud was perpetrated. Others continue to ceaselessly search for gold, hoping one day to tempt the wealthy westerners back again.

[1]Earth Science Communicator, Geological Society

Frauds on the scale of Bre-X are rare, but what happened in Borneo highlights how far things can be carried if the proper regulations are not put in place. Regulations for the reporting of exploration results, mineral resources and mineral reserves have become vital to the mining industry. They are necessary, not just for ensuring accurate reporting of what resources actually exist in the ground, but also for demonstrating that a site represents a viable extraction business opportunity. Before permits, licensing and supporting information about the extraction procedure and its impacts have been obtained, levels of confidence in a site cannot be considered high, and the minerals are referred to as resources, rather than reserves.

Codes for resources reporting set out a series of questions which need to be asked about a site, in order to satisfy one single overriding question: 'Would you invest your money in this mineral operation?' There is a huge array of such codes, published by various professional bodies in order to meet the requirements of the appropriate Stock Exchanges. In Australia, the JORC code presides, whilst CIM and the 43-101 rules meet the needs of the Toronto Stock Exchange, and so on. In Europe, a code was drawn up in 1991 by the Institute of Mining and Metallurgy Reserve Committee (IMM). When, IMM was replaced by the Pan-European Reserves and Resources Reporting Committee (PERC) in 2006, PERC took over responsibility for updating and managing the code. In June 2008, the PERC code was launched, setting out the minimum standards, recommendations and guidelines for the public reporting of exploration results, mineral resources and mineral reserves in the UK, Ireland and Europe.

The PERC code sets regulations for the reporting, not just of gold resources, but of all mineral reserves and resources. Among its many regulations, the code states that when reporting exploration results, all

The author

analytical results, along with their sample sizes or intervals, must be reported in full. Reporting of selected information, such as isolated drill holes, is not acceptable. Specific knowledge relating to the mineral in question is also required. Those who can be designated 'competent persons' for the estimation of mineral reserves for alluvial gold deposits, for example, are required to have considerable experience in the evaluation and economic extraction of this type of mineral. Because of the particular characteristics of gold deposits, a more general mining experience is not considered to be sufficient. The code also recommends the independent testing of laboratory results, and the use of scientifically valid, tested and approved methods for such tests.

As for the Bre-X scandal, the mystery continues. The Royal Canadian Mounted Police ended their investigation in 1999 without laying criminal charges against anyone. Geologist John Felderhof, who first advised Walsh to buy the land in Borneo, was charged with insider trading in 1999, but was found not guilty in 2007, after a six year long trial. The fate Michael de Guzman is no more certain. His second wife claims to have received money from him since his disappearance, and the doctor who first performed the autopsy on the remains now admits he was far from sure about their identification. Could he still be alive somewhere, living off his Bre-X fortune? Or did he really jump from a helicopter to escape the consequences of a massive fraud? Whilst resources reporting codes like the PERC code cannot render a fraud impossible, it does become much more difficult to perpetuate, making them a vital tool in preventing such large scale deception happening in the future.

Submission of articles to European Geologist Magazine

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

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European Federation of Geologists (EFG)

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

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

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

Objectives

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

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