

# European Geologist

Journal of the European Federation of Geologists



## MIN WIN-WIN - Minerals Reporting Standards





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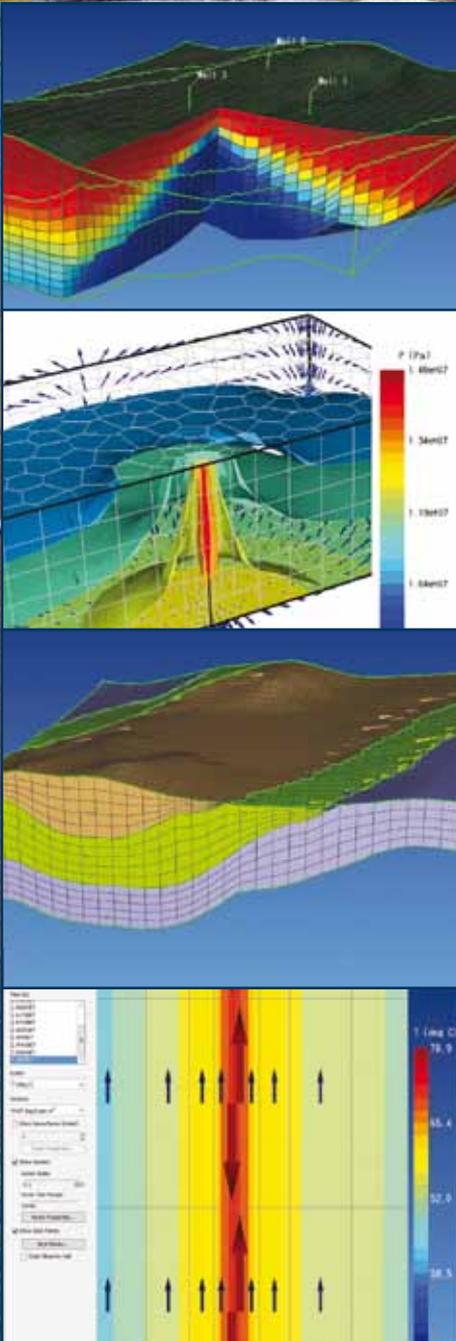
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# Foreword

*EurGeol. Vítor Correia, EFG President*

After the last edition dedicated to Geoarchaeology, we are back to Minerals, the theme of the two previous *European Geologist* numbers. This is not because of a biased view, ignoring the many other relevant (better to say critical) contributions geology and geoscientists bring to our daily life, with water and energy supply at the top. It's merely because of timing: last November EFG and PERC, with the support of the organisations listed below, organised a conference in Brussels about Mineral Reporting Standards. This number of *European Geologist* is a special issue on the MIN WIN-WIN conference, and it aims to disseminate the brilliant presentations made, carving in black and white the insights provided by the speakers to an interested audience.



The MIN WIN-WIN Conference brought together speakers coming from the European Parliament, the European Commission, governmental bodies, mining companies, Industry associations, the World Bank, consultants, investors and NGOs. The presentations delivered highlighted the fact that quality statistics and minerals reporting across the commodity life cycle (from discovery to end-of-life recycling) are paramount to policy makers wishing to promote inclusive and sustainable growth. It was also agreed that open dialogue between the major stakeholders in finance, regulatory and industry sectors is essential. And that dialogue can only be successful if all participants understand and agree the common principles; herein lie the contribution of skilled geoscientists and the importance of minerals reporting standards.

The contribution made by professional titles was also recognised, ensuring title holders are skilled and competent to deliver high quality services within the practice of geology, framed by a Code of Ethics and a commitment towards continuing professional development; the first article of this issue stresses EFG's commitment to expanding the network of EurGeol title holders, not only among geoscientists working in the minerals sector and in mining companies, but also among those who work within governmental and research organisations. Naturally, we look forward to welcoming new members to the EurGeol family.

To close, I would like to stress a fact echoed in many presentations delivered: the mining industry is under pressure (not only in Europe), pushed by an enlarged group of stakeholders. We can look at this "request for a social license" as a threat or as an opportunity. I prefer the last option, and I do trust this pressure will help reshape the approach of the mining industry to society and the creation of shared value for all.



P.S. The success of the MIN WIN-WIN conference was due to our colleagues from PERC (and especially Ruth Allington and Steve Henley), to the speakers (some of whom travelled half the globe), to the sponsors and supporting organisations (all listed on page 7) and, above all, to the public who attended. To all of them my renewed thanks.

P.P.S. EGJ has changed its name. Did you notice? The choice of the word *Journal* is intended to emphasise the increasing scientific quality of the articles published. We are indebted to the Editorial Board for this accomplishment.

For complementary information, all presentations given at the conference "MIN WIN-WIN Establishing Europe-wide minerals reporting standards - The key to reducing risk and increasing opportunity" may be downloaded at <http://eurogeologists.eu/min-win-win-conference/>.

## PROGRAMME MIN WIN-WIN Conference

**20 November 2014**

<b>Opening session</b>	
13:30	<b>Welcome address</b>
<b>1. Introduction to the RMI and progress so far</b>	
	<b>Chairperson:</b> <i>Vitor Correia</i> , EFG President
14:00	<b>Keynote speaker:</b> <i>Reinhard Bütikofer</i> , MEP, European Parliament
14:30	<b>Keynote speaker:</b> <i>Carlo Pettinelli</i> , Director Resources Based, Manufacturing and Consumer Goods Industries, DG Enterprise and Industry, European Commission
15:00	<b>RMI Implementation</b> <i>Slavko Solar</i> , Unit F.3, Raw Materials, Metals, Minerals and Forest-based industries, DG Enterprise and Industry, European Commission
15:20	<b>Q &amp; A Session and Discussion</b>
<b>2. Minerals supply chains and variability of information sources, public data and reporting requirements across the EU</b>	
	<b>Chairperson:</b> <i>Nicholas Arndt</i> , Coordinator outreach activities, European Geosciences Union
16:00	<b>Keynote speaker:</b> <i>Francisco Igualada</i> , World Bank, Sustainable Energy Department, Oil, Gas and Mining
16:30	<b>European Reporting of Mineral Assets - Experiences of a global diversified industrial minerals company</b> <i>Owen Herod</i> , Imerys
16:50	<b>Reporting Industrial Minerals from value impact for a mineral company, to value impact for Europe</b> <i>Pim Demecheleer</i> , Geology Director, Sibelco Europe
17:10	<b>Resources and Life Cycle Assessment</b> <i>Johannes Drielsma</i> , Euromines
17:30	<b>Q &amp; A Session and Discussion</b>

**21 November 2014**

<b>3. National economic policies, governance structures and the EU minerals knowledge database</b>	
	<b>Chairperson:</b> <i>Michelle Wyart</i> , IMA Secretary General
9:00	<b>Keynote speaker:</b> <i>Manuel Regueiro</i> , EuroGeoSurveys
9:30	<b>Implications of the ERA-MIN Roadmap on primary and secondary raw materials knowledge base</b> <i>Tamas Hámor</i> , Hungarian Office for Mining and Geology
9:50	<b>Minventory project</b> <i>Paul Lusty</i> , BGS
10:10	<b>Policy and regulation of Ireland's exploration and mining sector</b> <i>Eibhlin Doyle</i> , Department of Communications, Energy and Natural Resources

10:30	<b>Q &amp; A Session and Discussion</b>
<b>4. Stock exchanges, commodity markets, and financial systems, and their need for reliable and consistent minerals data</b>	
	<b>Chairperson:</b> <i>Paul Lusty</i> , BGS
11:30	<b>Is reliable and consistent data the holy grail and will investors thank you for it</b> <b>Keynote speaker:</b> <i>Michael Lynch-Bell</i> , Chair at Kazakhmys plc
12:00	<b>Explorers, Investors and Regulators – An Uneasy Threesome</b> <i>John Clifford</i> , Exploration Manager – Europe and Central Asia for Antofagasta Minerals
12:20	<b>Public Reporting at Rio Tinto, the benefits of aligned international resource reporting codes</b> <i>Adam Duffin</i> , Chief Geoscientist, Rio Tinto
12:40	<b>Reporting Dimension Stones</b> <i>Marco Cosi</i> , Alpiconsult Stones Consulting
<b>5. The PERC reporting standard, CRIRSCO, and the UNFC classification</b>	
	<b>Chairperson:</b> <i>Slavko Solar</i> , DG Enterprise and Industry, European Commission
14:00	<b>Improving fossil energy and minerals management by integrating the CRIRSCO template classifications and the UN Framework Classification for Fossil Energy and Mineral Reserves and Resources.</b> <b>Keynote speaker:</b> <i>Sigurd Heiberg</i> , Petronavitas a.s
14:30	<b>PERC - the CRIRSCO-aligned minerals reporting standard designed for use in Europe</b> <i>Eddie Bailey</i> , PERC Chairman
14:50	<b>Reporting standards, codes, systems, and classifications: conversion, bridging, and mapping</b> <i>Stephen Henley</i> , Resources Computing International Ltd, PERC past President
<b>6. «Best Practice», ethics and the role of skilled geoscientists</b>	
	<b>Chairperson:</b> <i>Stephen Henley</i> , Resources Computing International Ltd, PERC past President
15:30	<b>Keynote speaker:</b> <i>Ruth Allington</i> , GWP Consultants LLP, EFG Past President, IUGS – TG Chair
16:00	<b>EurGeol as competent person</b> <i>Isabel Fernández</i> , EFG Executive Director
16:20	<b>Discussion Panel with keynote speakers</b> Chaired by <i>Deborah McCombe</i> , President and CEO, Principal Geologist Roscoe Postle Associates Inc., and past Chair of CRIRSCO
17:00	<b>Conclusions</b> <i>Deborah McCombe</i>



## PRESS RELEASE MIN WIN-WIN CONFERENCE

The European Federation of Geologists (EFG) and the Pan-European Reserves & Resources Reporting Committee (PERC) were glad to co-organise the international conference “MIN WIN-WIN: Establishing Europe-wide minerals reporting standards – the key to reducing risk and increasing opportunity” from 20 to 21 November 2014 in Brussels. This two-day event was held at the Royal Belgian Institute of Natural Sciences, a privileged venue located in immediate proximity of the European Parliament, and was supported by a broad range of organisations active in the field of minerals and mining.

The continuing rise in global population and living standards, as well as technological innovation, is leading to increasing requirements for a broader range of metals, minerals and other raw materials. EU manufacturing and improved positioning of EU enterprises in the global value chain is currently dependent, to great extent, on imports of mineral raw materials from outside Europe. This dependency is associated with the contraction of primary mining activity in the EU over several decades, driven by lower production costs outside the EU and pressures to protect the natural environment within the EU. Increasingly, EU supply chains for raw materials are adversely affected by growing demand pressure from emerging economies and by an increasing number of restrictive national policy measures that impact the normal operation of supply chains. This dependence on supplies that are largely beyond EU control threatens the security of raw materials supply, but also highlights opportunities for expanding primary extraction and recycling within the EU, in line with sustainable development objectives. In this context, the European Commission launched the European Raw Materials Initiative (RMI) in 2008 in order to stabilize long-term commodity prices by removing market distortions, to provide alternative approaches to meet demand, and to support the transition to a low carbon and resource-efficient economy.

In this context, the conference’s main aim was to promote the adoption of a common reporting standard in the EU to be used both by the industry and by governments and European Community entities. Such an approach is intended to contribute to the convergence of terminology and the comparability/compatibility of data, thus facilitating the creation of a solid European Knowledge Database on mineral resources and to the successful delivery of the Raw Materials Initiative.

Providing the audience with a unique opportunity to learn about and discuss concrete steps regarding mineral reporting in a cross-disciplinary environment, the conference was attended by more than 100 participants including EU policy makers, national government officials, academics, minerals company executives, consultants, finance and industry experts. The organisers were particularly pleased with the presence of several keynote speakers from the European Institutions, the World Bank and leading geosciences organisations.



During the first session that familiarised the audience with the framework of current EU policy on Raw Materials, Reinhard Bütikofer, Member of the European Parliament and representative of the German Green party (die Grünen) underlined the crucial necessity for Europe to develop a common Raw Materials Policy, required, as he explained, by a decisive shift that has taken place over the past years in the balance of global economic power linked with the emergence of several new players such as China, Brazil and India. In the context of recent changes in global consumption and life style patterns that are reflected in intensification of international competition, a reliable supply of raw materials is becoming critical for Europe. Mr. Bütikofer therefore called upon the strengthening of cooperation at European level in the field of trade, domestic mining and technology efficiency; the innovation sector being particularly significant for the success of this approach. Bütikofer furthermore emphasized that Europe must be more ambitious in this field and that the input of geoscientists towards the European Parliament is most welcome in this matter.

In the second session that presented different information sources used for reporting across the EU, major industry representatives highlighted the importance of making quality data available for reporting purposes and clarified why the PERC standard - as the European member of the CRIRSCO reporting standards family - is so useful for the development of a common language for reporting in Europe.

On Friday morning the third session, dedicated to Dan Germiquet, former senior geologist of IMERYS and major representative of PERC deceased in 2013 in the Paris train crash, emphasized the existing discrepancies between national economic policies and governance structures in Europe and the opportunities offered by a common EU minerals knowledge database.



The main conclusions that can be drawn from the following sessions were summarised by Deborah McCombe during a panel discussion at the end of day two. Deborah McCombe, President, CEO and principal geologist at Roscoe Postle Associates Inc., and past Chair of CRIRSCO, highlighted in her concluding words the decisive role played by professional geoscientists. The main function of geoscientists as Competent Persons - with the relevant experience to give accurate estimates of resources and reserves, and the authority to approve market-sensitive reports - is thus to be useful, not only to investors and regulators, but principally to society. McCombe also stressed the need to avoid a language of conflict in discussions with regulators and investors, and to improve communication in general, and she emphasised that listening to the concerns of other interested parties is key to this role. She furthermore underlined the importance of disciplinary procedures: disqualifying or sanctioning any professionals who fail to meet the high standards required. She described the Canadian system in which the development of peer review processes within the geoscientists' community allowed improvement in the quality of reporting.



The organisers and keynote speakers concurred that the broad recognition of the European PERC standard that is based on the international template provided by CRIRSCO, together with the improvement of communication between investors, regulators and industry, and the systematic involvement of Competent Persons for reporting, are crucial for winning the confidence of public institutions and society. Only a pan-European approach fully compatible with the international reporting template (CRIRSCO) and the United Nations Classification Framework (UNFC) may help European states in facing the challenges arising from globalisation and increasing raw materials scarcity. In this context, the European Federation of Geologists can play a major role by providing accreditation for qualified persons within its 24 member states.

**About EFG:** The European Federation of Geologists is a non-governmental organisation that was established in 1981 and includes today 24 national association members. EFG is a professional organisation whose main aims are to contribute to a safer and more sustainable use of the natural environment, to protect and inform the public and to promote a more responsible exploitation of natural resources. EFG's members are National Associations whose principal objectives are based in similar aims. The guidelines to achieve these aims are the promotion of excellence in the application of geology and the creation of public awareness of the importance of geoscience for the society.

[www.eurogeologists.eu](http://www.eurogeologists.eu)

**About PERC:** PERC is the organisation responsible for setting standards for public reporting of exploration results, mineral resources, and mineral reserves by companies listed on markets in Europe. It is a member of CRIRSCO, the Committee For Mineral Reserves International Reporting Standards, and the PERC Reporting Standard is fully aligned with the CRIRSCO Reporting Template.

[www.PERCstandard.eu](http://www.PERCstandard.eu)

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**Supporting organisations:** Committee for Mineral Reserves International Reporting Standards (CRIRSCO), Euromines, Geological Survey of Belgium – Royal Belgian Institute of Natural Sciences, Geological Society of London (GSL), Institute of Geologists of Ireland (IGI), Industrial Minerals Association (IMA), Institute of Materials, Minerals and Mining (IOM3), International Union of Geological Sciences (IUGS) Task Group on Global Geoscience Professionalism and United Nations Economic Commission for Europe (UNECE).

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# EurGeol as competent person

Isabel Manuela Fernández Fuentes\*

In an increasingly global world, we need instruments which recognise competent professionals and guarantee high-quality work. In the 1980s, the European Federation of Geologists (EFG) set up a system for mutual recognition of professional geologists throughout Europe.

Transnational cooperation and coordination of knowledge and intelligence of geological resources is crucial to address the major challenges facing Europe today. This includes Europe's need for reliable and clean energy, the need to mitigate the effects of climate change, the need to guarantee EU citizens a sufficient supply of food and water in a healthy, clean and safe living environment, and the need for a reliable supply of raw materials, whether land-won or from the ocean basins.

The mentioned challenges are all related to, or framed by, geosciences. Geological expertise is needed to promote economic competitiveness, to assess sustainability issues and to ensure proper resource governance. Geological knowledge also helps to ensure more enlightened public participation in decision making and better informed political decisions. Geoscientists have an important role in answering all the described challenges. Much of today's geological practice affects the health, safety and welfare of the public, the environment, and the economy and feasibility of engineered works.

This article presents the criteria established by EFG to guarantee common standards of quality, which provide industry in Europe and beyond with excellent geologists holding the title of European Geologists (EurGeol).

The need to ensure mutual recognition of qualifications across European countries has encouraged the European Commission to launch legislation in this area since the 1990s. EFG has tried to respond to these legal criteria, even though its objective is not exclusively to recognise the qualification. The objective of EFG is to recognise professionals, which implies additional

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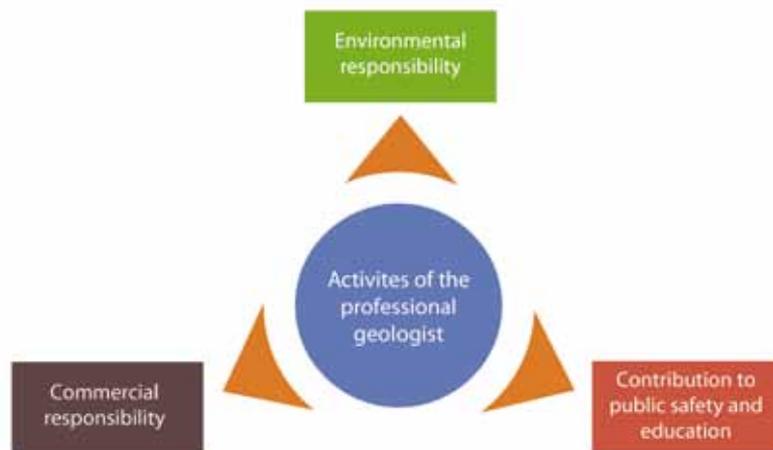


Figure 1: EFG's vision of professional geologist activities.

requirements beyond the qualification, as demonstrated in this article.

Due to the high level of mobility in our profession, it is indispensable to also ensure the professional recognition of geologists outside Europe. This article presents the advances in the recognition of the EurGeol title outside Europe, and the efforts made by EFG to achieve recognition of the geology profession at a global level.

## 1. Why a EurGeol Title

The European Federation of Geologists (EFG) is a not-for-profit organisation whose purpose is to represent the professions of geology in Europe, especially to the European Union (EU) and its various bodies.

In line with the overall European policy for a sustainable economy based on environment, economy and society, the vision of EFG on the activities of the professional geologist should take in consideration environmental responsibility, commercial responsibility and contribution to public safety and education (Figure 1).

Based on this concept, EFG has a mission to contribute to the protection of the environment, public safety, responsible exploitation of natural resources and effective prediction, prevention and mitigation of natural hazards. This is achieved by promoting excellence in the application of geoscience, by supporting research and

teaching that underpins it, and also by creating public awareness of the importance of geoscience to society.

With this aim, at the end of the 1980s EFG adopted a system of multilateral recognition between affiliated geological associations. Candidates who meet the requirements are awarded the professional title of European Geologist (EurGeol). The European Geologist title is a professional title which recognises the ability to deliver a high quality of services within the practice of geology.

Professional titles have become important in demonstrating the suitability of a professional to provide geological services. The professional title provides a quality mark to demonstrate to clients, regulators and the general public that the individual is competent to provide geological advice, and allows employers to offer competitive commercial services. To adapt to the current and future challenges within the geopolitical framework of the European Union, it is necessary that geologists achieve, and can demonstrate, a high degree of professional experience to be able to respond to the demands of society in practicing their profession.

## 2. How we can achieve the maximum quality standards

The European Geologist (EurGeol) title is awarded by the European Federation of

Geologists (EFG). The Federation represents the geological profession across Europe and has members from the professional associations of 22 of the EU member countries.

Applicants for registration must be recommended by their National Association and accepted by EFG before they are awarded the EurGeol title. The process of vetting applications for the title is carried out for the Federation by its Licensed Bodies. Today EFG has five National Licensed Bodies and fourteen National Vetting Committees coordinated by the International License Body. Recommendations for election from the Licensed Bodies are passed to the EFG Council for ratification. A register of title holders is maintained on the EFG web site.

**EFG National Licensed Bodies:**

Ireland: IGI; Italy: CNG; Spain: ICOG; Switzerland: CHGEOL; United Kingdom: GSL

**EFG National Vetting Committees:**

Belgium/Luxembourg: UBLG; the Czech Republic: CALG; Finland: YKL; France: GSF; Germany: BDG; Hungary: MFT; the Netherlands: KNGMG; Poland: PAMAV; Portugal: APG; Russia: NAEN; Serbia: SGS; Slovenia: SGS; Sweden: NA; Ukraine: UAG.

Today there are nearly 1,300 individual EurGeol title holders in Europe. *Figure 2* shows the evolution in the number of EurGeols approved since the creation of this professional title:

The title held by a professional geologist, EurGeol, means that the holder has

achieved suitable academic training and a level of professional experience, skill and competence to perform tasks within their professional practice. It also means that the geologist undertakes continuing education and training, demonstrating a personal commitment to stay up to date and informed within the sphere of their professional work. The European Geologists are bound by a strict code of professional conduct.

A professional geologist who is a member of a National Association member of EFG with not less than eight years of training and experience may apply to a Licensed Body (LB) to be validated as a European Geologist, in accordance with criteria and procedures established by Regulation E. The European Geologist title is built of four pillars:

**Academic qualifications:**

An applicant for the title of European Geologist must have followed and satisfactorily completed an educational programme at university level in geology or a related subject and have been awarded a degree or equivalent qualification. The period of the educational programme shall normally be for a minimum of four years. The education level required is according to Level 7 of the European Qualifications Framework (EQF) or the second cycle for the Framework for Qualifications of the European Higher Education Area (see <https://ec.europa.eu/ploteus/content/descriptors-page>).

The EQF system is defined by a set of descriptors indicating the learning outcomes relevant to qualifications at that

level in any system of qualifications. For Level 7 this means:

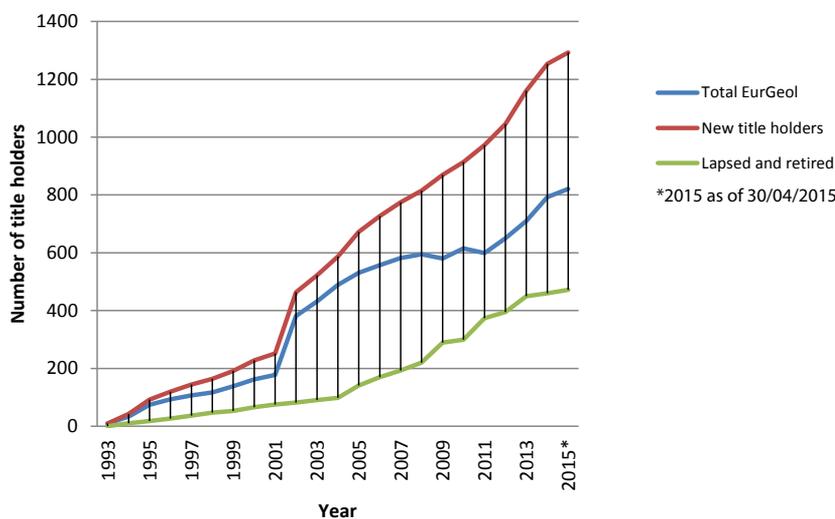
- highly specialised knowledge, some of which is at the forefront of knowledge in a field of work or study, as the basis for original thinking and/or research. Critical awareness of knowledge issues in a field and at the interface between different fields;
- specialised problem-solving skills required in research and/or innovation in order to develop new knowledge and procedures and to integrate knowledge from different fields;
- and competences to manage and transform work or study contexts that are complex, unpredictable and require new strategic approaches; take responsibility for contributing to professional knowledge and practice and/or for reviewing the strategic performance of teams.

**Professional Experience:**

Applicants for the title of European Geologist must demonstrate their professional experience through the application form, supporting documentation, a professional practice report and a professional interview. Applicant must demonstrate that they have obtained sufficient knowledge and experience, over a combined minimum total of eight years, to be able to work independently and to be capable of supervising others. An applicant who is only able to undertake routine activities or who requires extensive supervision would not meet the requirements for award of the title of European Geologist.

**Code of Ethics:**

All European Geologists are required to abide by the Code of Ethics established by the European Federation of Geologists. Any individual European Geologist who provides advice to others, whether to clients and employers in a professional capacity, through membership of committees or to the general public directly or via the media is required, under the Code of Ethics, to restrict such advice to their own areas of expertise. An explicit commitment to abide by a code of ethics/conduct is made by those who obtain professional qualifications, having been judged by their peers to have reached the necessary standards of scientific/technical competence, to demonstrate commitment to continuing professional development (the reflective practitioner)



Source: EFG Office. Data provided through national association reports.

Figure 2: EurGeol title holders 1994-2015.

and to understand their limitations and the principles of professionalism. In case of allegations made against a European Geologist for breach of the Code of Ethics, a complaint shall be submitted to the Secretary General who will collaborate with the Registration Authority to establish an Investigation Panel in order to evaluate the complaint.

**Continuing Professional Development (CPD):**

CPD is the systematic maintenance, improvement and broadening of knowledge and skills and the development of personal qualities necessary for the execution of professional and technical duties throughout a practitioner’s working life. CPD aims to keep professionals up to date in their existing areas of expertise. CPD addresses the pace of technological change in the geosciences, as well as the danger of skills obsolescence and over-specialisation. To keep up to date the European Geologists are required to present annual CPD records.

In the process of vetting applications the EurGeol applicant needs to demonstrate:

- ability to understand the complexities of geology and of geological processes in space and time in relation to their speciality;
- ability to use geoscience information to generate predictive models;
- ability to communicate clearly, both verbally and in writing;
- understanding of the meaning and needs of professionalism;
- awareness of Health and Safety and other statutory obligations applicable to their area of work;
- knowledge and understanding of the Code of Ethics;
- appreciation of the role of Continuing Professional Development after validation.

Figure 3 illustrates the standards of the EurGeol title based on the four pillars mentioned above, also taking into account accumulated knowledge and professional skills.

With the aim to improve the services offered to EurGeols, in 2013 the EFG created an electronic tool. The mobility of European Geologists is encouraged through the EurGeol web tool. This is an electronic service for European Geologists. It allows companies



of European Geologists is encouraged through the EurGeol web tool. This is an electronic service for European Geologists. It allows companies

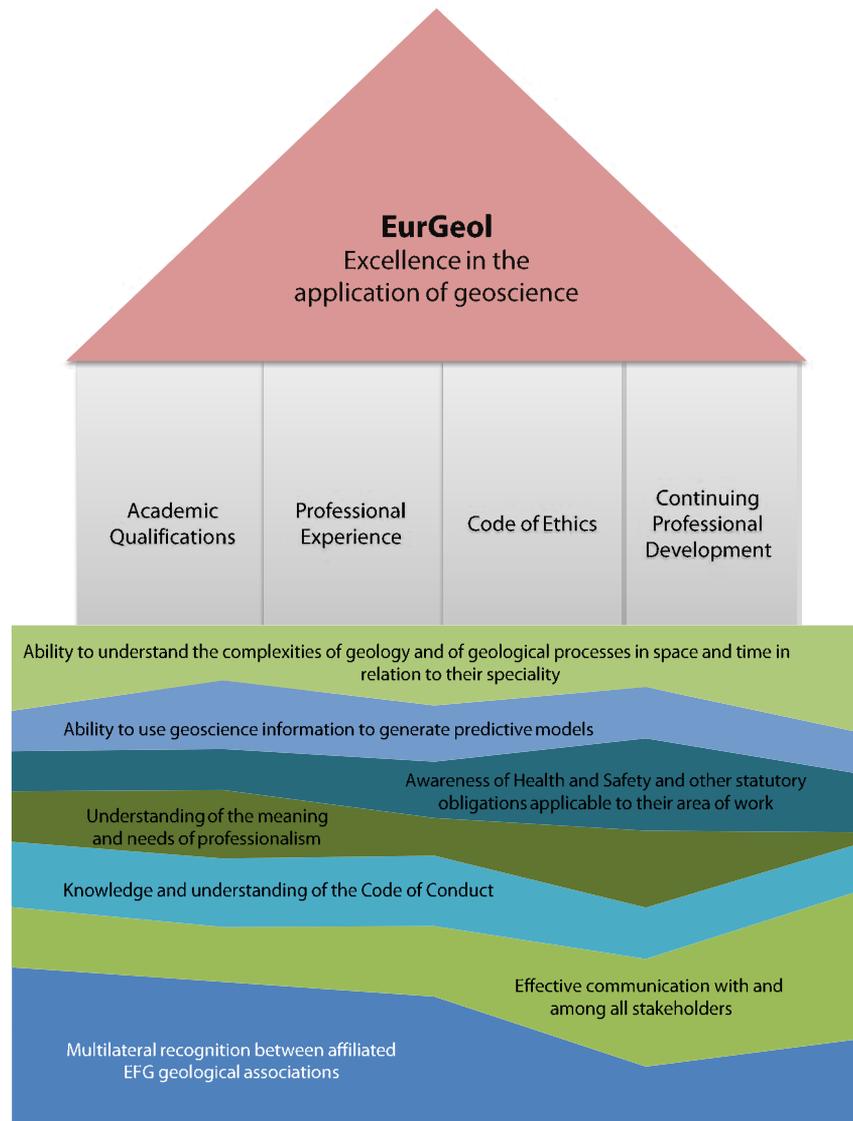


Figure 3: The foundations of excellence of the EurGeol title.

and organisations to search for EurGeols active in one specific country and/or one specific professional geology domain. The section ‘EurGeol searcher’ provides information about all European Geologists registered and validated by EFG as Competent Persons. In the section ‘EurGeol Service’, European Geologists can complete their annual record of Continuing Professional Development (CPD) online, and create an electronic CV or visit card. In terms of quality control, each EFG Licensed Body can supervise and audit the EurGeol’s CPD records in the section “Licensed Bodies service”. Each Licensed Body has access to the details of the EurGeols registered in its organisation.

**3. Regulation of the profession of geology in the EU member states**

EFG has been working since the 1990s on the mutual recognition of geologists in

Europe. Pursuant to Directive 89/48/EEC (on a general system for the recognition of higher-education diplomas awarded on completion of professional education and training of at least three years’ duration) and Directive 92/51/EEC (on a second general system for the recognition of professional education and training to supplement Directive 89/48/EEC), the EFG adopted a system of multilateral recognition between affiliated geological associations. Candidates who meet the requirements are awarded the professional title of European Geologist (EurGeol).

The primary stated purpose of regulatory frameworks applied to professional practice (including in geoscience) is to avoid harm to people (health, safety, economic wellbeing) or the environment caused by malpractice or faulty products. In general, regulation of professional practice is applied to services that are considered as public goods (and where errors or wilful malpractice have the

potential to cause harm).

There are two distinct models of regulation of the practice and profession of geoscience:

- Mandatory registration or licensure (legally required and enforceable by law); and
- Systems based on the award of professional titles and voluntary registration (operated by professional geoscience organisations and with assessment by peers).

The different approaches taken in different jurisdictions reflect cultural and legal differences in approaches to regulation and the extent to which the practice of geoscience (or aspects of it) is considered to have the potential for significant harm within that jurisdiction.

**Compulsory registration or licensure.**

In many countries, the geoscience professions are regulated by law, and registration or award of a licence to practise is compulsory before a geoscientist is allowed to work as a geoscientist (other than as a trainee or assistant). An application for a licence (or for registration) normally requires evidence to be submitted of the content and level of academic qualifications, which must satisfy certain criteria related to content and level of attainment. The criteria may be expressed in generic terms or may be linked directly to qualifications in that jurisdiction specifically. In many jurisdictions, candidates must also sit an examination which may test basic geological knowledge and adequacy of foreign language skills.

According to the EU Single Market regulated profession database, below the generic name of the profession ‘geologists’ there are 10 countries in Europe in which the profession of geology is regulated: Croatia, Cyprus, the Czech Republic, Greece, Italy, Liechtenstein, Poland, Slovakia, Spain, and the United Kingdom (see [http://ec.europa.eu/internal\\_market/qualifications/regprof/index.cfm?action=profession&id\\_profession=6630](http://ec.europa.eu/internal_market/qualifications/regprof/index.cfm?action=profession&id_profession=6630)).

A *voluntary professional card* is awarded by professional geoscience organisations to those of their members who are judged by their peers to meet or exceed qualification and experience criteria. The professional card held by geoscientists indicates to the public, employers or other professionals that the holder has achieved suitable academic training and a level of professional experience, skill and competence to perform tasks within their professional practice. It also confirms that the holder under-

takes continuing education and training, demonstrating a personal commitment to staying up to date and informed within the sphere of their professional work as well as a personal commitment to adherence to a code of conduct or ethics.

The application requirements for voluntary professional titles in terms of providing information about qualifications may be similar (or identical) to those relating to registration and licensure, and there may be an examination (sometimes written but normally oral). Another common feature is a requirement to adhere to a code of conduct or ethics and agreement to be subject to disciplinary sanctions. However, such titles differ from compulsory registration or licensure in three important ways. First, the practitioner must demonstrate their experience and level of competence as a practitioner – these titles are not awarded immediately after graduation, as a licence to practise or registration may be. Second, their voluntary nature underlines the personal professional commitment made by individuals who hold them. Third, central to these titles and associated regulation and disciplinary codes is assessment and being called to account by one’s peers.

Professional cards, whether voluntary or related to mandatory registration or licensure, have become important in demonstrating the suitability of a professional to provide geological services. They are sometimes used as a ‘threshold’ level of experience and expertise in legislation

or guidance.

There are 16 EU Members States in which the voluntary professional card in geology (the EurGeol title) is available, as listed in *Figure 4*.

**4. Qualified person concept**

The mineral sector is one of the main employers for geologists and the recognition of the professional competence, integrity and ethics are very advanced in this area. The recognition of EurGeol title holders as Competent Persons able to sign off reports has been extended.

International developments within the natural resource and financial sector require that technical reports, particularly those reporting on a company’s mineral resources assets, must be signed off by a “qualified person”. A qualified person:

- Must be a geologist or engineer;
- Must be an individual, not a firm;
- Must have at least five years of experience relevant to the particular project; and
- Must belong to a self-regulatory organisation with disciplinary power that is recognised by statute (a “professional association”).

Various government bodies responsible for the licensing and regulation of mineral exploration and development have set up a system of Recognised Overseas Professional

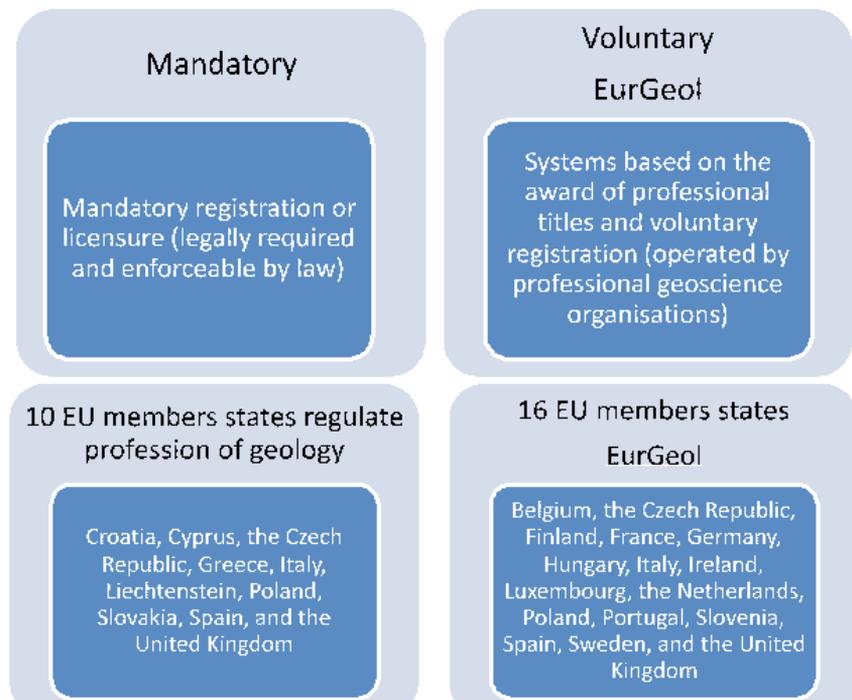


Figure 4: Systems for professional regulation or recognition in Europe.

Organisations (ROPO, RPO) in order to identify Qualified Persons or Competent Persons. To be recognised as an ROPO or RPO an organisation must satisfy the following criteria:

- be a self-regulatory organisation covering professionals in the mining and/or exploration industry;
- admit members primarily on the basis of their academic qualifications and professional experience;
- require compliance with the professional standards of competence and ethics established by the organisation anywhere in the world (not just within the home jurisdiction of the organisation); and
- have disciplinary powers, including the power to suspend or expel a member for breaches of professional standards of competence or ethics anywhere in the world.

These institutions have published lists of professional titles that they recognise. In many jurisdictions the EurGeol title is recognised, subject to the individual having relevant experience.

The concept of Competent Person is central in the mining sector, but also in other sectors, where the concept of Qualified Person is required increasingly often.

The roles and expertise of the geologist are many and varied. Geologists are the experts in discovering the raw materials that underpin and sustain modern life, such as oil and gas, base and precious metal ores and construction materials. Bedrock geologists educated in structural geology and tectonics work on locating sites for the disposal of radioactive waste, both regionally and locally. Engineering geologists evaluate the natural conditions necessary for the safe construction and operation of roads, railways, high-rise buildings, industrial complexes and dams. Hydrogeologists and environmental geologists are responsible for finding and advising on the protection of water supplies, for locating sites for the safe containment of hazardous wastes, and for mitigating the impact of floods such as those which affected much of central Europe in recent months. Geophysicists work at understanding and developing models to predict volcanic eruptions and earthquakes.

## 5. EurGeol International Recognition

The mobility of geologists is essential and their vocation is transnational, not only

because they often work for multinational companies, but also because most of the challenges they face have a cross-border character. EFG has made agreements that mean that the EurGeol title is recognised in countries around the world (see *Figure 5*).

### 5.1. Europe

The mineral sector is one of the main employers for geologists and the recognition of professional competence, integrity and ethics is very advanced in this area.

The Pan-European Reserves and Resources Reporting Committee, PERC, is the organisation responsible for setting standards for public reporting of exploration results, mineral resources, and mineral reserves by companies listed on markets in Europe. EFG is one of the founding members of PERC and thus its national associations are considered as Recognised Professional Organisations (RPO) qualifying European Geologists as Competent Persons.

PERC is a member of the international initiative to standardise market-related reporting definitions for mineral resources and mineral reserves, CRIRSCO, Committee for Mineral Reserves International Reporting Standards. As a member of CRIRSCO, the PERC Reporting Standard is fully aligned with the CRIRSCO Reporting Template.

The recognition of EurGeol title holders as Competent Persons able to sign off reports has been extended.

### 5.2. Australia

EFG has a cooperation agreement with the Australian Institute of Geoscientists (AIG). Both organisations recognise that their objectives with respect to the professional practice of the geological sciences are

similar and further recognise the importance of cooperation, as the practice of the geological sciences transcends international borders.

The EurGeol title holder is also recognised as a Competent Person in Australia. JORC is the Australasian code for reporting of exploration results, mineral resources and ore reserves ('the JORC Code'). JORC is a professional code of practice that sets minimum standards for public reporting of minerals exploration results, mineral resources and ore reserves in Australia. The Australian Securities Exchange (ASX) introduced in 2003 a procedure for identifying Recognised Overseas Professional Organisations (ROPO) as accredited organisations to which Competent Persons must belong for the purpose of preparing reports on exploration results, mineral resources and ore reserves. In the 2012 edition, the updated language of 'Recognised Professional Organisation' (RPO) was adopted. European Geologists (EurGeol) are recognised as fulfilling the requirements for recognition as members of an RPO as International Reciprocity of Competent Persons.

### 5.3. Canada

EurGeols are recognised as Qualified Persons in Canada. National Instrument NI43-101 is an instrument for the standards of disclosure for mineral projects within Canada. It is a codified set of rules and guidelines for reporting and displaying information related to mineral properties owned by, or explored by, companies which report these results on stock exchanges within Canada. This includes foreign-owned mining entities who trade on stock exchanges overseen by the Canadian Securities Administrators, even if they only trade in over-the-counter (OTC) derivatives or other instrumented securities. EFG is



Figure 5: EurGeols International Recognition.

recognised as a foreign association and the European Geologist title (EurGeol) as its membership designation.

#### 5.4. Peru

The EurGeol title is recognised as designating a Competent Person by the Committee Qualification Lima Stock Exchange (BVL, Bolsa de Valores de Lima), approved in January 2004. This Committee aims to assess the ability of applicants to meet requirements of the Registration Qualified Persons Registry of the Lima Stock Exchange. Holding the title European Geologist from the European Federation of Geologists (EFG) is required for registration in the Register of Qualified Persons of BVL.

#### 5.5. South Africa

EFG has a cooperation agreement with the Geological Society of South Africa (GSSAF). The signing organisations recognise that their objectives with respect to the professional practice of the geological sciences are similar and further recognise the importance of cooperation, as the practice of the geological sciences transcends international borders.

In addition, the EurGeol title is recognised as designating a Competent Person in South Africa. SAMCODE is a group of South African codes to set out minimum standards, recommendations and guidelines for public reporting of exploration results, mineral resources and mineral reserves in South Africa, and for public reporting of mineral asset valuation in South Africa. EFG is a Recognised Overseas Professional Organisation (ROPO) of SAMCODE, and consequently a holder of the EurGeol title is recognised as a Competent Person.

#### 5.6. USA

EFG has mutual recognition of professional qualifications with the American

Institute of Professional Geologists. With this mutual recognition of professional qualifications agreements the American Institute of Professional Geologists (AIPG) will accept applications for the title of Certified Professional Geologist (CPG) from a member of the European Federation of Geologists who are registered as a European Geologist (EurGeol) with a single sponsorship affidavit from the European Federation of Geologists, in lieu of the standard application requirements. The objective is to have an accelerated application process which will not require the submission of transcripts or certified record of employment. Each organisation will provide an application to meet these objectives.

#### 6. Conclusion

The search for excellence in geology and its application has been, and will remain, one of the fundamental objectives of EFG. To achieve this, EFG is continuously following the major political objectives in Europe and working hard to adapt to them. This is also the case for EU legislation on the recognition of professional qualifications. However, beyond legal requirements, our organisation has put in place a voluntary system of mutual recognition serving the mobility of geologists not only within Europe but also at a global level.

The search for quality includes, and goes beyond, academic recognition. EFG has based its work on international standards to develop the recognition of qualifications for competent persons. The criteria embrace not only education but also systems recognising professional experience, continuous training, and the strict application of the Code of Ethics established by our organisation.

Industrial sectors where the profession of geologist has a considerable economic impact, such as the mining sector, have highlighted the necessity to have clear criteria on what guarantees a Competent

Person in geology. However, the concept of Competent Person must also be extended to other areas of our profession. This demand is increasing also in sectors where geologists have a high impact on society, and bear societal responsibility, e.g. natural hazards, hydrology, and sustainable use of natural resources. Consequently, the criteria accepted for a Competent Person in the mining sector should also be applied in other professional sectors where geology is at the service of society.

The standards established for the EurGeol title are compatible with those used at international level to recognise a Competent or Qualified Person. Thanks to this, EFG as an organisation has managed to sign several international agreements of mutual recognition and understanding with organisations at the global level. In addition, EFG is included in the list of Recognised Overseas Professional Organisations (ROPO, RPO) by various government bodies responsible for the licensing and regulation of mineral exploration and development. Due to this, the title of EurGeol has become the required identification for European geologists, enabling them to sign official reports in the mining sector. The title is compulsory for certifying that the exploration work is carried out to the highest quality and professionalism standards and that the subsequent obligation of public dissemination of technical information for the investors is properly met.

As one European Geologist phrased it: *“Without the title, I wouldn’t have been able to reach the stage where I am now, where I was able to find, promote and finance with public funds my own discoveries, and have this way founded my own companies.”*

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# Public Reporting of Mineral Assets - Experiences of a global diversified industrial minerals company

Owen Herod\*

*The business of Industrial minerals is inherently different from metals mining, not least in huge diversity of products and the mechanisms of sales. However, in both cases, mineral assets are an important component of the value chain and, when publicly listed, companies are required to disclose these to stakeholders. The typical reporting prescribed by international reporting codes, such as the PERC Reporting Standard, is not suitable for industrial minerals groups; in many cases disclosure of grades, recoveries and products would compromise the commercial position of the reporting company. In the case of Imerys, the world's largest industrial minerals group, reporting mine site level details across its portfolio of 17 minerals over 100 sites would not be material to the overall company position. To further support its commercial positions and also to simply the report minerals and geographies are aggregated. These approaches are fully supported by specific clauses in the PERC Reporting Standard which address the needs to Industrial Minerals companies.*

*Le commerce des minéraux industriels est fondamentalement différent de celui des minéraux métalliques, ne serait-ce que par la diversité des produits et les mécanismes de vente. Cependant, dans les deux cas, les actifs miniers sont un composant important du processus de fixation des prix et, lorsque divulgués publiquement, les compagnies sont priées de les communiquer aux parties prenantes. Le compte rendu habituel prescrit par les codes internationaux, tels que le "PERC Reporting Standard" ne convient pas pour les groupes de minéraux industriels; dans nombre de cas, divulguer les teneurs, les produits récupérés et leur nature, mettrait en danger la position commerciale de la compagnie ayant livré ces informations. Dans le cas d'Imerys, le premier groupe au monde pour les minéraux industriels, détailler, par site minier, ses activités à partir de données concernant 17 minéraux répartis sur 100 sites, ne poserait pas de problème majeur vis-à-vis de la situation globale de la compagnie. Pour conforter ses positions commerciales et aussi pour simplifier le processus de rapport, minéraux et régions économiques sont traités ensemble. Ces approches sont entièrement soutenues par des clauses spécifiques du Code PERC (Reporting Standard) qui définit les besoins pour les compagnies de minéraux industriels.*

*El negocio de los minerales industriales es muy diferente de la minería de metales, en particular la gran diversidad de productos y los mecanismos de ventas. Sin embargo, en ambos casos los recursos minerales son un componente importante de la cadena de valor y cuando están cotizados en la bolsa, las empresas están obligadas a revelarlos a los interesados. Los requerimientos típicos exigidos por los códigos internacionales para los informes de minería, como por ejemplo la norma de estandarización PERC, no es adecuado para los grupos de minerales industriales; en muchos casos, revelar el grado de recuperación y producción comprometería la posición comercial de la empresa notificante. En el caso de Imerys, la empresa de minerales industriales más grande del mundo, declarar detalles sobre minas a través de su cartera de 17 minerales en más de 100 sitios no sería primordial para la posición global de la empresa. Por tanto para apoyar la posición comercial y simplificar el informe, los minerales y geografías son englobados. Estos enfoques son completamente compatibles con cláusulas específicas de la norma de informe PERC que abordan las necesidades de las empresas de minerales industriales.*

Industrial Minerals are difficult to define; some authors group non-metal ores with construction material (e.g. Scott and Bristow, 2002), others prefer to contrast the difference in price, sales mechanisms or end use as the defining factor (European Commission Website). What is clear is that they are different from metallic ore (ferrous, non-ferrous and precious); metals are extracted (smelted) from their ores whereas industrial minerals are used in their mineral or rock form; metals typically occur as low grades ores, from a few grams per tonne to a few percent whereas industrial

minerals range from a tenth to 100% of the ore; metals are globally traded based on purity whereas industrial minerals are sold based on industrial properties and through negotiated contracts.

Throughout the latter part of the 20<sup>th</sup> century a number of Codes or Standards were developed around the world to address the public reporting of mineral assets. Through the work of the Committee for Mineral Reserves International Reporting Standards (CRIRSCO) these codes have become aligned and now offer a common framework of public reporting across the spectrum of the (solid) extractive industries. The origin of these codes can be traced back to a number of investment boom and bust cycles; notably the nickel boom in Aus-

tralia in the 1960s and the Canadian BreX scandal in the 1990s. This, coupled with the dominance of metals mining and exploration companies on global stock exchanges compared to industrial minerals, resulted in a metals focus to the codes. However, many codes now include specific clauses dealing with Industrial Minerals and this paper reviews how Imerys, a European based, international diversified Industrial Minerals company use these clauses in the Pan European Standard for Reporting of Exploration results, Mineral Resources and Reserves (PERC Reporting Standard) in their public reporting. Imerys is discussed to present how the principles of materiality and confidentiality are applied in its public reporting to the PERC Standard.

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**Imerys**

Imerys can trace its history back to non-ferrous metals mining in the late 1880s but its recent history starts when it was consolidated into a single group, Imetal, in the 1970s. During the 1990s Imetal diversified into a range of industrial minerals which culminated, in 1999, with the acquisition of English China Clays (ECC). This led to divesting all non industrial minerals activities and the renaming as Imerys. Since 2000 the group has continued to grow, through organic growth and acquisition; notably World Minerals in 2005, Talc de Luzenac in 2011 and S&B in 2015.

Imerys categorises its mineral solutions into three groups: Functional Additives, Raw Materials and Process Enablers. Functional Additives are mineral products added to a final product to enhance its properties; for example kaolin, mica, talc or feldspar in paints and plastics used to enhance shock absorbing and weight characteristics. Raw Materials are minerals which make up an important part of the product; for exam-

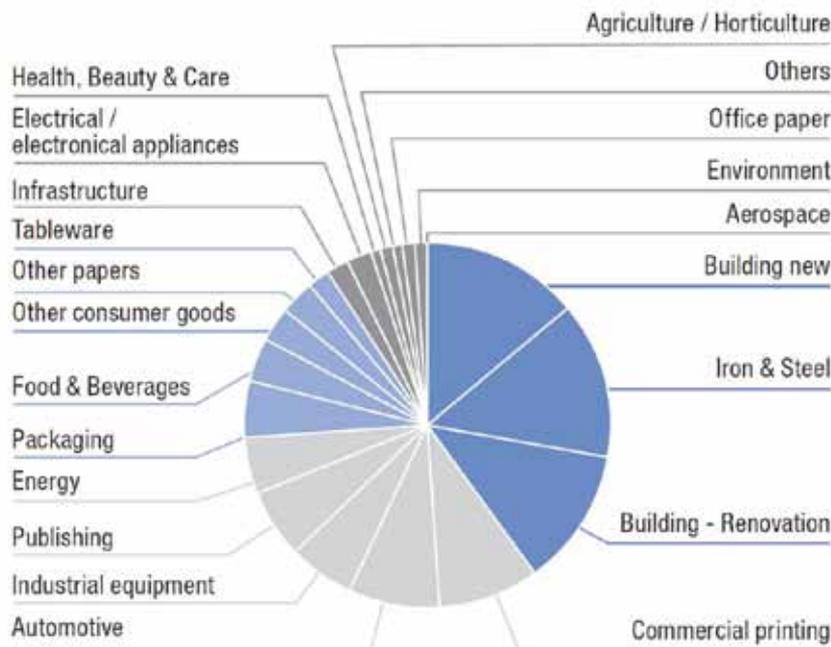


Figure 1: Graph illustrating the proportion of Imerys revenue which is derived from different end use markets (after Imerys 2015).

Table 1: List and description of the mineral and rock groups mined by Imerys in 2014.

Mineral	Description
Andalusite	Alumino Silicate with up to 60% alumina which transforms into mullite which calcined to 1350°C. Generally used in refractory products due to its thermal properties and resistance to wear
Ball Clays	Very fine grained sedimentary clays. Their high plasticity and rheological stability has application in ceramics industry
Bauxite & bauxitic kaolin	These low iron, moderate to high level alumina clays and bauxites are typically sedimentary in origin with some post deposition enrichment in alumina content. Once calcined they have refractory properties
Bentonite	A fine grained sedimentary clay with a high smectite content which gives the final products useful absorption and swelling properties. Used as binders and sealers
Diatomite	Generally lacustrine sedimentary deposits with high concentration of diatom micro fossils. Structure of the diatoms gives the product unique density, porosity and surface areas characteristics which are used in filtration and as functional additives in products such as paint
Feldspar	Alumino Silicate with varying content of sodium, potassium, calcium and/or lithium. Used for its fluxing properties in ceramics and glass making
Calcium Carbonate	Generally termed Ground Calcium Carbonate (GCC) produced from marble, chalk and limestone deposits. Colour and particle size of the engineered product are important and it is used extensively as a filler and coating pigment in paper and well as additives in paints and plastics
Graphite	Naturally occurring crystalline form of Carbon used in mobile energy, polymer additives, lubricants and as a refractory product
Kaolin	A white pigment and additive comprising mainly the alumina silicate Kaolinite. Typically very fine particle size. Used extensively in the paper industry and also in paint, plastics and rubber. Important constituent in ceramic bodies
Mica	Covering both muscovite and phlogopite, micas are used for their insulation and elastic properties either as coating or as additives, specifically in automotive plastics
Perlite	Partially hydrated rhyolitic glass which when heated expands like popcorn. Expanded products are low density, high surface area and high permeability. They are used in filtration, construction and horticultural applications
Quartz	High purity quartz (>99.8% silica) used as a raw material for silicon and ferrosilicon. Also used as a refractory product
Red Clay	Sedimentary clay deposits which turn red when fired and primarily used in roof tiles and bricks
Refractory clay	Fine grained kaolin; often partially enriched by gibbsite, an intermediate between kaolin and bauxite. In calcined form names chamotte and used in various refractory applications
Slate	Fined grained pelitic metamorphic rock used in roofing and decorative gravels
Talc	Hydrated magnesium silicate which displays various hydrophobic and oil-philic properties. Softest mineral in the world. Used as a performance additive in polymers, paints, paper and cosmetics
Vermiculite	Hydrated micaceous mineral which expands on heating, used in horticulture and heat insulation

ple clay, kaolin and feldspar introduce whiteness and strength to ceramic bodies. Process Enablers are minerals used in an industrial process but not consumed by the process; for example monolithic refractories used in industrial equipment where they are resistant to high temperature and wear.

In 2014 Imerys mined 17 primary minerals or rocks (*table 1*) from 99 active mine sites around the globe. In addition 13 by-product minerals or metals were mined and sold. These primary minerals are used in a multitude of different end markets from construction to pharmaceutical (*figure 1*) and in many cases Imerys holds significant, if not world leading, positions in supply of industrial mineral solutions to these markets. The group is organised into four Business Groups, each aligned with different market groupings; Energy Solutions & Specialties, Filtration and Performance Additives, Ceramic Materials and High Resistance Minerals. The Group's mining activities contributed to a total group revenue of €3,688 million generating a Current Operating Income of €494.6million. Please refer to the 2014 Imerys Annual Report for further details on the Imerys Group.

### Reporting using the PERC Reporting Standard

Imerys is listed on Euronext Paris and is required to disclose its mineral assets to the investment community within its annual report. Since 2007 Imerys has chosen to use the Pan European Standard for reporting of Exploration Results, Resources and Reserves (PERC Reporting Standard) or its precursors as the basis for reporting of its mineral assets. As such, Imerys classify its mineral assets as either Reserves or Resources and appropriate categories therein. For the sake of brevity, a summary of Imerys 2014 Reserve and Resource position is shown in *table 2*. It shows that Imerys maintains a significant inventory across all its mineral types with a spread across the different reporting categories. In support of this reporting, Imerys have over 30 Competent Persons who work within a larger community of over 100 geologists and mining engineers.

Imerys employ a consolidated approach to reporting, grouping its mineral assets firstly by broad mineral type (as in *table 2*) and then by geographic region (see page 38 and 39 of Imerys 2014). In addition it reports using a final product basis. In contrast, the standard approach described in the PERC reporting standard and other aligned codes, such as the Australasian Code for Reporting of Exploration Results,

Table 2: Summary of Imerys' 2014 Reserves and Resources (after Imerys 2015) figures in in thousand metric tonnes on a dry, final product basis.

	Reserves		Resources		
	Proved	Probable	Measured	Indicated	Inferred
BALL CLAYS	16,508	2,333	17,357	13,898	12,462
CARBONATES ( calcite, marble, chalk, limestone, dolomite & dimension stone)	113,065	141,632	64,946	173,669	154,952
CLAYS (brick & roof tile raw materials)	19,688	33,979	18,195	22,225	6,037
FELDSPAR, FELDSPATHIC SAND & PEGMATITE	18,190	6,516	6,915	23,494	31,151
KAOLIN	48,044	54,333	46,684	64,966	67,814
MINERALS FOR FILTRATION (perlite & diatomite)	36,602	9,512	22,000	35,013	114,496
MINERALS FOR REFRACTORIES (andalusite, quartzite, bauxite, bauxitic kaolin, ref clays & kaolin )	6,462	5,172	7,671	11,823	2,550
TALC	26,072	8,120	9,796	8,978	11,628
OTHER MINERALS (bentonite, mica, vermiculite, quartz, slate, graphite)	4,330	925	6,712	2,015	423

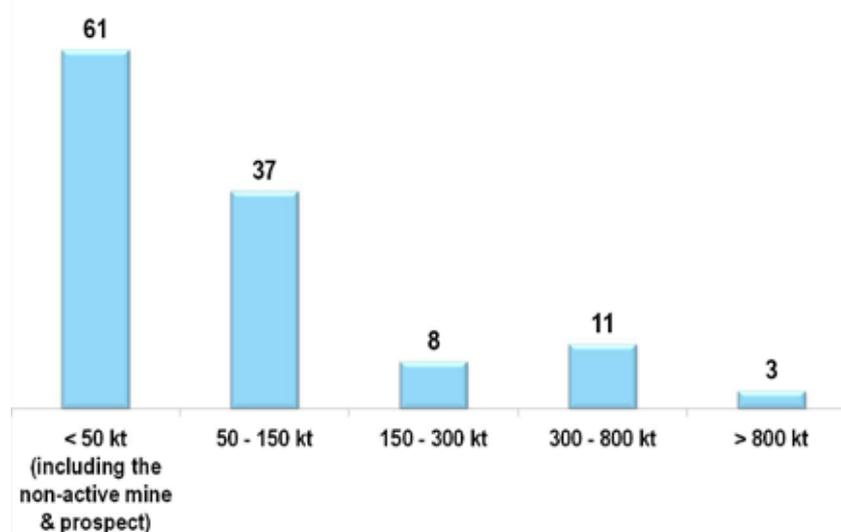


Figure 2: Graph showing number of Imerys mining sites categorised by their annual production expressed as final product tonnes.

Mineral Resources and Ore Reserves (the JORC Code), require that mineral assets are described in terms of both tonnage and grade. These requirements are well known within the mining industry. So why does Imerys take the approach that it does and what allows it to do it whilst claiming that its mineral assets are reported in compliance with the PERC Reporting Standard?

The majority of annual reports by mining companies (for example Rio Tinto 2014) list all their mine sites and development projects in their tabulation of Reserves and Resources. Imerys has over 100 mine sites and development projects with a huge range of sizes (*figure 2*). Although the number of

sites is comparable with some other large mining companies, the details of smaller sites is not material. For example, some Ball Clay sites in France are operated intermittently and on average produce on a few thousand tonnes per year compared to an annual total Group mining production of around 14Mt this tonnage is not significant. This materiality is also found in the Group's balance sheet where the total mining assets comprise fewer than 10% of the Group's total assets, in this context individual site's Reserves and Resources are not considered material at Group level.

The second reason for aggregated reporting is confidentiality. Imerys is a business-

to-business seller with all products sold on a contractual basis. Detailed knowledge of a specific mine's Reserves and Resources may give customers or competitors a competitive advantage during contract negotiations. Imerys approach is to consolidate its reporting by mineral group and geographic region. These two grouping loosely translate to the different markets supplied by the business and hence give both investors and customers a level of information suitable for evaluating the long term future of the raw materials supply and related sustainable business. In summary, the consolidated presentation of Imerys' Reserves and Resources protects commercially sensitive details of its mine sites whilst not compromising the overall materiality of the reporting.

Consolidation of Reserve and Resource estimates for Industrial Minerals is not simply a case of aggregating all the ore tonnages and grades as all mines are different; they have different processes, final products and end markets for their products. This difference is illustrated through two case studies; one illustrating the complexity within a single site and the second comparing two sites which produce the same mineral.

**Refractory Clays** – Imerys operates a site in Clérac, west central France which produces clays used in refractory products. The deposits form as channels and sheets of fine grained, mainly kaolinitic clays within the sedimentary Aquitainian basin. These clays have undergone some post depositional gibbsite formation which has upgraded their  $Al_2O_3$  content which now ranges from 35% to 50% on a calcined basis. The deposits range in size from a few 10kt to 1Mt and all have unique properties which determine their specific end use. From multiple quarries, up to 10 in a single year, a number of blends are produced and processed in two plants. Processing is typically shredding, milling and calcination. These two plants can produce a portfolio of over 400 different products, ranging from shredded pellets with 20% free moisture through to fine grained milled calcined product with 0% moisture, both free and within hydrated minerals (figure 3). To allow comparison between different quarries within this single site a common 'final product' basis is used. In this particular instance this is the dry calcined product. To arrive at this tonnage, a series of 'Conversion Factors' are applied to the in-situ tonnage. These are effectively the modifying factors described in the PERC Reporting Standard. Imerys also apply these Conversion Factors to Resources; in most cases Resources are linked to exist-

ing operations and the Competent Persons are able to make some assumptions about the likely validity of the factors applied to Resources based on the experience of the Reserves. The approach of using final products throughout the reporting removes the impact of processing and sales details from the reported tonnages and allows for a sensible aggregation at the level of the site.

**Kaolin** – Imerys' kaolin operations in Brazil and the UK both serve similar markets, but have contrasting geologies which prevent direct aggregation. The kaolin deposits of South West UK are primary; they formed by the in-situ weathering and hydrothermal alteration of granites which give coarse kaolinite crystals often forming stacked layers (Bristow *et al*, 2002). Only 10-15% of the rock mass is kaolin. Mining is through blasting and truck and shovel to a central trommel and make-down plant or in-situ washing using high pressure water (figure 4a). In contrast, the kaolin mined in Para state, Brazil is of sedimentary origin having been deposited by a part of the Amazon river system. The kaolinite has

been secondarily enriched and is typically fine-grained and makes up about 30% of the rock mass. Mining is with excavators feeding a central make-down plant. The extraction is configured as strip mining with systematic and continued backfill behind the working face (figure 4b). Both sites further process the kaolin, generally by size classification to control the  $2\mu m$  size fraction and then by chemical treatment to improve the optical properties. Both sites have historically supplied the paper industry with the UK also have strong ceramics contribution to sales. Sales are typically in bulk with variable moisture content. Any comparison, or aggregation, of traditional mining metrics such as ore tonnes, waste-to-ore ratios between these two sites are meaningless because of the difference in underlying geology. Equally, the two sites combined have many 10s of product forms. For purposes of reporting, a single standard of dry final product is used which permits some aggregation and is more focused on the product market rather than internal processes.

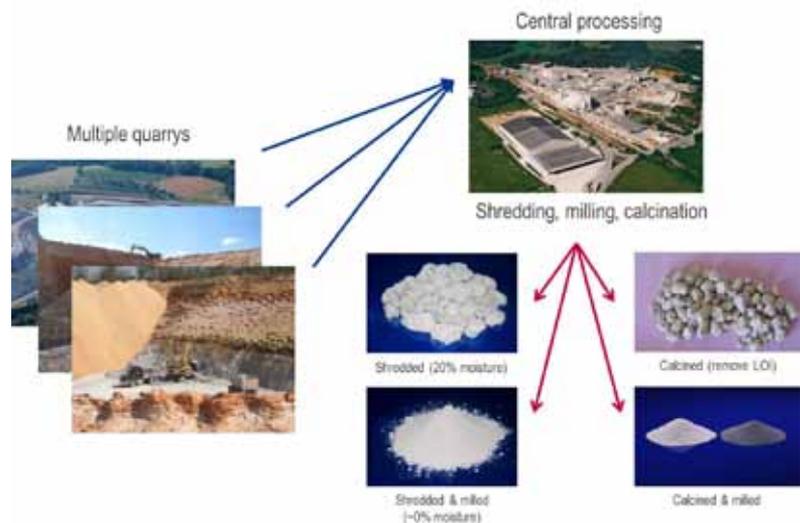


Figure 3: Representation of material flow at a refractory clay operations showing multiple quarries feeding a centralised processing plant and producing multiple products which have different forms.



Figure 4: Photographs of (a) UK kaolin operations showing deep pits with centralised pond used to capture slurry washed directly at the face, and (b) Brazilian kaolin operations showing shallow, strip mining configuration, the photograph is taken from a reclaimed portion of the operation.

The previous discussion noted that mining and processing metrics, including recovery, vary hugely between Industrial Minerals mining sites, even for those producing the same or similar minerals. Were these data to be available in the public domain they could be used by customers as the basis to force price negotiations. They may also be used by competitors to undercut prices and attack margins. These types of data, specifically ore grade which is equivalent to what is typically called recovery in industrial minerals, are freely reported in public documentation of metals mining companies as metals are typically sold related to a spot market price. In effect, metals mining companies have limited control on their revenue and have to focus on costs. By contrast Industrial Minerals have more influence on the revenue side of the equation and any industrial information, including mining, can alter this competitive landscape. Were this type of industrial information required to be listed for industrial minerals companies it would put them at a significant commercial disadvantage.

**Conclusion**

All the CRIRSCO aligned reporting codes clearly state that it is not acceptable to just state ore tonnage without also providing grade. Equally, reporting in-situ or recovered metal without either ore grade or tonnes is not permitted. The reasoning behind these restrictions is that only

reporting one of these three data can be misleading and prevent meaningful comparisons between projects and companies. This is completely contrary to Imerys', and Industrial Minerals in general, need to mask elements of these details to maintain their commercial position. Equally many products are produced from a specific ore body, or even ore type, in Industrial Minerals sites, so much so that the concept of grade or recovery becomes impossible to report in a meaningful manner and hence could confuse, rather than inform external interested parties.

The PERC Reporting Standard contains a specific section addressing the requirements of Industrial Minerals reporting. It recognises the need to maintain confiden-

tiality and that final-product reporting in an aggregated form are suitable in some cases. It is these clauses that Imerys use to ensure that its public reporting is compliant with the PERC Reporting Standard. Internally within Imerys far more detail is collated from each mining site. These data are consolidated at site level using a final product basis and then further consolidated at group level. The estimation and reporting culture within Imerys has hugely benefited from being aligned with the principles of the PERC Reporting Standard and although many details are not public reported, they are important within internal processes for managing the companies portfolio of mining sites.

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# Explorers, Investors and Regulators - An Uneasy Threesome

John A. Clifford\*

In September 2003, Elias Ehdalh, until recently the Director of the Geological Survey of Finland, began a presentation at a conference in Dublin with the statement that “mining is not a sunset industry”. This was a revolutionary idea at the time as, for several decades prior to that, Europe had an unwritten policy of outsourcing their raw material needs to third world countries and to the colonies. During this same period former European giants of the global resource sector, such as Outokumpu, Metallgesellschaft, BRGM and others either closed their operations, or changed their business focus. Recognizing this trend, many of the European mining schools closed their doors.

All of this happened notwithstanding the fact that many millions of European jobs depend on access to raw materials.

Furthermore, the clean and renewable technologies on which Europe wants to build its future cannot be developed in isolation – they require the products of mining.

For a time everything went well. Supplies of raw material were imported into Europe from all over the world.

But then the world changed. China started to develop as a major industrial power and became a voracious consumer of raw materials. This changed the game. Then Putin turned off the gas, for the first time. Suddenly, our sources of raw material supply were no longer assured.

Starting at the individual level, but increasingly adopted as policy, the EU Commission woke up to the danger and, starting in the late 2000’s, began to promulgate a series of discussion papers addressing the issues. The current Raw Materials Initiative is a direct product of that process. One of the key pillars of that Initiative is to increase the sustainable supply of raw materials from within the EU. That means getting back into the business of exploration and mining.

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Many trees have been destroyed in the publication of documents on how we might re-energise the resource sector. It has not happened. Fundamentally we need to understand a few basic truths.

Firstly, orebodies are fixed in space – we must be able to mine them where we find them and not just where society would like us to operate.

Secondly, we are dealing with risk – the most important question being – does an orebody exist. Statistics suggest that for every 1,000 drill targets, 10 progress to become advanced projects and 1 will be

developed as a mine, and not necessarily a profitable one.

Not all of the actors in the business understand this.

Essentially you have three actors – Explorers, Investors and Regulators. Each of them have different Drivers. Explorers are driven by Discovery, Investors by Profit, and Regulators by the need to ensure compliance with Socio-Political regulation and policy.

Exacerbating the communication problem is a different perception of time. Currently it takes about 20 years to progress

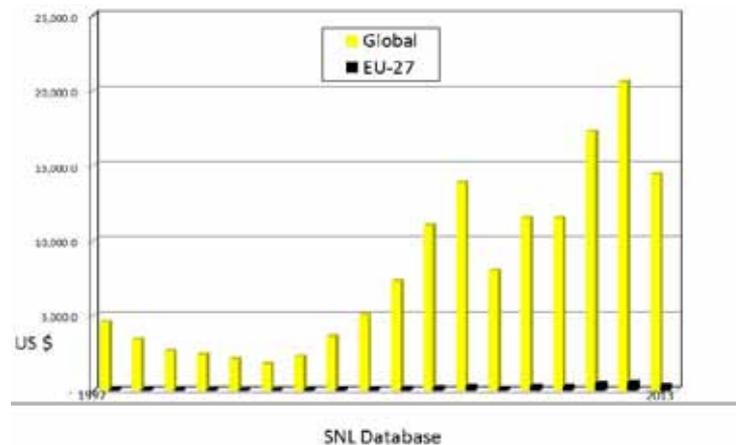


Figure 1: Global and EU-27 Exploration Expenditures (SNL Database).

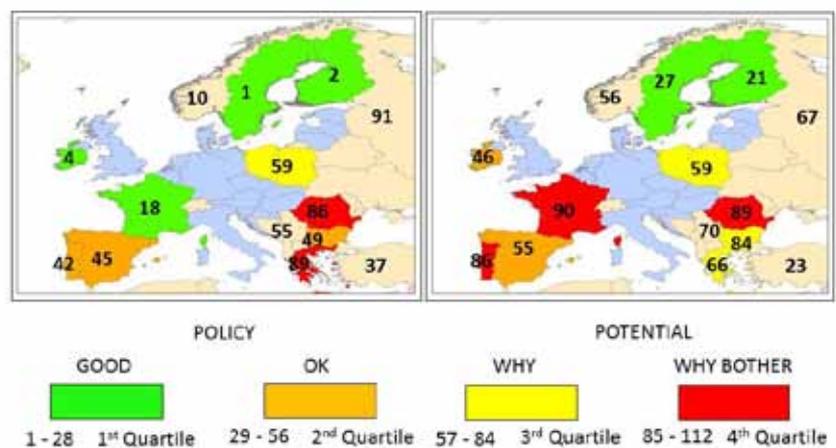


Figure 2: European Rankings (Fraser Institute, March 2014) (Classification Ranking Nomenclature by author).

from discovery to production. Yet, many investors, and some company executives, are focussed on the results of the next quarter. The regulators very often do not have a concept of time.

The result is that you have three monologues, and that does not result in a dialogue.

Turning now to the situation in the EU. Analysis of global exploration expenditures over the past 15 years shows that the EU has attracted a derisory percentage of that investment (*Figure 1*).

Clearly not everybody has bought into the Raw Materials Initiative, especially exploration management.

In an attempt to better understand the issues, a study of the Fraser Institute's surveys of mining investment proves informative. The most recent study, published in March 2014, analyses 112 jurisdictions worldwide in terms of their mining policies and mineral prospectivity. As with any such study, one can question certain of the conclusions. Nonetheless, we need at least to listen. Not all of the EU-28 were analysed, on the basis that the level of investment did not warrant the effort (*Figure 2*).

Only two of the 10 EU member states rank in the upper quartile of the Potential Index. These are Sweden and Finland. Two others, Ireland and Spain are grouped in the 2<sup>nd</sup> Quartile. The remainder are in the Why and Why Bother categories.

A similar analysis of government policy as it appertains to mining has 4 of the 10 EU-28 countries listed in the upper Quartile. These are Sweden, Finland, Ireland and France. Three others, Portugal, Spain and Bulgaria are in the 2<sup>nd</sup> Quartile.

The overall message from this study is that only a few of the EU-28 countries are deemed attractive for exploration and mining investment by global mining executives.

This conclusion is supported when the annual exploration expenditures over the past 15 years are examined (*Figure 3*). Almost 50% of the investment during the period has been directed to Finland and Sweden. Four others, Ireland, Poland, Portugal and Spain, bring the total to almost 80%.

Part of the reason for this highly selective investment is the difficulty in getting a licence to operate, and not just from communities. These difficulties can be highlighted by an examination of maps showing the current designation of Natura 2000 areas and of the urban and discontinuous urban development (*Figure 4*).

Notwithstanding EU statements that the presence of a Natura 2000 designation is not a fatal flaw, personally I would

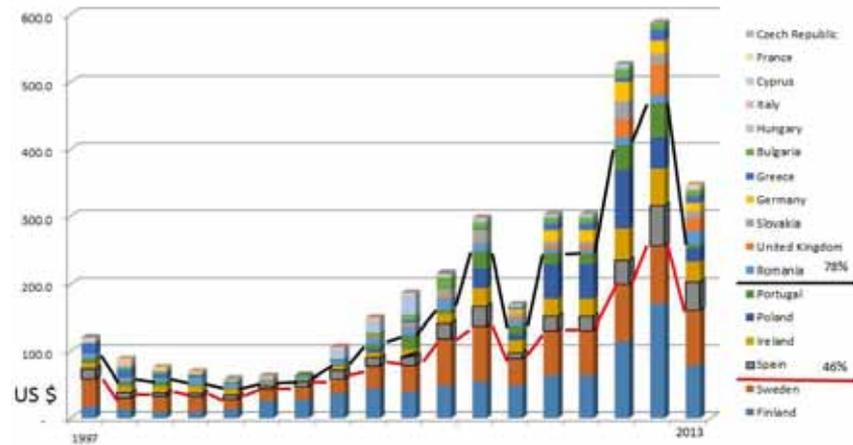


Figure 3: European Exploration Expenditure Distribution (SNL Database).

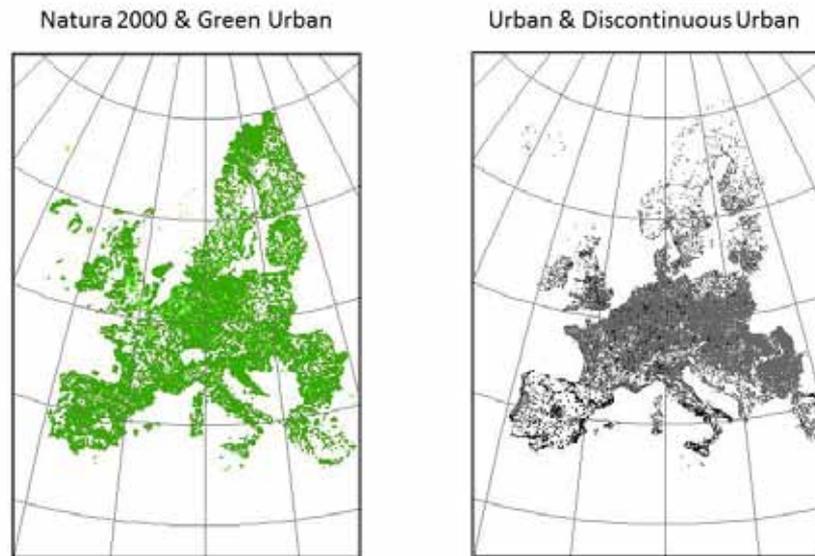


Figure 4: Natura 2000, Green Urban, Urban and Discontinuous Urban Designated Areas (European Environment Agency Website).

put many of these areas in the “too hard” category. Another reason is that regulators in many of the EU-28 countries have lost their expertise and the current incumbents often have little knowledge of the industry.

So, how do we address the problem? The only way is through Communication. We must start listening to each other and to speak in a language that the non-expert can understand. By the way, geologists are some of the best examples of poor communicators.

One of the mechanisms that we might use is the format suggested by the various Codes on the Reporting of Mineral Exploration Results, Mineral Resources and Mineral Reserves. These reports now have the same structure worldwide. The problem is that, when the codes are presented in the standard format they put

listeners to sleep. In addition, many of the reports are very similar to documents that emanate from Brussels – they are totally incomprehensible except to the initiated. The authors of the reports have another characteristic in common with the Brussels bureaucrats – they think that they are doing a fantastic job.

It is suggested that in order to communicate effectively we need to look behind the terminology of the codes and focus on the essentials.

So let's try and look through the gibberish and develop a dummies guide to mining (*Figure 5*).

The first, and most important point, is that, in order to be able to mine, you need to be able to explore for and define a resource. We have seen the problems associated with this issue.

Having a resource automatically implies that you must understand the geology of the deposit. This is not an academic matter. Rather it seeks to explain the size and shape of the mineral deposit, the distribution of the economic minerals within it, and the nature of the rock that hosts those minerals. These basic characteristics will define the mining and processing methods that can be used. Get the geological model wrong and the project will fail. Research over the decades has shown about 50% of feasibility studies fail to deliver the desired project outcome. The reasons for the failure are many and varied. However, most can be traced back to errors and omissions in the geological model. This will not be addressed by investing in more computing power, or applying ever more sophisticated geostatistics, but by putting boots on the ground and spending more hands lens time studying drill core. So, as we close down our mining schools and reduce funding to our geological surveys, let's bear that fact in mind.

The next step is to decide on the mining method – will it be an open-pit or an underground operation. That decision determines the type of mining equipment you require and the tonnage that will be sent for processing. It also determines the employee skills required, a factor that will be important to the local community.

The type of mineralisation present in the orebody dictates the processing method. Sulphides will most likely be treated in a flotation plant, oxides possibly by heap,

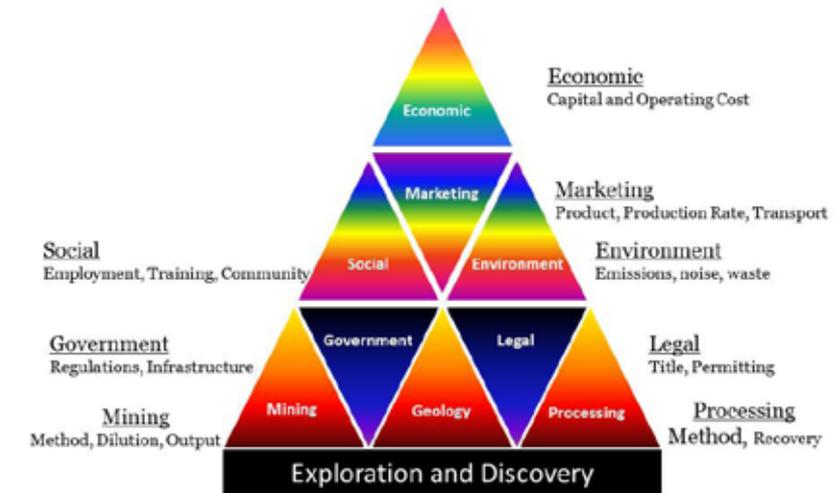


Figure 5: Resource – Reserve Classification – Modifying Factors (CRIRSCO Template).

or dump, leach. Each has its own environmental impact. This leads on to consideration of external factors.

Clearly, legal issues of title and permitting are of fundamental importance, as are interaction with government regulators. The environmental issues need to be quantified and properly explained to all of the stakeholders, and in particular to the local community who will also be very interested in the employment opportunities and of the training requirements to avail of those opportunities.

The project does not exist in isolation. The product must be transported and sold into international markets.

This industry is cyclical with sometime dramatic price changes over short time intervals. Hence decisions must be made relatively speedily. Therefore a close examination of the economics is essential for an informed production decision.

Those are the essential elements behind the reporting codes.

Take one of these triangles out of the pyramid and it will collapse.

To conclude, if we are to be taken seriously in both the marketplace and the boardroom “we all must do better”.

# Geology for Society

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# Policy and regulation of Ireland's exploration and mining sector

Eibhlín Doyle\*

*Ireland is a politically stable country with a long-standing policy of encouraging free enterprise, a long mining tradition, diverse geology with a wealth of mineral potential, and a highly developed infrastructure. In a climate of strong Government support for responsible development, major mineral deposits worked in recent years include Zn-Pb deposits at Navan (at >100Mt the largest in Europe), Lisheen (circa 22Mt), Silvermines (17Mt), Tynagh (10Mt) and Galmoy (9Mt). Ireland is Europe's largest zinc producer. In terms of tonnes of zinc discovered per square kilometre, Ireland ranks first in the world. In terms of global ranking the Fraser Institute has ranked Ireland highly in the last number of years. In their recently published survey for the year 2014, the Institute ranked Ireland first in terms of Policy Perception Index, which ranks the attractiveness of Government mining policies to industry.*

*L'Irlande est un pays politiquement stable avec une politique de longue date, en faveur de la libre entreprise, une longue tradition minière, une géologie variée avec un riche potentiel minier et des infrastructures très développées. Dans un contexte gouvernemental de fort soutien pour un développement responsable, les principaux gisements miniers, d'exploitation récente, incluent les minéralisations plomb-zinc, à Navan (site le plus important d'Europe avec plus de 100 millions de tonnes), Lisheen (environ 22 millions de tonnes), Silvermines (17 millions de tonnes), Tynagh (10 millions de tonnes) et Galmoy (9 millions de tonnes). L'Irlande est le premier producteur de zinc d'Europe. En termes de découverts de zinc par kilomètre carré, l'Irlande est classée au premier rang mondial. En termes de classement mondial, l'Institut Fraser a classé l'Irlande en position élevée, ces dernières années. Pour l'année 2014, le rapport d'étude de cet Institut a placé l'Irlande en première position pour ce qui est de l'Index de sensibilisation politique ce qui explique l'attrait de la politique minière gouvernementale vis-à-vis de l'Industrie.*

*Irlanda es un país políticamente estable, con una política que fomenta la libre empresa, una larga tradición minera, geología diversa con una gran cantidad de potencial minero, y una infraestructura altamente desarrollada. En un clima de fuerte apoyo gubernamental para el desarrollo responsable, depósitos de minerales importantes están siendo operativos en los últimos años, incluyendo depósitos de Zn-Pb en Navan (a >100Mt el más grande de Europa), Lisheen (22Mt), Silvermines (17Mt), Tynagh (10Mt) y Galmoy (9Mt). Irlanda es el mayor productor de zinc de Europa. En términos de toneladas de zinc descubiertas por kilómetro cuadrado, Irlanda ocupa el primer lugar en el mundo. En cuanto a su clasificación mundial, el Instituto Fraser ha clasificado Irlanda muy alto en los últimos años. En su estudio recientemente publicado para el 2014, el Instituto coloca a Irlanda en primer lugar en términos del "Índice de Percepción Política", el cual mide el atractivo de las políticas mineras del gobierno para la industria.*

Ireland has a long history of mining dating back to the Bronze Age. Coal, lead and copper mining flourished during the eighteenth and nineteenth centuries. During the 20<sup>th</sup> century a number of metal mines were discovered and developed including Silvermines, Tynagh, Gortdrum, Avoca, Galmoy, Lisheen and the Navan mine. Silvermines, Tynagh and Gortdrum closed in the 1970s and 1980s. More recently, the Galmoy Mine finished production in 2012. Lisheen and the Navan mine continue production although Lisheen is scheduled to close in 2015. In addition, there is production of gypsum near

Kingscourt, and over 200 quarries for construction materials and dimension stone. This paper will deal primarily with the minerals industry covered under the Minerals Development Act 1940-1999, which excludes stone, gravel, sand and clay, with some exceptions.

## Ireland's Mineral Potential

In spite of Ireland's relatively small size (70,000 km<sup>2</sup>), it has a diverse geology, with rocks ranging in age from Proterozoic (2500 million years ago) to the present. There are a number of mineral provinces that are endowed with a diverse suite of base and precious metals, and industrial minerals.

The Lower Carboniferous carbonate rocks of the Irish Midlands host one of the great orefields of the world. Since 1960, a

significant number of base metal deposits have been discovered, with six becoming producing mines, including the giant orebody at Navan, Co Meath (>100Mt). Ireland has been ranked first in the world in terms of zinc discovered per square kilometre, and second in the world with respect to lead. Ireland is Europe's largest zinc producer. Its two underground base metal mines account for some 31% of European zinc production and 11% of lead production. Recent and current exploration has intersected significant zinc-lead mineralization in the southwestern part of the Irish Midlands at Caherconlish and Stonepark in Co Limerick, and Kilbreckan in Co Clare. The Lower Carboniferous limestones are also host to the vein and massive replacement copper-silver deposits at Gortdrum, Aherlow and Mallow which are associated with the struc-

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turally controlled southern margin of the Central Ireland Basin.

Large tracts of Ireland are underlain by metasediments and metavolcanics of Proterozoic and Lower Palaeozoic age. These lithologies are known to contain significant volcanogenic massive sulphide (VMS) mineralization (e.g. Avoca, 16Mt @ 0.6% Cu) and auriferous mesothermal quartz veins. The latter style of mineralization has been and continues to be the focus of extensive exploration across Ireland and Northern Ireland. As a result two significant discoveries were made in Northern Ireland that of Cavanacaw and Curraghinalt. This prospective geology extends into Ireland.

In addition to its gold and base metal potential, Ireland's varied geological framework renders it prospective for a number of other commodity types. In the last few years, exploration has been undertaken for the following commodities:

- PGM mineralization associated with mafic intrusive complexes in north-east Ireland.
- REE and speciality metals (Li, Ta, W, Sn) associated with pegmatites that cross-cut the Caledonian Leinster granite batholith in southeast Ireland.
- Nickel and chromite associated with ultramafic intrusions in the west of Ireland
- Diamonds and other gemstones associated with Pre-Cambrian rocks in Donegal, in the northern most part of Ireland.

Ireland also has potential for gypsum, barytes, dolomite, brick shale, fireclay and dimension stone (marble, granite and limestone),

**Regulation of Ireland's Minerals Industry**

The discovery of mineral deposits and their development is not just down to the prospectivity potential of a country, although this is clearly a critical component. It is also vital that where there is potential for deposits that there is a supporting legislative framework in place to allow exploration, discovery and responsible development of deposits. This requires a transparent legislative framework which allows companies to apply for licences and ensures that their activities are carried out in an environmentally sensitive manner. The legislation must provide security of tenure in the event that a company makes

a discovery. Ireland's legislation has been operating successfully for many decades. Over the years there have been a number of refinements introduced. Currently there is a New Minerals Bill at an advanced stage of drafting which aims to modernise and consolidate the current legislation.

The Exploration and Mining Division (EMD) is a line division of the Department of Communications, Energy and Natural Resources responsible for the regulation and permitting of exploration for and extraction of minerals along with policy development in this area. In addition the Division is responsible for the promotion of Ireland as a country of destination for inward investment.

The legislation is considered to be user friendly. Administrative procedures for the application of Prospecting Licences (PL) are simple, and PLs are typically issued within four months of application. A PL gives the holder the right to explore for specific minerals and the exclusive right to seek mining facilities. A PL covers an area of approximately 35 sq. km, and is issued for six years, with renewal if required.

Mining facilities are issued either as Mining Leases for State owned minerals or Mining Licences for privately owned minerals. Royalty terms are currently set on a "case-by-case" basis. For metal mines they are based on Net Smelter Return NSR and are consistent with international standards. In addition to a mining facility an applicant is also required to obtain planning permission and an Integrated Pollution Control Licence from the relevant authorities.

Ireland has ranked highly in the Fraser Institutes Annual Survey of Mining Companies in the last number of years. For 2014, Ireland ranked first globally in the Policy Perception Index which ranks the attractiveness of Government mining policies to industry.

**Exploration Reports and Data Available Free of Charge**

Exploration companies must submit the results of all exploration work every two years to demonstrate that they are carrying out a suitably dynamic exploration programme that is satisfactory to EMD. After six years, or upon surrender of a PL, company reports and associated data are made available free of charge and online. This information includes geological mapping, geochemical surveys, airborne and ground geophysical surveys and drilling

logs. This provides a strong data/information framework for companies to assess the potential of an area and evaluate it in the light of exploration programmes already carried out. It also reduces duplication, allows reinterpretation of data and encourages new approaches. This in turn increases the probability of discoveries. This wealth of relevant information is one of the attractions of working in Ireland.

In addition to the significant dataset released by EMD the Geological Survey of Ireland also makes all of its data and information available free of charge and online.

**Other**

Ireland is politically stable with an excellent infrastructure and climatic conditions that facilitates year round exploration. In addition, because of its long history, it has internationally recognized companies with wide ranging expertise in all aspects of mineral exploration and development.

**Economic Value of the Minerals Industry to Ireland**

In 2013 the Government commissioned a report on the 'Assessment of Economic Contribution of Mineral Exploration and Mining in Ireland'. The report was carried out by Indecon International Economic Consultants and concluded that the output in mining as measured by sales revenue amounted to €426m. The Gross Value Added of the industry amounted to €274m and the economy wide expenditure was €810m. The industry employs over 3,300 people (direct, indirect and induced). One of the features of the industry is the broad regional distribution of its workforce. In addition, exploration and mining companies contributed a total €56.6M in tax and other payments to the Exchequer and to local authorities during 2012.

**Conclusion**

In conclusion Ireland has a user friendly exploration and mining legislation system in place ranking first for policy in the Fraser Institute's survey for the year 2014. Despite its small size it has diverse geology and mineral potential for a range of commodities. This along with freely available exploration data and excellent infrastructure makes Ireland an attractive country to carry out exploration and responsible development.

# The dimension stone sector: new perspectives on the global market and on the reporting of international mining standards

Marco Cosi\*

**D**imension Stone, as also described in the new draft PERC Standard, is a technical/commercial term that includes all natural stones that can be quarried in blocks of different dimensions, are processed by cutting or splitting, and that possess specific technical and aesthetic properties that drive their demand in the building and construction industries.

Dimension stones are distinct, in both mining methods and their end uses, from all other materials derived from natural rock, such as aggregates and granulates, cement materials, crushed stone, or industrial minerals. While aggregates, cement raw materials and crushed stones are almost exclusively used in load-bearing, filling and structural functions in building and construction, and industrial minerals are utilised for multiple purposes in many industries (ceramics, glass, pharmaceuticals, paper, etc.), Dimension Stone materials offer special qualitative features which mean they can perform both structural and decorative architectural functions in building and construction as well as in internal decoration and landscaping projects.

Commercially, dimension stones are generally divided into three categories for business transactions: marbles, granites and stones.

## Marbles

Marbles include all materials that can be quarried and processed using the techniques, equipment and tools that are typically utilised for marble, in the strict geological sense. This category therefore also includes several other rock types, such as limestones, serpentinites and other sub-groups like travertines and onyx, which are not geologically classed as marble. This is despite the fact that the international market currently distinguishes the term marble (crystalline marble) from materials such as limestones, as is evident from the discrepancies in their respective demands and prices.

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## Granites

This term embraces a wide range of rocks of intrusive, volcanic and metamorphic origin that can be quarried and processed

using the techniques, equipment and tools generally utilised for granite in the strict geological sense. This commercial group includes granites, granodiorites, diorites,

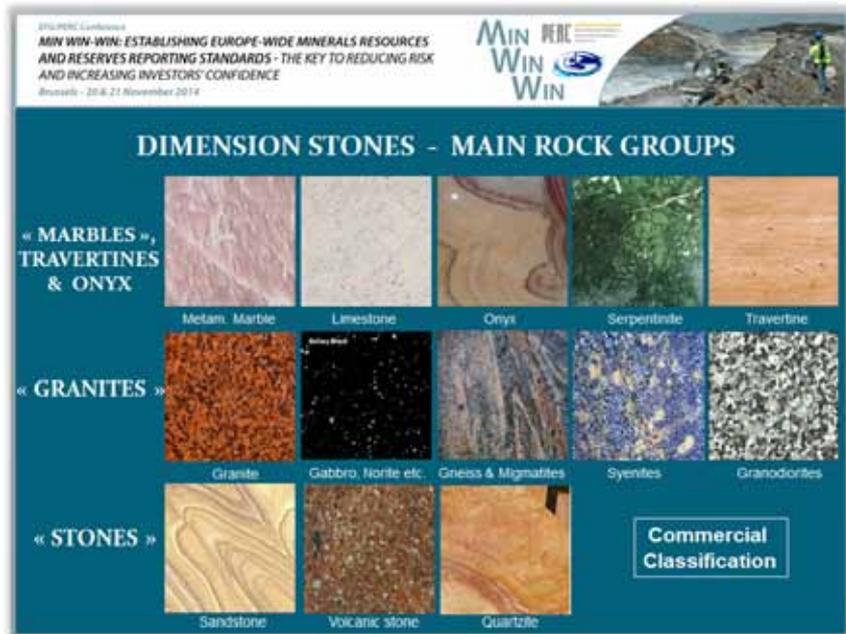


Figure 1: Dimension stones: commercial classification groups.



Figure 2: a. Typical quarrying methods for building stones - b. Building stones in small blocks - c. Building stones as final products (in this case, for cladding).



Figure 3: a. Naturally cleft stone (quartzite) slab - b. Ignimbrite cubes used for paving in the 'porfido' style - c. Quartzite paving slabs laid in style known colloquially as 'crazy paving'.

norites and gabbros (black ‘granites’), labradorites, gneisses, migmatites and syenites.

**Stones**

This term mainly refers to rocks with technical features that differentiate them in overall terms from those of the two previous groups. In general, a ‘stone’ cannot be polished; it sometimes cannot be quarried in large blocks and it may not always have exclusively decorative functions. It might also be used in functions such as urban landscaping projects (private and public), although also granites (e.g. granite cubes) can be used for that. Examples of stones include volcanic porphyry lava or ignimbrite (see Italian “porfido”), some sandstones, slates, some quartzites, some schists, tuffs, lavas, basalt and dolerite, and in general all the naturally cleft stones (as defined below).

The dimension stones (DS) belongs to a wider group of natural stone materials which includes several other groups with different features and applications. The other categories of natural stone are building stones, naturally cleft stones, ornamental and decorative stones and construction stone materials.

**Building stones**

Building stones are stone products generally sourced from raw stone materials that can be extracted in artisanal or semi-artisanal ways and utilised for building and other construction purposes (walls, housing, cladding, gardening, etc.). They can also be produced by processing the stone waste of other production lines.

**Naturally cleft stones**

Naturally cleft stones are hard and resistant stones that undergo natural splitting due to structural layering, schistosity or regular jointing (e.g. quartzite, slate, limestone) and that are typically used for paving in both exterior and interior environments (roads, squares, houses, gardens). Like building stones, these can be quarried and processed by hand and by simple mechanical equipment. The stone paving cubes produced by mechanical splitting guillotines belong to this group.

**Ornamental and decorative stones**

Any coloured or attractive stone that can be worked to produce small decorative elements for internal decoration can be classified as an ornamental or decorative Stone, for example coloured tuff, ignimbrite, sandstone and limestone. Some examples of ornamental stones can also be defined

as part of the DS production group, such as cut-to-size architectural decorative products like columns and fireplaces.

**Construction stone materials**

Construction stone materials, including the materials used for cement, are mainly made up of aggregate and sand but are important to consider as part of the overall natural stone value chain, because these materials are generally derived from processing the waste of other natural stone types, including DS.

**Valuation methodologies in the dimension stones sub-sector**

The dimension stones mining sub-sector is very particular, with its own rules, features and driving factors. Consequently,

the valuation of DS projects needs to be approached and evaluated using sector-specific methodologies and tools, different from those used in other sectors. Resource-reserve calculations of DS projects should also be made considering slightly different factors to those typically considered for general mining projects.

In general most Dimension Stone projects cannot be evaluated and valued like all other mining projects.....they are totally different. This is the reason why a specific paragraph for dimension stones is proposed in the PERC Standard, a first for an international set of standards.

In a DS mining project, the mineral ore body is not a mineral assemblage contained within the rock mass (country rock). Instead, it is the rock mass itself! To evaluate and measure this material, it is not

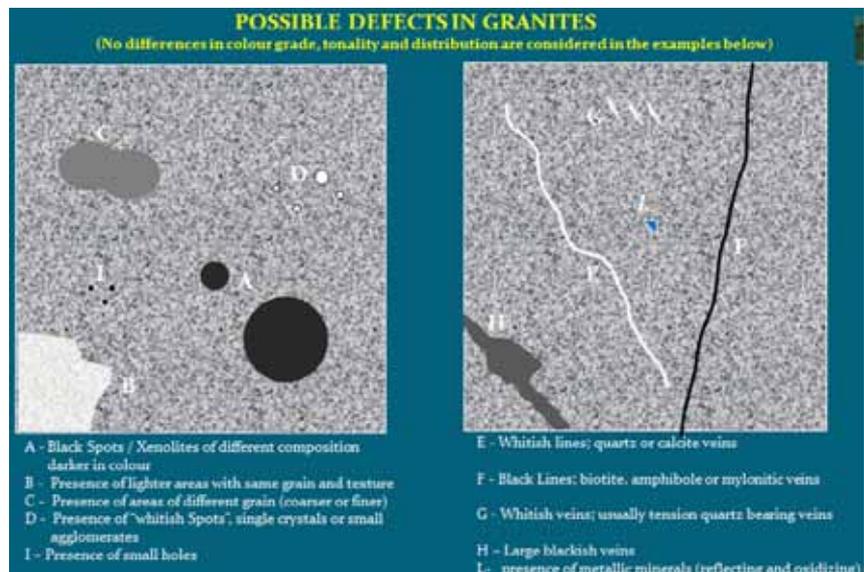


Figure 4: Most typical defects in granites.

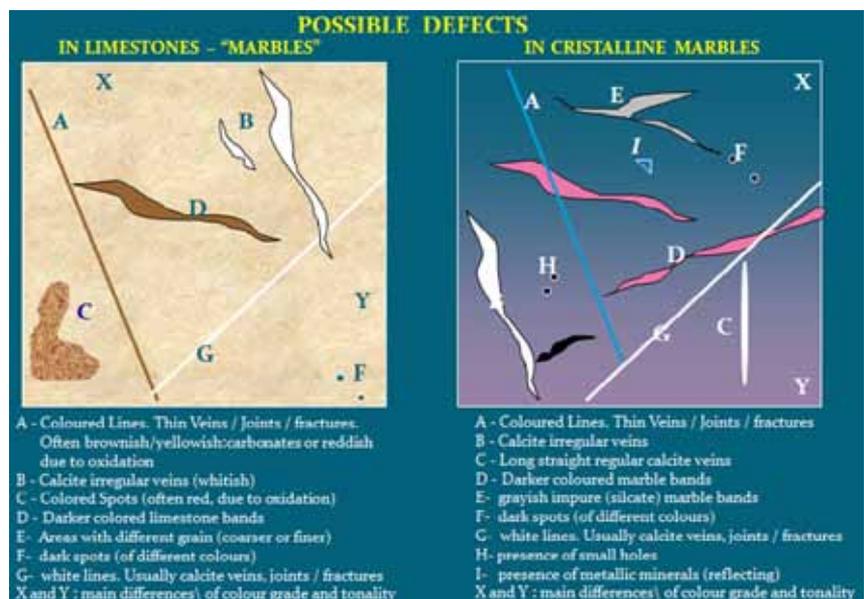


Figure 5: Main possible defects in marbles.



Figure 6: Regular large granite blocks, mined by drilling and splitting.

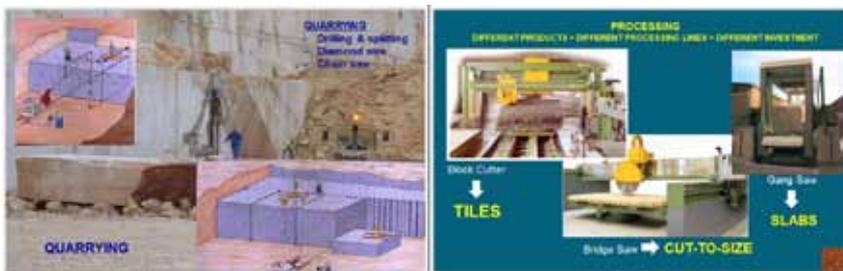


Figure 7: Methods of mining Dimension Stones.

enough to define its geometrical characteristics (the volume). It is also necessary – and in fact, more important – to consider its market quality.

In principle, any dimension stone can be sold on the market; however, only projects with competitive features will have any chance of success. The salient features of a successful dimension stone project are:

- i. the right mineral texture and colour and their regular and homogeneous distribution;
- ii. no particular defects;
- iii. correct evaluation of reserves according to the real market value;
- iv. low transport costs to both the factory and the market;
- v. correct professional market evaluation

- vi. and preliminary tests;
- vi. accurate and sector-specific market knowledge;
- vii. appropriate quarrying method and equipment, according to the target material and its geo-structural situation;
- viii. quarried blocks of large enough size with regular shape<sup>1</sup>.

In general, dimension stones can be quarried in regular and/or unshaped blocks by using different mining methods and can be

<sup>1</sup> In general, it is better to produce small regular blocks with good colour and textural characteristics than large blocks with defects and/or lower colour and texture quality.

Ore bodies of gold or any other metal, as well as of most industrial minerals, can be evaluated and described relatively easily by a series of sampled drillings or trenches, together with the chemical analyses of those samples, representative of a certain thickness. This provides a clear and comprehensive picture of the volume and grade of the ore body, as the chemical analyses can give precise information on the quality and grade of the target mineral. From this type of report, it is relatively straightforward to determine if the material is of low, medium or high quality in relation to market demand and/or to define the content of the mineral in a unit volume or length. In general, the geo-mining and market values of a DS ore body and its grade cannot be defined by laboratory tests such as the chemical tests that are performed for most other minerals. Nor can its objective market value be easily presented by numbers alone.

processed to produce either semi-finished products (slabs) or finished products (tiles and other cut-to-size products).

Producing the best possible large and regular block, in terms of shape and quality (colour, grain and texture), is the key to a successful DS mining project. This depends on:

- I. professional geological evaluation;
- II. good knowledge of the market demand;
- III. professional mining design in line with the target stone geo-structural features;
- IV. appropriate mining methods and equipment.

There are various methods of mining Dimension Stones, and the method used is determined by the geological and structural features of the ore body and by the nature of the final product being produced. Typical mining methods include:

- I. drilling and splitting (generally utilised for granites);
- II. diamond wire cutting (utilised for marbles and also in some granite quarries);
- III. chain sawing (in some limestone quarries, with well-organised bench structures).

Once extracted from the quarry, DS blocks can also be cut and processed in different ways, based on both the characteristics of the rock and the market strategy of the company, to produce various types of semi-finished and finished products. These include slabs (semi-finished), tiles (finished) or cut-to-size products like tables, table tops, stairs or columns, for example (finished).

### The global dimension stone market

The demand for dimension stones dates back several thousand years ago to many of the world's ancient civilisations and as such, DS mining is one of the oldest of man's mining activities. Today, DS mining represents a dynamic industry in many areas of the world. Following early market leadership by European countries such as Spain, Italy, Greece and Portugal, new countries such as the BRICS members and others in the Far East, like Taiwan and Indonesia, entered the game during the 1990s, opening up strong new markets in emerging global economies. China and Indonesia, in par-

particular, have evolved from being merely source countries for DS raw resources to become key DS producers and consumers themselves, with market demand increasing tremendously in recent years. In these and other Southeast Asian countries, existing DS companies are enlarging and new groups are entering the market with interest in investing in new DS mining projects both in Asia and across the world. Several of these groups have also signed agreements and formed formal partnerships to acquire DS quarries and processing facilities further afield, in Turkey, Europe (mainly Spain and Portugal, at present) and the

United States. As a result, the global DS industry has grown steadily since around 1980, at average rates of between 7 and 9 % per annum. While the sector is by no means a leading sector within the mainstream mining industry, it boasts a current annual global turnover estimated at between US\$70 and 90 billion, with more than 140 million tons of material traded. Starting in 2011, several DS companies have also begun the process of listing on various stock exchanges, mainly on the Hong Kong Stock Exchange. Although they have faced several challenges, most notably a lack of experience and knowledge of the DS indus-

try on the part of many dominant stock exchange players, five of them have completed the IPO process to date. There is also currently one DS group listed on a European exchange, specifically London's LSE.

However, despite this overall positive trend, it is important to emphasise that different DS materials have different market fundamentals. While some materials sustain steady long-term demand (e.g. black granites, white crystalline marbles, beige limestones) others fluctuate strongly, with market demand highly variable over time and for different geographical areas. This is the case for several coloured granites and other specific DS materials such as black marbles (see below some examples of market trends often utilised in DS market analyses).

Notwithstanding these possible variations in the market, this steady growth has also triggered a significant general trend in many countries towards the adoption of a more professional and technical approach to DS mining, both in the exploration phase and in the operation of DS quarries. Production technologies have developed rapidly over the past three decades, particularly in the developed world where labour costs are high, and developing countries such as Brazil, China and India have also developed their own equipment manufacturing industries in the last 15 to 20 years. This trend, among others, has allowed the start-up and development of new quarries of DS in many countries of the world, including some developing countries.

Furthermore, in traditional mining regions in the developed world, such as the European Union and the United States, this development trend has been accompanied by a period of increased attention to the environmental impacts and safety risks associated with mining, and many of these regions have experienced increased regulation during the past decade. The growth of the dimension stone industry in the Far East has also begun to follow a more mature development process, particularly in the past five years, following the economic boom in China, however the relevant environmental and social issues are not yet priorities in many of these areas. For these reasons any official evaluation report, and in particular all Competent Person Reports, must include paragraphs regarding environmental, social and safety issues. Furthermore, most of the international mining standards (see CRIRSCO standards) are now discussing the official inclusion of these issues as "modifying factors" for the reserves estimation.

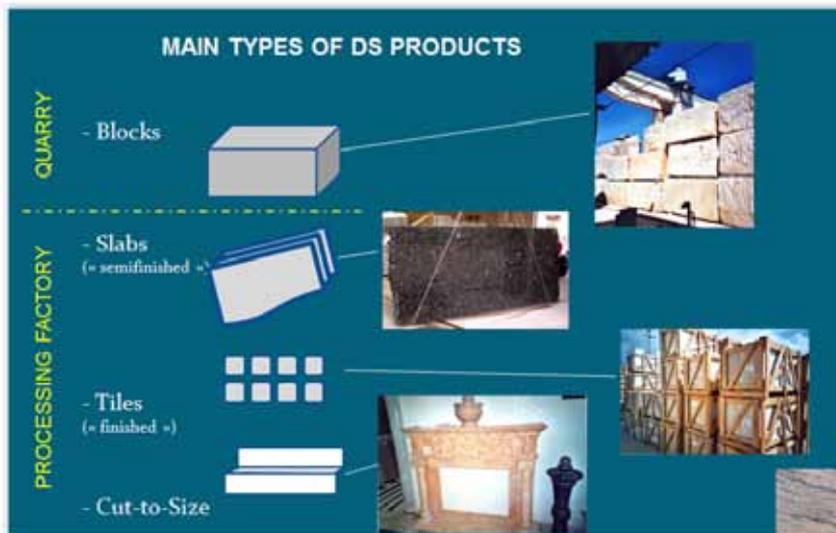


Figure 8: Dimension Stones: main products.

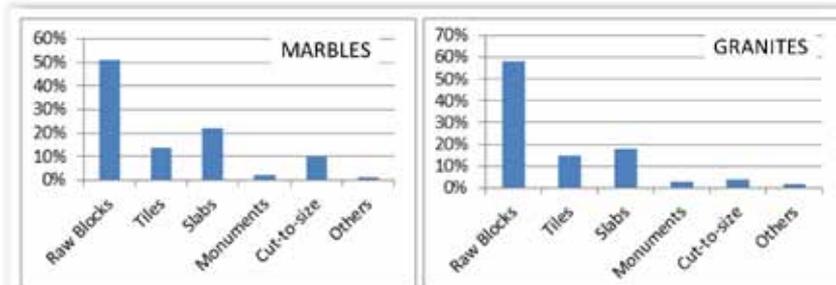


Figure 9: Global market profiles for 2012 for marbles (left) and granites (right) by different product form (source IMM Carrara-Italy).

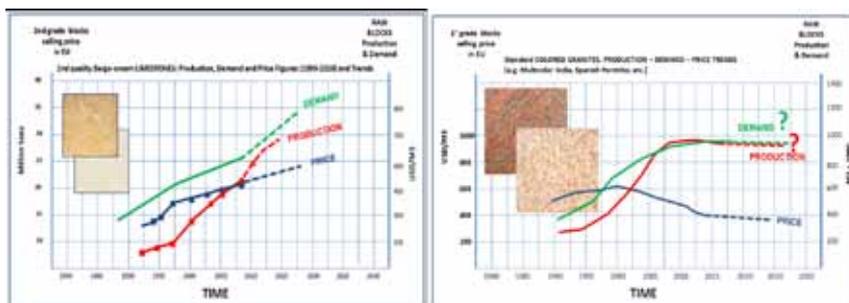


Figure 10: a. Market trends for 2<sup>nd</sup> quality beige limestones, 1980-2020 - b. Market trends for standard coloured granites, 1980-2020.

**The reporting and evaluation of dimension stone projects**

The International Valuation Mining Standards (Valmin, JORC, CIM, SME, SAMVAL, PERC) at present do not include any specific chapters and notes regarding the Dimension Stones sector and are not currently prepared for this new developing trend. Currently the best available standards for the valuation of DS projects are some of the very general notes regarding the valuation of industrial minerals and construction materials, such as those contained in JORC and PERC, both of them already including the general concept of ‘quality’.

In order to change this, PERC, first of the international bodies, launched a specific Dimension Stone Committee in 2014, coordinated by the author in collaboration with Mr. Steven Henley of the PERC Board. One of the main aims of the committee is to collect input from all European Dimension Stones experts and from other PERC members for the necessary formulation of a new modern method to evaluate DS projects and to calculate DS resources and reserves. This method will then be proposed and promoted to the international geo-mining community as a reference instrument to try to homogenise and standardise the way in which the particular and unique features of DS projects are evaluated. Innovation and standardisation are considered two of the keys to the modernisation, international growth and development of the DS sector.

Based on this input, PERC is also currently drafting a new Standard text that will include some points specifically for Dimension Stones. The new text will not include or propose any specific methodology for

DS project evaluation or the calculation of DS reserves and resources. This is left to the Competent Person (CP) responsible, based on his/her own experience. The new version should be officially available in 2015 to 2016, following approval by CRIRSCO.

Here below is described the first input of the author from his direct experience in project evaluation and in the drafting of Competent Person’s Reports (CPRs) for DS projects in China, Turkey, Indonesia and India, several of which will be entering the initial public offering phase in 2015.

Firstly, a DS project should preferably be evaluated by a DS CP, with sufficient knowledge and experience in the geology and mining of DS materials and in the relevant market areas. It is crucial in fact, for a DS CP to be fully up to date with current market rules and trends, in addition to his/her knowledge of the technical features of the project in question. Without this knowledge it is impossible to correctly evaluate the potential quality of the target material and consequently its likely value in different markets. In fact the quality, as mentioned above, represents the most important factor in dimension stone project evaluation and resources-reserves estimation, which as a modifying factor can be in principle compared with the “grade” of other mining ores. Detailed market and price benchmark analyses should therefore always be included in evaluation CPRs in order to estimate the quality of the identified resources, so that the final economic reserves can be accurately calculated (see the section on proposed modifying factors below).

Secondly, it is now widely understood in the global mining industry that the economic, social and environmental aspects

of the production of metals and minerals are irrevocably linked to one another. The products of mining need to be sustainable. What is a sustainable product? This is an economically profitable product that has been produced under ecologically and socially justifiable circumstances whereby the potential for affected people to provide for themselves is not compromised, in either the present or in future generations (UN definition). The DS sector needs to become more closely aligned with these principles. A DS CPR therefore should include all available information on the safety, environmental and social aspects of the project, with comments and evaluation on the project’s sustainability from these and any other relevant non-financial perspectives.

**Proposed modifying factors for the current evaluation of DS reserves**

This section focusses on known and new proposed modifying factors to the current methods used to transform DS resources into reserves. For the sake of clarity, the resource evaluation and calculation phase is also mentioned briefly.

**Phase 1: The calculation of resources (inferred, indicated and measured)**

Resources are calculated using various data and field evaluation techniques, such as core drillings, trenches and pits and regular sampling. In particular cases, for example well-exposed steep cliffs or steep rocky pyramidal-shaped hills, a professional geo-structural and sampling section carried out along a clean outcropping rock slope could substitute for a core drill.

**Phase 2: The calculation of reserves.**

Taking into consideration the PERC/JORC correlation scheme for the transformation of resources into reserves (see figure below), the following modifying factors scheme for DS reserves calculations are proposed, keeping in mind that these are suggested for use in combination with the traditional standard factors considered in reserve calculations.

The modifying factors suggested are based on the concept of market quality, which is new and unique for DS projects, as for some construction materials and industrial minerals. Market quality considers the effective volume of resources that could be realistically sold on the present market, depending on real market demand.

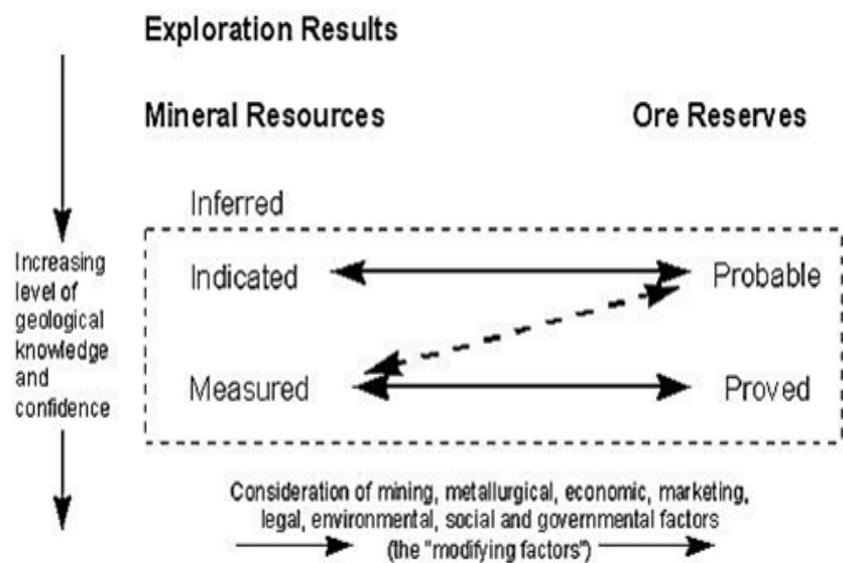


Figure 11: Correlation between mineral resources and reserves (source: PERC and JORC Standards).



Figure 12: Example of defect in "Thaila Black" black granite currently quarried in Mauritania.

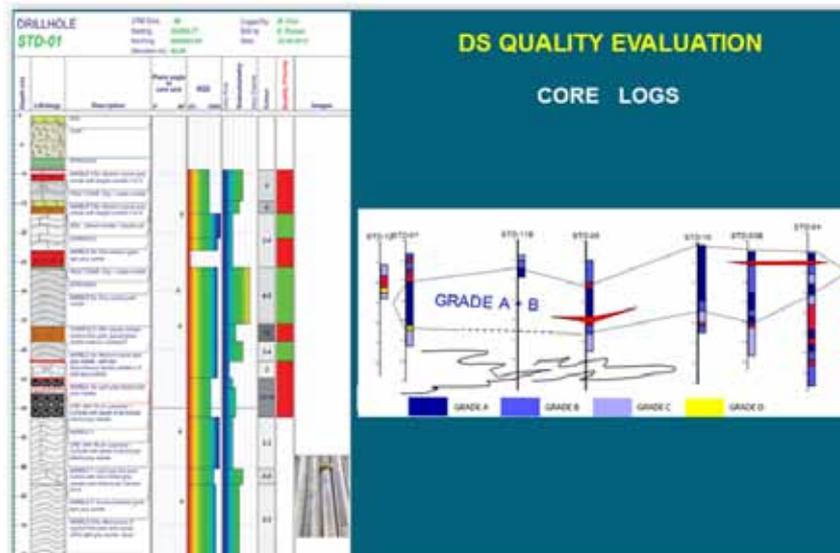


Figure 13: Examples of graphic representation of quality grades in core logs and sections.

The concept is necessary in order to quantify the estimated percentage of volumetric reserves of target rock that can realistically be considered as marketable reserves, and as such, to assign a more accurate real market value to a DS project. Market quality can be calculated as a single 'Market Quality Factor' (MQF). For DS projects, the MQF can generally be compared with the ore body grade reported for most other mineral ore bodies, which is usually estimated using a combination of unit volume chemical analyses and calculated volumes. However, the component factors that combine to determine the MQF of a DS project are not easy to evaluate and calculate and are often not precise. What is clear is that it cannot be

evaluated by chemical or any other laboratory analyses!

The MQF has to be evaluated, together with other geological and structural modifying parameters, from drill cores, direct analysis and/or from other rock sampling data. It should also be justified by comparison with similar materials already priced and sold on the market, as well as by the specialist expertise of the DS CP. Each evaluation of the MQF of a DS project should therefore contain an in-depth detailed professional benchmark analysis of similar materials.

There are five main parameters that define the MQF and the value of a dimension stone:

- Colour;
- Texture;
- Grain;
- Presence of defects (each material has its own set of particular possible defects);
- Volume distribution of the four parameters above.

The quality of stones, formed by a mix of these parameters, directly influences the demand and the selling prices (see the example for black "granites" in figure 12).

Quality can be estimated by the analysis and evaluation of the target rock mass from samples, trenches, quarry faces and obviously drill cores. Then core logs should include columns regarding this key parameter and justification for the quality categorisation. In particular each quality "family" should be described for each project. The graphic representation of quality grade will also allow the drafting of indicative quality sections and 3D block models (see figures 13 and 14).

Other modifying factors, in addition to the quality factor, are proposed for inclusion in the estimation of mining reserves:

- Joint-fissures opening factor (JOF): Percentage of absent target rock due to voids produced by the opening of joints, fissures, holes and caves. This is usually described for limestones and marbles not directly produced by karstic phenomena.
- Karstic factor (KF): Percentage of voids due to karstic phenomena (determined by core logging and from field analysis)
- Weathering Factor (WF): Percentage of weathered rock that cannot be mined (determined by field analysis and core logging). In some particular cases (e.g. some yellow granites) the superficial weathered rocks, often of yellow colour, represent saleable target rocks for some markets. Even if weathered, reserves can still be calculated in this particular environment, due to the new resin and back netting techniques, although only when the WF is very low.
- Mining Factor (MF): Portion of target resources that cannot be included as reserves due to the mining plan/design (e.g. final bench quarry shape, reserves that cannot be economically mined, etc.)

- Mining Lease Life Factor (MLF). This varies from case to case and from country to country.
- Joint Factor (JF): Determined by a comprehensive joint structural analysis and the related evaluation of various geo-mechanical parameters (e.g. VP, JV index, etc.). A correct analysis and evaluation of the JF is necessary for accurate estimates of the minimum, average and maximum values of the volume of unfractured rock mass, and therefore to predict the percentage of solid unfractured blocks that can be mined from the analysed rock mass. The JF is exclusively and directly linked to the recovery rate of the final blocks (the percentage of massive marketable blocks exploited). The recovery rate may vary in relation to the final target product (type, shape and size of block) and may also depend on the company's market strategy.

It is important to bear in mind that some modern sophisticated technologies exist to analyse and measure joints and other planar anisotropies (bedding, schistosity, etc.) directly from the quarry face and outcrops, and these are becoming more widely utilised in quarry dimension stone project analysis (e.g. drone aerial photogrammetry analysis and laser scanning).

**Laboratory tests for the classification of dimension stones**

With regard to the use of laboratory tests for the classification of DS materials, there are only a few tests that are generally requested. These are mainly physical-mechanical tests (compressive strength, flexural strength, porosity and water absorption, abrasion and friction resistance, bulk density), as well as a gloss test to evaluate the polishing attitude of the stone and finally a radioactivity test (only required for certain markets, such as China for instance).

A second phase of further physical-mechanical as well as chemical-mineralogical analysis can also help to define other characteristics of the identified stone, concerning its processing and attitude (cutting

and polishing, for example, such as the gloss test mentioned above) as well as the potential for weathering and alteration after its installation as a finished product.

Although the text is not exhaustive and complete, the author hopes that this first general paper on dimension stones can open a fruitful discussion among mining consultants in order to finally find a professional modern method to evaluate DS projects and their resources and reserves. Moreover, investors and financial key deci-

sion makers, usually not yet skilled in this particular unique mining industry, should also begin an interaction with the DS industry for better final decision making.

With this aim and hope in mind, the author intends to participate to international conferences and workshops and to write more detailed papers on this issue, focussed on specific aspects, with the main scope being to stimulate productive discussion. Input from colleagues operating in the specific sector and with experience in project evaluation is welcome.

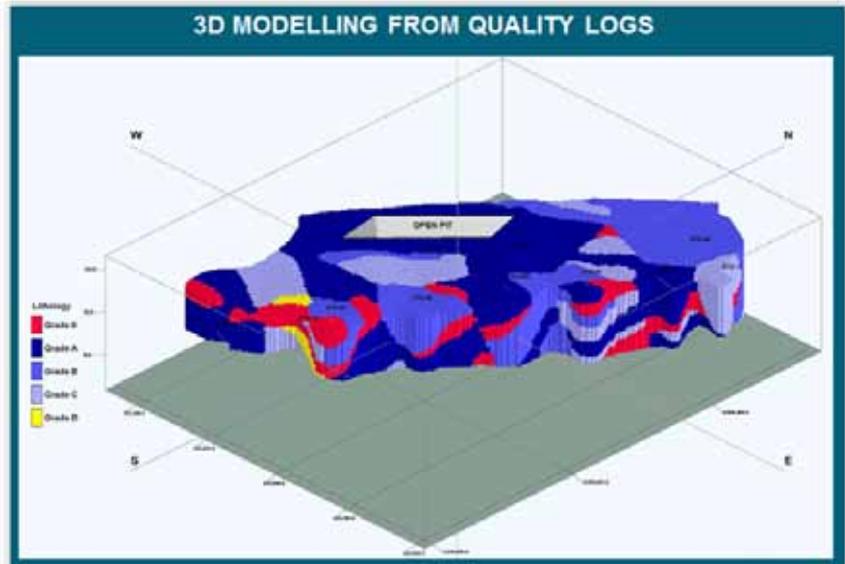


Figure 14: Example of quality 3D block diagram.

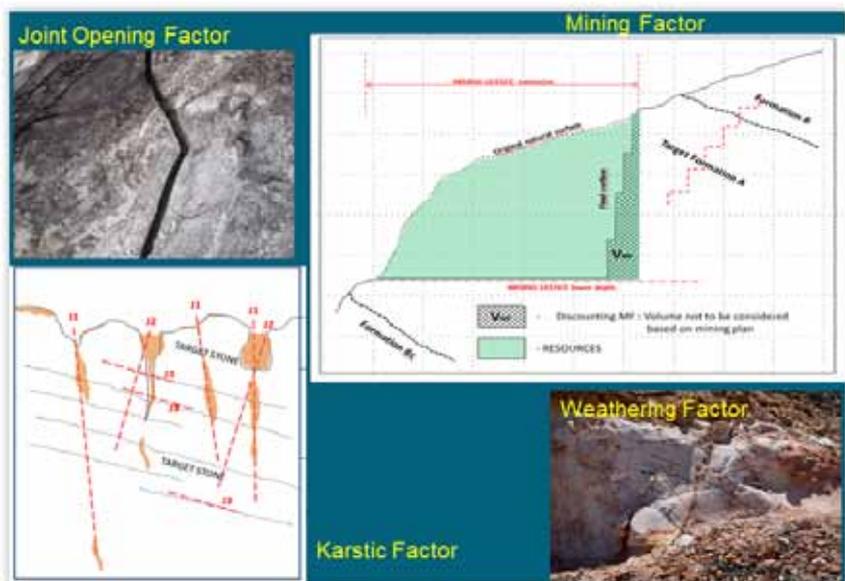


Figure 15: Other modifying factors to be utilised also for dimension stones.

# Geological Surveys' contribution to the EU minerals knowledge database

Manuel Regueiro y González-Barros\*

*EuroGeoSurveys (EGS), a not-for-profit organisation based in Brussels, represents 37 national geological surveys and some regional surveys in Europe, and an overall workforce of several thousand experts. The EGS mission is "to provide public Earth science knowledge to support the EU's competitiveness, social well-being, environmental management and international commitments". EGS has several expert groups in its different fields of competences, including a Mineral Resources Experts Group (MREG).*

*This paper will review the incredible number of mineral-related projects and networks in which the EGS and its members have been involved in the past few years. The role of EGS in integration of data from EU-financed geoscientific information projects is discussed, as well as MREG's role in networking and exploiting project results varying from data provision to applied research performance and technology development (e.g. exploration, waste re-use, mineral processing).*

*EuroGeoSurveys (EGS), une organisation à but non lucratif, basée à Bruxelles, représente 37 Bureaux géologiques nationaux plus quelques Bureaux régionaux, européens, et globalement, un panel de plusieurs milliers d'experts. La mission de l'EGS est de "délivrer une connaissance publique en Géosciences pour appuyer la compétitivité européenne, le bien-être social, la gestion de l'Environnement et les obligations internationales". L'EGS dispose de plusieurs groupes d'experts dans ses différents champs de compétences, comprenant un Groupe d'Experts en Ressources Minérales (GERM).*

*Cet article passe en revue le nombre incroyable de projets et réseaux du secteur minier dans lesquels l'EGS et ses membres ont été impliqués, ces dernières années. Le rôle de l'EGS dans l'intégration de données tirées de projets avec financement européen et consacrés à l'information en Géosciences, est analysé ainsi que le rôle du GERM dans les résultats de projets en réseau et d'exploitation, variant depuis la simple tenue de données jusqu'au développement de la performance et de la technologie, en recherche appliquée (c'est-à-dire, concernant l'exploration, le recyclage des déchets et le traitement des minéraux).*

*EuroGeoSurveys (EGS) es una organización sin fines de lucro con sede en Bruselas, que representa 37 servicios geológicos nacionales y algunos servicios regionales en Europa, y una fuente de trabajo para varios miles de expertos. La misión EGS es "proveer conocimientos públicos de las ciencias de la Tierra para apoyar la competitividad de la UE, el bienestar social, la gestión ambiental y los compromisos internacionales". EGS tiene varios grupos de expertos en sus diferentes esferas de competencia, entre ellos un grupo de expertos de Recursos Minerales (MREG).*

*En este artículo se revisará el increíble número de proyectos y redes relacionados con minerales en las que EGS y sus miembros han participado en los últimos años. Se discute el papel de EGS en la integración de los datos provenientes de los proyectos de información geocientífica financiados por la UE, así como el papel de MREG en la creación de redes y la explotación de los resultados de los proyectos, que va desde la toma de datos hasta el rendimiento de la investigación aplicada y el desarrollo tecnológico (por ejemplo la exploración, la reutilización de los residuos, procesamiento de minerales).*

## 1. EuroGeoSurveys

**E**uroGeoSurveys (EGS), The Geological Surveys of Europe, is a not-for-profit organisation representing 37 national geological surveys and some regional surveys in Europe, with an overall workforce of several thousand experts.

The national geological surveys are the agencies legally mandated for monitoring and assessing the subsurface and its resources, including carrying out related research, often with exclusive responsibility for the domains of geohazards, natural resources (soils, groundwater and miner-

als), geoinformation (mapping and modelling), and with partial responsibility for several others, most often with an environmental protection focus. These organisations have a long tradition – in many cases more than 100 years – in collecting data, preparing information and conducting research focused on their national subsurface.

EGS provides the European institutions with expert, neutral, balanced and practical pan-European advice and information as an aid to problem-solving, policy, regulatory and program formulation in areas such as:

- The use and the management of on- and off-shore natural resources related to the subsurface of the Earth, (energy, including the renewable resource of geothermal energy; minerals and water, soils, underground space and land)

- The identification of natural hazards of geological origin, their monitoring and the mitigation of their impacts (deficit or excess of trace elements in soils and waters, earthquakes, natural emissions of hazardous gases, landslides and rock falls, land heave and subsidence, shrinking and swelling clays)
- Environmental management, waste management and disposal; land-use planning
- Sustainable urban development and safe construction
- e-government and the access to geoscientific metadata and data
- The development of interoperable and harmonised geoscientific data at the European scale.

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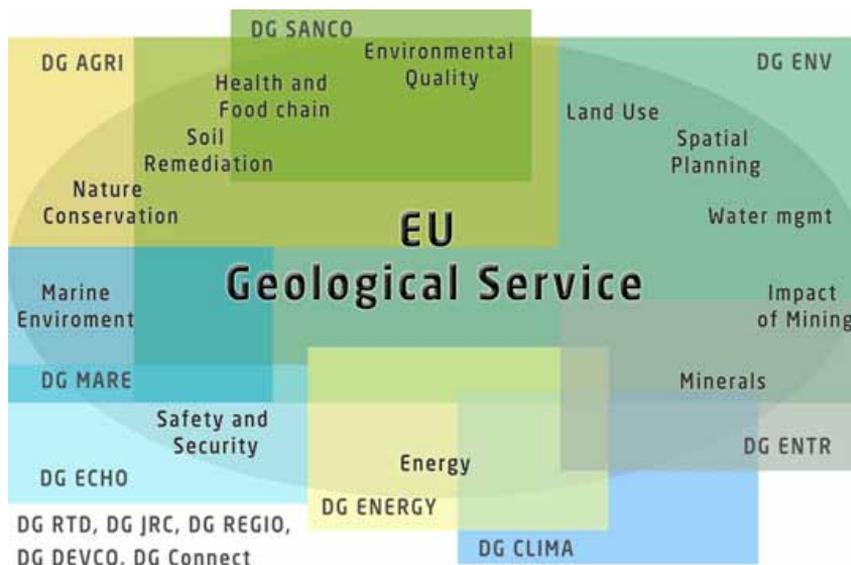


Figure 1: Model for a future **Geological Service of Europe** and its competences and potential relation with all of the Directorates General (DG) of the Commission.

The main mission of EGS is to provide public Earth science knowledge to support the EU's competitiveness, social well-being, environmental management and international commitments. EGS pursues activities that lie exclusively in the public interest or in the interest of public administration that will benefit from the combined and coordinated expertise of our members and in the direct interest of the European Union and/or of the European Free Trade Association. The portal of EGS ([www.eurogeosurveys.org](http://www.eurogeosurveys.org)) provides access to geoscientific metadata, information and knowledge at European and national scales, following the links in the thematic pages. It also presents information on the activities of EGS and the Member Organisations.

EGS promotes the contribution of geosciences to European Union affairs and action programs, and provides a permanent network between the Geological Surveys of Europe and a common, but not unique, gateway to each of the Members and their national networks. We jointly address European issues of common interest in the field of geosciences, with the aim to publish, or see our Members publishing, technical advice for the European Union institutions. The 2020 vision of EGS is to establish a common European Geological Knowledge Base and to jointly provide a Geological Service for Europe (Figure 1).

- This vision is based on three main pillars:
1. A joint research program with a focus on EU policy
  2. Harmonising, sharing and providing pan-European geological data
  3. Sharing knowledge, capacities and infrastructure

EGS strategic vision and its action plan explaining how EGS aims to fill critical gaps and guarantee Europe access to objective and seamless data and knowledge on geology and wider geosciences can be downloaded from <http://www.eurogeosurveys.org/wp-content/uploads/2014/08/EGS-Strategy-Document-2014-A4.pdf>.

The EGS technical body comprises a number of expert groups integrated by leading national specialists in the various fields of expertise. Currently EGS has the following expert groups and task forces:

- Marine Geology
- Earth Observation – GeoHazards
- Geochemistry
- GeoEnergy
- Water Resources
- Mineral Resources
- Spatial Information (INSPIRE)
- Soil Resources – Superficial deposits
- International Cooperation and Development Task Force

## 2. Mineral Resources Expert Group

The mission of the EuroGeoSurveys Mineral Resources Expert Group (EGS MREG) is to provide the best available mineral expertise and information based on the knowledge base of member geological surveys, for policy, communication and education purposes at the European level, focusing on strengthening the position of the European minerals industry towards resource sustainability and competitive growth. The EGS MREG aims to have a leading role within a European mineral knowledge base and information network,

or other forms of cooperation that will provide innovative tools and expertise to support a sustainable mineral supply for Europe.

All main areas of activity stay well within the scope lines of the EGS MREG, addressing and considering:

- EU agenda priorities (RMI, EIP, ETP SMR, KICs...1)
- Work related focus
  - Mineral Intelligence Network for Europe Mineral4EU proposal submission and selection for funding
  - Promotion and coordination of EU projects and calls related to minerals among all members of EGS
  - Member of Advisory Boards – AEGOS, EuroGeoSource, EURARE
- EGS strategy issues, e.g. ART 185/ ERA-NET+ ,EGDI
- International co-operation and representation, e.g. EU-Greenland days, EU-USA, EU-Africa, EU-Russia, etc.

## 3. Mineral related projects & networks

There is a long tradition of EGS and/or its members participating in EU-financed projects in the field of mineral resources. A brief account follows of some of them, both finalised and ongoing.

### 3.1. Finalised projects

#### AEGOS. African-European Georesources Observation System

(<http://www.aegos-project.org/index.php>)

The AEGOS project aimed at setting up the preparatory phase for the building of an information system containing and making accessible data and knowledge on African geological resources, including mineral resources, raw material, groundwater and energy (georesources). This information was/has been collected through numerous initiatives by African countries, regional, international and European organisations collectively, and is a unique archive of Africa-related geoscientific observation data which primarily need to be shared with African partners. Developing capacity building activities in the domain of Earth observation in developing countries is a priority.

AEGOS is a Support Action of the European Union 7<sup>th</sup> Framework Programme. It

1 RMI: Raw Materials Initiative; EIP: European Innovation Partnership; ETP SMR: European Technology Platform on Sustainable Mineral Resources; KICs: Knowledge Innovation Communities.

is actually the preparatory phase of a pan-African observation system including the information and knowledge so far collected and future acquisitions regarding georesources in Africa. The information system will be based on a distributed architecture with local and Internet access. The management of the intellectual propriety rights on the data sets will be addressed.

The main objectives of the AEGOS project were the definition of:

- operational procedures for data management (spatial data infrastructure, metadata and data);
- user-oriented products and services including the preparation of innovative spin-off projects;
- the African-European partners network: strengthening and development;
- a geoscience contribution to GEOSS, in the context of the Infrastructure for Spatial Information in Europe (INSPIRE).

*Project duration: December 2008 - May 2011. Budget 2.4M€.*

**SARMa. Sustainable Aggregate Resource Management**  
(<http://www.sarmaproject.eu/index.php?id=1554>)

Aggregates (crushed stone, sand and gravel) are crucial for infrastructure and construction. South East Europe countries are rich in aggregates, but supply is not coordinated within or across the area. The main objective of the project is to develop a common approach to (a) sustainable aggregate resource management (SARM) and (b) sustainable supply mix (SSM) planning, at three scales: regional, national and transnational. The project will build the foundation for a Regional Centre on sustainable aggregates management and supply.

The main results of the SARMa project were:

1. To raise the awareness of stakeholders through relevant activities. These included:
  - the organisation of 13 regional and national capacity-building workshops for stakeholders in all participating countries
  - the organisation of 6 transnational capacity-building events for stakeholders
2. To develop a number of manuals and guidelines for relevant stakeholders such as (a) industry; (b) local, regional and national authorities, EU level; and (c) local communities. These included:
  - a manual for stakeholders' decision making at local level: how to achieve

aggregate resource efficiency in local communities: environmental footprints, recycling and illegal quarrying;

- an action plan for the social license to quarry;
  - guidelines for using Life Cycle Assessment methodology within the SARMa Project – definition of a methodology for the Life Cycle Assessment (LCA) of natural and recycled aggregates;
  - a manual on construction and demolition waste management;
  - a manual on sustainable aggregates resource management (SARM) and sustainable supply mix (SSM) at regional, national and transnational levels;
3. To set the ground for a regional centre for sustainable aggregates supply. This included:
- a feasibility study for a Regional Centre on SARM and SSM;
  - a joint action plan for the establishment of the Regional Centre on SARM and SSM.

*The project had a budget of 1.92M€, 23 partners and a duration of 30 months, from 2009 to 2011.*

**ProMine. Nano-particle products from new mineral resources in Europe**  
(<http://promine.gtk.fi/>)

The non-energy extractive industry (NEEI) is a significant contributor to the economy of the EU, providing metallic and non-metallic mineral resources to society as well as direct and indirect employment. The philosophy behind ProMine is to stimulate the extractive industry to deliver new products to the manufacturing industry. ProMine will start a process of renewal whose momentum will carry over into the coming decades.

The main objectives that the project achieved were:

- To develop the first pan-European GIS-based database containing the known and predicted metallic and non-metallic resources, which together define the strategic reserves (including secondary resources) of the EU;
- To calculate the volumes of potentially strategic metals (e.g. cobalt, niobium, vanadium, antimony, platinum group elements and REE) and minerals that are currently not extracted in Europe;
- To develop five new, high value, mineral-based (nano) products;
- To enlarge the number of profitable potential targets in Europe;
- To establish a new, cross-platform

information group between the European Technology Platform on Sustainable Mineral Resources (ETP SMR) and other platforms.

*ProMine had a budget of 17M€ (11M€ EU contribution) and 27 partners from 11 countries.*

**EuroGeoSource**  
(<http://www.eurogeosource.eu/home>)

EuroGeoSource is a data portal which allows access by Internet to the aggregated geographical information on geo-energy (oil, gas, coal etc.) and mineral resources (metallic and non-metallic minerals, industrial minerals and construction materials: gravel, sand, ornamental stone, etc.), coming from a wide range of sources in a significant coverage area of Europe (ten countries). The project is co-funded by the Competitiveness and Innovation Framework Programme (CIP) under the Policy Support Programme (PSP), Geographic Information Theme.

The aim of the project is to provide information on oil and gas fields, including prospects and mineral deposits, in order to stimulate investment in new prospects for geo-energy resources, as well as in renewing production at mines undergoing economic decline or closure, contributing in this way to reducing the dependence of the EU on imports of valuable minerals from outside resources.

By developing web services for sharing spatial data between public organisations and authorities (including EC and EU research and policy making institutions), as well as commercial stakeholders, the project will enable the creation of value-added services (such as demand-supply modeling) for the sustainable geo-energy and mineral supply of Europe. The portal welcomes all other national/local data providers who wish to join in these initiatives by either using the web services to deliver their data on the Internet (according to their licensing conditions), or by incorporating these services into their own applications.

The EuroGeoSource outputs are intended for the use of the European Commission and its institutions, EU and national geo-energy and mining authorities, oil, gas and mining companies, investment companies, geological surveys, research institutes, universities and the general public. The practical implementation of the spatial infrastructure for oil and gas and mineral deposit data sets will also contribute to themes 20 and 21 of Annex III of the INSPIRE Directive.

The EuroGeoSource system has implemented content-specific and user-oriented GIS map services on the Internet, based on an inventory and analysis of geo-energy and

mineral resource data sets existent in the project countries, together with the user needs regarding these data.

The following elements characterise the EuroGeoSource portal:

- Multilingual interface of the map viewer (English plus the languages of the project countries);
- Possibility of displaying the data on various backgrounds, using the already implemented map services developed in previous eContent Plus Program projects (eEarth, eWater, Geomind, EuroGeoNames, OneGeologyEurope);
- Harmonisation of geo-energy and mineral resource data coming from various countries based on key economic and geological parameters;
- Multilingual legend of the data sets using geological dictionaries built especially for the project.

The portal is based on open-source software and standards and includes also an ISO-compliant metadata catalogue. Thus, other organisations can use it for the registration and publication of their data sets, or for deploying it in their own web server applications.

*EuroGeosource had a budget of 2.6M€ and was executed by a consortium of 11 geological surveys, 1 university and 2 private companies from April 2010 to April 2013.*

#### **MIN-NOVATION. Mining and Mineral Processing Waste Management Innovation Network**

(<http://www.min-novation.eu/>)

From 2011 to 2013, a network of scientific and regional expertise brought together in the Min-Novation project has put the topic of mining waste and what to do about it, in the spotlight. Min-Novation has created a transnational network with regional networks as building blocks of effective multi-lateral cooperation. The activities carried out on the regional and transnational level have served to secure better access to knowledge, state-of-the-art technologies and good practice to SMEs active in the mineral waste management & prevention sector. The project has addressed all the waste management challenges and opportunities faced by the mining industry of the Baltic Sea Region (BSR), which should be understood as extending to all forms of extraction of natural non-renewable resources. The partnership consists of 11 core partners, who represent five EU-27 countries (Poland, Denmark, Finland, Estonia and Sweden) and Norway, and who include both local/regional authorities and innovation sources. The project activities

have been facilitated by the participation commitment of an additional 16 associated organisations representing mining industry stakeholder associations and/or national government bodies. The budget of this project was 3.5M€.

The main transnational outputs by work package were:

- WP3. Baltic Mining Waste Management Business Database, a series of reports on the status of mine waste management in the Baltic Sea region;
- WP4. Compendium & State-of-the-Art of mining waste management technologies, Baltic guidelines and Declaration on Waste Management & Prevention;
- WP5. 4 Pilot installations with follow-up activities:
  1. Estonia – Oil Shale Waste-to-Product Mobile Unit
  2. Finland – Mining Waste and Process Side Stream Assessment Lab
  3. Poland – Coal-Derived Aggregate Production Line
  4. Sweden – Mobile Metal Recovery Installation

The main results, thus, have been a sustainable multi-sector network for supporting transfer of knowledge and innovation in the BSR to SMEs, as well as sustainable regional networks carrying out activities meant to strengthen the SME sector in given countries of the BSR and influence policy related to mining and mineral processing waste management. The project has produced also a common BSR-wide approach to selected mining sector growth issues and effective action by the MIN-NOVATION transnational network on knowledge transfer issues found in EU-level policies on waste management/prevention and mining. MIN-NOVATION is the response to a clear need to tackle waste management/prevention issues for the entire life cycle of the mine and from a legal, financial and economic perspective, which requires multi-sector involvement. The relevance of addressing this topic is obvious if one notes that 29% of the total waste generated in the EU each year is from some type of mining activity.

#### **EO-MINERS. Earth Observation for Monitoring and Observing Environmental and Societal Impacts of Mineral Resources Exploration and Exploitation**

(<http://www.eo-miners.eu/>)

The project was designed to identify policies that address the environmental social and societal footprint of mineral industries

of industry, civil society and government. Based on results, the project will initiate and develop a sound “trialogue” between the three main groups involved based on reliable and objective information about ecosystems, populations and societies affected by mining activities. This “trialogue” will assist towards the reconciliation of interests in order to reach common agreement upon actions to deal with environmental and societal impacts of mining activities. The aim of EO-MINERS was to bring into play Earth Observation (EO)-based methods and tools to facilitate and improve interaction between the mineral extractive industry and society in view of its sustainable development while improving its societal acceptability.

#### **Strategic objectives**

Mining companies, regulatory bodies and stakeholders need various EO-based tools and methods adequately juxtaposed regarding the local contexts and applications (in compliance with Group on Earth Observation and Global Monitoring for Environment and Security objectives and tasks).

Forecasting impacts and footprints and relevant remediation measures require developing prospective tools. GIS using EO data will enable visualisation of prospective evolution over time (flow modelling), playing on one or several GIS-layer parameters. For instance, population migration flow is often taken into account during the pre-feasibility phase, but not properly monitored further. Cumulative impacts must be adequately addressed at the regional scale (valley, district...), including induced impacts (population migration, livestock impact...) with respect to the concept of a heavily exploited area. As the EU is strongly interested in the establishment of measures for raw material flow analysis, especially for imported mineral resources, this project will contribute to the development of measures that can be used to analyse the mining operations taking the individual potential ecological and societal footprint into account.

#### **Scientific and technical objectives**

The social acceptability of a mining project, from exploration to closure, is among the major key issues to be dealt with. EO-MINERS scientific and technical objectives were to:

- Assess policy requirements at macro (public) and micro (mining companies) levels and define environmental, socio-economic, societal and sustainable development criteria and indi-

cators to be possibly dealt with using Earth and diagrammatic satellites Earth Observation (EO);

- Use existing EO knowledge and carry out new developments on demonstration sites to demonstrate the capabilities of integrated EO-based methods and tools in monitoring, managing and contributing reducing the environmental and societal footprints of the extractive industry during all phases of a mining project;
- Contribute to making available reliable and objective information about affected ecosystems, populations and societies, to serve as a basis for a sound “dialogue” between industrialists, governmental organisations and stakeholders.

### Results

- EO MINERS identified policies that address the environmental and social footprint of mineral industries or corporations, public authorities and civil society. Based on this policy analysis, expertise of the project consortium members, and targeted interaction in the form of interviews with stakeholders, specific information needs were derived that represent the basis for the development of indicators of the footprint of mining activities. The project has led to the identification of 11 categories of EO indicators to measure the footprints of mining operations. These indicators were then applied in 3 different sites:
- The Sokolov lignite open pit in western Bohemia, Czech Republic
- The Mpumalanga coal field, the largest coal field in South Africa, near the town of eMalahleni
- The Makmal gold mine and processing plant in Kyrgyzstan, near the town of Kazarman

The obtained EO datasets (from space, aircraft and in-situ) acquired and processed during previous stages were integrated into one (or several) products to meet the environmental indicators identified and the environment concerns documented in the Conceptual Site Models.

### Minventory. Statistical Information on EU Raw Materials Deposits (<http://www.minventory.eu/>)

The European Commission commissioned this work to analyse the availability

of public geological data (land and marine), and household, commercial and industrial waste data, related to resources and reserves of mineral raw materials. Many different organisations have amassed and even published aspects of such data. However, it is often presented in different formats using varying terminologies. An important aspect has therefore been the proposals for harmonising these protocols to ensure congruency in the presentation and use of statistical geological data.

As such, it had three main objectives:

- To create a comprehensive directory of where information regarding key resources, public and private, in various formats and for diverse uses may be located within the EU28 countries;
- To build a web-site so that users may access this listing and find resource data more quickly;
- To develop an action plan for harmonisation of European mineral resources data where this is useful and feasible up to 2020.

The outputs of this project take the form of:

- A description of the current situation at national and, where relevant, regional level, with respect to statistical information on resources and reserves in Europe, including an assessment of the level of application of a system of reporting resource and reserve data.
- Analysis of barriers to harmonising data and interoperability development, and remedial action required including:
  - A combined timeline (“roadmap”) and outline plan for implementation including: a statement of target outcomes on the road to harmonisation; options for action; and target dates for achievement by 2020 or beyond.
  - An action plan to incorporate a section on harmonised resources and reserves statistics into a future European minerals yearbook.
- A Commission portal that summarises metadata available on primary raw material resources and reserves (by mineral, country and land/marine domain), on secondary raw materials (mining wastes, landfill inventories and waste flows), and where such data might be found.

The portal (<http://www.minventory.eu/portal.html>) provides a directory of key

mineral and resource data in the EU. Whilst it does not hold or access the data itself, it is structured around the resource metadata – the data that describes the data held by owners. This metadata comprises:

- Resource type
- Mineral
- Geo-located data
- Owner
- Data location
- Format
- Accessibility
- Standard and more.

The portal permits filtering and sorting based on these criteria.

This project was executed by a consortium comprising primarily Oakdene Hollins Ltd, British Geological Survey (BGS), and Bureau de Recherches Géologiques et Minières (BRGM), and which also included other partners: Bundesanstalt für Geowissenschaften und Rohstoffe (BGR), Český Geologický Ústav (CGU), Hrvatski Geološki Institut (HGI), Geološki zavod Slovenije (GeoZS), Greek Institute of Geology and Mineral Exploration (IGME), Institutul Geologic al României (IGR), Państwowy Instytut Geologiczny (PIB) and SNL Metals & Mining.

*The budget of this project was 0.7M€.*

### 3.2. ONGOING PROJECTS:

#### POLINARES. EU Policy on Natural Resources

(<http://www.polinares.eu/>)

The POLINARES project will examine how tension and conflict may undermine future global peace and economic development, and explore new modes of behaviour which promote an appropriate balance between competition and collaboration. The project sets out to take a global view of challenges, rather than focus on those specifically relating to the EU. This approach is justified by the increasing interdependence of the world’s nations in the context of energy and minerals. A problem facing one party has the potential to affect other parties, however distant. Likewise the proposed solutions will be directed at those choices which are collaborative, because the scale and nature of the challenges are such that unilateral solutions are unlikely to be effective in the long-run. Specific proposals will be made as to how the EU can participate in the formulation and implementation of policy proposals.

The objectives of the project are:

- To identify the main global challenges relating to competition for access to

oil, gas and mineral resources;

- To propose new approaches to collaborative solutions for the various policy actors, including the EU;
- To disseminate widely the results of this research.

To achieve these policy objectives, the POLINARES project is directed at meeting the following research objectives:

- To develop a better understanding of how global interactions and interdependencies relating to oil, gas and minerals have been changing and are likely to change, how they relate to the development trajectories of different parts of the world, and what their implications are for global economic, social, institutional and security relations;
- To identify principles which can underpin the development of new policies, new policy-making processes, and new networking systems which, in turn, can assist in promoting an appropriate balance between competition and collaboration with respect to access to oil, gas and minerals in a manner which minimizes conflict and promotes sustainable economic development.

*This project has a budget of 2.7M€.*

#### **CRM\_InnoNet. Critical Raw Materials Innovation Network** (<http://www.criticalrawmaterials.eu/>)

Securing availability and access to critical raw materials constitutes a strategic objective for the EU political and economic agenda. Key EU industrial sectors such as construction, chemicals, automotive, aerospace and machinery provide a total added value of €1.324 billion and 30 million jobs and depend on access to critical raw materials. Rare earth elements are essential to industrial production, particularly for clean energy options such as wind turbines, solar cells, electric vehicles and energy-efficient lighting. The scarcity of critical raw materials, together with their economic importance, makes it necessary to explore new avenues towards substitution in order to reduce the EU's consumption and decrease the relative dependence upon imports.

The EU-funded CRM\_INNONET project is focused on stimulating progress toward development of appropriate alternative solutions for applications relying on critical raw materials. Over 100 organisations have now joined the Critical Raw Materials Innovation Network.

The objectives of the project are:

- Mapping of critical raw material substitution initiatives: CRM\_InnoNet will carry out a "top down" sector-based approach to identify potential bottlenecks in the raw materials value chain and a "bottom up" raw materials-based approach, including mapping of on-going initiatives in the field of substitution of critical raw materials at the EU and Member States level;
- Prioritisation methodology: CRM\_InnoNet will develop a methodology to establish clear criteria for the prioritization of applications which are at risk due to resource scarcity and identify opportunities for technological and non-technological development in the field of substitution of critical raw materials;
- Substitution roadmap: CRM\_InnoNet will propose a roadmap for the substitution of critical raw materials in five key applications;
- Innovation Network: the Innovation Network will constitute a dynamic, open and proactive platform for the entire stakeholder community;
- Policy recommendations: CRM\_InnoNet will prepare recommendations, future initiative ideas and suggested actions for policy makers.

*The project started in November 2012, will end in June 2015, and has a budget of 3.87M€ (EU contribution, 2.93M€).*

#### **ERA-MIN. Network on the Industrial Handling of Raw Materials for European Industries**

(<http://www.era-min.eu.org/>)

To foster coordinated research on the entire raw materials value chain, ERA-MIN focuses on mapping and networking the European non-energy mineral raw materials research community.

#### **Networking**

ERA-MIN creates networks at several levels within the European non-energy mineral raw materials research community:

- Networking between the EU Member States to build common and long-lasting interfaces between industry, research, education and policy-makers.
- Networking of national, regional and European research programs to reduce fragmentation and duplication of research
- Networking of the contrasted European non-energy mineral raw materials research community (ENERC).

An integrated approach to research - the entire raw materials value chain requires the involvement of many skills and varying expertise: Earth, environmental, life, social and material sciences, engineering and processing and knowledge from organisations involved in the recycling, down-stream users of raw materials and economists.

#### **Mapping**

The mapping of existing European initiatives and programs is also necessary to identify the different stakeholders, their activities, their technical and scientific bottlenecks and their strategies for overcoming them. ERA-MIN has proposed a research roadmap on the major scientific and technical challenges that should be addressed by specific research in the next five to ten years. This roadmap will be fed by the outcomes of five working groups that were created in February 2012, which gather about 150 experts from industry, academia, research centres, and funding agencies. The ERA-MIN Roadmap is now available at <http://www.era-min.eu.org/documents-page/era-min-documents/roadmap-16122013/detail> and the network has five working groups with the following scopes:

- Working group 1: Developing new innovative technologies and solutions for sustainable primary resources supply;
- Working group 2: Developing new innovative technologies and solutions for sustainable secondary resources supply;
- Working group 3: Developing new innovative technologies and solutions for the substitution of critical materials;
- Working group 4: Public policy support for primary, secondary resources and material, and mineral intelligence.
- Working group 5: Cooperation, public education and teaching.

The network has already launched three calls for projects. The third ERA-MIN joint call has been launched for 2015 on the basis of the topics and rules of the previous joint call 2014, addressing research on the entire value chain of non-energy raw materials (non-energy primary and secondary raw materials, recycling and substitution).

The countries which have committed to the third Joint Call are: Argentina, Finland, France, Hungary, Germany, Ireland, Poland, Portugal, Romania, South Africa, Sweden and Turkey. Funding organisations from other European countries or regions, as well as non-European countries, are also invited to join.

*The budget of this network is 3.9M€.*

**EURARE. Research for a sustainable European REE Exploitation Industry**  
(<http://www.eurare.eu/about.html>)

EURARE is a project funded by the European Commission for the 'Development of a sustainable exploitation scheme for Europe's Rare Earth ore deposits' that will safeguard the uninterrupted supply of REE raw materials and products crucial for EU industry sectors, such as automotive, electronics, machinery and chemicals, in a sustainable, economically viable and environmentally friendly way. The Geological Surveys involved in the project have determined that Europe has a number of areas with suitable geology for REE deposits. These include alkaline igneous rocks such as those found in the Gardar Province of southwest Greenland (Kvanefjeld and Kringlerne exploration projects) and within the Fennoscandian Shield (including the carbonatites of Fen in Norway and Sokli in Finland and the Norra Kärr syenite in Sweden). They also include secondary placer deposits such as those in Greece and Serbia. Based on the information received from ongoing advanced exploration projects there is potential for more than 6 Bt of ore resources, more than 38 Mt TREO (total rare earth oxides) and more than 10 Mt HREO (heavy rare earth oxides).

*Eurare has a budget of 13.8M€.*

**Minerals4EU. Minerals Intelligence Network for Europe**  
(<http://www.minerals4eu.eu/>)

Minerals4EU is a two-year EU project (started 1st September 2013) under DG Research and the 7<sup>th</sup> Framework Programme funding scheme. The project is also of interest to DG Enterprise (now in DG Growth) which has responsibility for the mineral raw materials sector. Minerals4EU aims to address the objectives of the EU raw materials knowledge base action, as part of the Strategic Implementation Plan (SIP) of the EIP RM (European Innovation Partnership on Raw Materials). It is a strategic target both for the Commission and the National Geological Surveys (NGS) of Europe which are the key providers of pan-European minerals data and services, complemented by other organisations.

Minerals4EU is creating a knowledge-based data platform (WP5) for European non-energy raw materials aiming to become Europe's permanent service (WP2) in providing information and intelligence on minerals. It will deliver a wide range of products including mineral statistics (WP4) and a foresight study (WP6) on primary and secondary mineral resources.

Important beneficiaries are:

- Government
  - EU
  - National
  - Regional
  - Local policy and decision makers
- Authorities managing and evaluating cohesion policy programmes and projects
- Industry
  - Mining
  - Mining downstream industries
  - Traders
  - Financial institutions
- Associations
  - European: European Federation of Geologists, Euromines, etc
  - National associations
  - NGOs
- Academics

Minerals4EU will operate as an interactive, transparent and open source of standardized cross-border intelligence for minerals, easily accessible for all categories of end user. Any stakeholder will be able to access information on Europe's potential mineral resources, recycling and resource efficiency. Minerals4EU will develop a responsible, authorised and reliable mineral data source and thus contribute to the sustainable and secure supply of mineral resources.

*The budget of the project is 2.37M€ (EU funding 1.99M€).*

**ProSUM. Prospecting Secondary raw materials in the Urban Mine and mining waste**

The aim of the recently approved ProSUM project is to create an EU Information Network (EUIN) that allows partners in the network to provide and use data in an inventory for waste streams with a significant potential to serve as a source of Critical Raw Materials (CRM). This includes waste electrical and electronic equipment (WEEE), end of life vehicles (ELV), batteries and mine waste. Access to the inventory will be through the EU Urban Mine Knowledge Data Platform (EU-UMKDP) and web portal. The EUIN will assist in the development of the EU-UMKDP by providing current and new data on products put on the market and on past and ongoing mining tailings containing CRMs. The data network partners working together with the research partners will jointly deliver structured data, standard methodologies for sampling and analysis of CRM content in WEEE, ELVs and spent batteries. This allows for better presentation and harmonisation of data as well as improved coverage and accessibility

of data in the future for a wide range of possible end users, including policy makers. The basic architecture has been designed to allow for the development of the knowledge platform to include additional materials in the future.

*This project has a budget of 3.7M€.*

**EGDI-Scope. European Geological Data Infrastructure**  
(<http://www.egdi-scope.eu/>)

EGDI-Scope is an EU-funded research project under the 7th Framework Programme. The project is administered by the European Commission's DG Connect and executed by a project consortium of four Geological Surveys (the Netherlands, the United Kingdom, France, Denmark), the EuroGeoSurveys Secretariat (EGS) and the Catholic University of Leuven (Belgium). It is embedded within the framework of close cooperation of 32 geological survey organisations in Europe. Europe is facing major challenges to the further development of European society. The most important challenges have been prioritised by the European Commission, providing the framework for the Horizon 2020 Research Programme. These include stimulation of economic recovery in a global economy, securing energy, water, food and natural resources, protection against natural hazards and consequences of climate change, and securing a healthy environment. In many of these domains the use of geological knowledge and information is crucial to enable stakeholders from policy, research and industry to contribute to sustainable solutions.

At national and regional levels, the geological survey organisations of Europe play an important role in the long-term (public) management of substantial geological data and knowledge repositories. At the European level, the surveys collaborate in many cross-border and EU projects to develop interoperable, harmonised geoscientific information in multiple domains, based on their national knowledge and databases. This concerns for example the Raw Materials Initiative, the Strategic Energy Technology Plan (SET Plan), the Soil thematic strategy, the Water Framework Directive and the INSPIRE Directive.

Working towards meeting European societal challenges, international and European stakeholders are calling for increased coordination and more sustainable accessibility of geological information at the EU level. To support this, the geological surveys of Europe have joined forces to prepare for a European Geological Data Infrastructure (EGDI), under the framework of the EU-funded EGDI-Scope study. This is an

important pillar under the joint strategy towards the development of a European Geological Service.

The EGDI-Scope study is the starting point of EGDI. It assesses relevant use cases, datasets, functional and technical requirements, legal topics and governance framework. The next phase will cover the implementation of a first operational technical and organisational structure, securing the maintenance and further development of datasets, tools and functionalities from prioritised European projects: OneGeologyEurope, Minerals4EU/EuroGeoSource, EMODnet-Geology, PANGEO and GEMAS.

#### **EUMINET. European Minerals Information Network**

(<http://ec.europa.eu/eip/raw-materials/en/content/european-minerals-information-network>)

The EUMINET commitment is a contribution by Geological Surveys to the European Union Raw Materials Knowledge Base and intelligence capacity. Building on the ongoing EGDI-Scope and Minerals4EU projects, its general objectives are, by 2020, to stimulate investment in the exploration and exploitation of EU mineral resources, as well as to provide data, knowledge and tools for their sustainable management, and technological services across the minerals value chain. The SC5 13e 'Raw materials intelligence capacity' support and coordination action call – which may be seen as a partial continuation of the Minerals4EU project – will be addressed through a new proposal (RAFFIA) involving certain geological surveys (BGR, BGS, BRGM and GTK), with EGS acting as an umbrella for other geological surveys and key external partners. Other known commitments with involvement of Geological Surveys are:

- ExplOre – European Exploration Project
- REMIND – EU Responsible mining demonstrations: best practice and capacity building
- OPTIMIN\_2020 – Optimising the Minerals Policy Framework at EU and National Levels by 2020

#### **I<sup>2</sup>MINE. Innovative Technologies and Concepts for the Intelligent Deep Mine of the Future**

(<http://www.i2mine.eu/>)

The I<sup>2</sup>Mine project marks the start of a series of activities designed to realise the concept of an invisible, zero-impact mine. It will concentrate on the development of technologies suitable for deep mining activities. The project is undertaken by a

consortium of 26 organisations from 10 European countries, and is scheduled for November 2011 to November 2015.

The I<sup>2</sup>Mine Project aims to develop some of the technical solutions to the issues identified during SMIFU I. Further information can be found at the Rock Tech Centre (Smart Mine of the Future). The I<sup>2</sup>Mine project will mark the start of such an initiative: the invisible, intelligent and zero-impact mine of the future.

The concept of I<sup>2</sup>Mine is to develop innovative methods, technologies, machines and equipment necessary for the efficient exploitation of minerals and disposal of waste, both of which will be carried out underground. This will dramatically reduce the volume of surface transportation of minerals and waste, minimising above-ground installations and reducing the environmental impact.

I<sup>2</sup>Mine will focus on the entire cycle of mining with the following objectives:

- Concepts for innovative mining methods for deep deposits (steep and flat), leading to improved resource efficiency through higher extraction rates (20% and more), a higher selectivity of extraction (10 to 20%) together with a 20% higher deposit utilisation as well as increasing productivity and decreasing production costs by 20%.
- Tailor-made concepts for underground near-to-face processing to reduce the mass flow to surface by 15 to 25%.
- High resolution 3D exploration methods for deep deposits.
- New concepts for mine management to reduce operational expenditure and new methods for predicting, monitoring and controlling subsidence.
- New methods to handle waste rock underground and backfill products with similar characteristics to the original rock;
- Health and safety design criteria and guidelines for the new concepts and technologies developed.
- Concepts for clean, safe and comfortable climate conditions in the underground workings.
- New concepts and technologies for deep mine rescue.
- On-line best practice database for all environmental aspects associated with deep mining projects (water management, waste management, emissions, subsidence, etc.).

*The budget of I<sup>2</sup>Mine is 25ME.*

#### **4. European context for mineral issues**

The main target of the EU initiated strategies in relation to raw materials aim to:

- Reduce import dependency and promote the production and export of raw materials by improving supply conditions from EU and other sources. (*"Reducing Europe's import dependency on the raw materials that are critical to Europe's industries"*).
- Increase resource efficiency, including recycling, and alternatives through substitution (*"Providing Europe with enough flexibility and alternatives in the supply of important raw materials"*).
- Put Europe to the forefront in the raw materials sectors (*"Making Europe a leader in the capabilities related to exploration, extraction, processing, recycling and substitution by 2020"*).
- Mitigate related negative environmental and social impacts (*"taking into account the importance of mitigating the negative environmental and social impacts of some materials during their life cycle"*).

In this respect, mineral resources information sharing and networking by European Geological Surveys is essential. The Strategic Implementation Plan (SIP) of the EIP-RM highlights the need to establish and maintain a common and uniform EU Geological Knowledge Base, including Minerals Intelligence Information. Such a knowledge base will allow a common European exploration effort for natural resources as well as effective policy and decision making related to the subsurface.

Specific objectives and targets of the SIP EIP RM actions to which such a knowledge base can contribute include:

- Better insight into the distribution of known raw material resources;
- A prerequisite for finding new and as yet undiscovered resources – particularly at depth – e.g. through innovative 3D/4D modelling applications;
- Innovation in understanding and predicting mineral occurrences in 3 and 4 dimensions through advanced modelling applications and space observation technologies;
- The use of standards for the reporting of primary and secondary resources and reserves (land and marine) which can contribute to enhancing investment conditions for the mining industry;

- Innovation in exploration and mining technologies which can contribute to the discovery of as yet unknown resources (e.g. marine resources, low grade deposits, deep seated ore bodies) and/or can facilitate the working of currently uneconomic deposits;
- New production technologies to mitigate environmental and social impacts;
- Reprocessing mine waste that may be an important source of minerals and metals which could not be recovered using earlier technologies;
- The analysis of global raw materials flows and trends that can inform and enhance strategic decision and policy making;

Better networking between all players, facilitating the exchange of best practices and including them in an improved regulatory framework.

Europe's mineral potential is under-explored, both with regard to the subsurface (particularly deeper than 150 meters) and the sea bed within EU Member States' exclusive economic zones (possibly containing metals such as copper, zinc, gold, silver and rare earth elements). Opportunities also exist within the EU today for mining small deposits. The existence of mineral deposits on the sea floor could lead to world-wide competition for marine mineral deposits. A framework of stable economic and technological conditions will facilitate the development of sustainable and resource efficient exploitation of minerals in Europe.

There is therefore a challenge to better understand ore genesis and direct exploration at deeper, unexploited levels of the Earth's crust. This may be possible by developing and applying innovative exploration technologies (3D/4D) to locate deep-seated deposits.

### 5. Challenges and opportunities

The emphasis of EGS MREG needs to go beyond its present role – largely a lobbying and advisory service – to become an institution and active partner (using the expertise and involvement of all geological surveys) participating in projects, becoming involved in coordinating and support actions, and contributing to the development of minerals policy.

This will include:

- New opportunities for EGS and individual geological surveys;
- Further implementing the three pillars and 24 action areas of the European Commission's Strategic

Implementation Plan (SIP) of the European Innovation Partnership on Raw Materials (EIP-RM), which in total contain 97 specific actions, along with related raw materials commitments (RMC) and H2020 calls, through active involvement in the Operational, Sherpa and High Level Groups.

- Participating in the development of documents, white papers and communications, such as providing input to the updating of the list of Critical Raw Materials and on Recommendations for the extraction of non-energy raw materials in the European Union.
- Participating in the H2020/Challenge 5 Advisory Group.
- Changing the activity profile for MREG, for example:
  - Seeking partnerships for networking and the exploitation of project results.
  - Providing minerals data and intelligence along with services and products.
  - Contributing to applied research and technology development (e.g. exploration, waste re-use, mineral processing).

The changed focus will support

- A coherent resource-efficient policy framework:
  - Recycle and re-use waste materials and by-products from all mineral value chain activities in order to increase the supply of valuable secondary resources.
  - Many critical minerals and metals may be collected through reprocessing of some mine waste.
- However, even with the important contribution from recycling or reprocessing, to secure sufficient supply it will still be necessary to extract from primary mineral deposits, focusing on:
  - Applying new technologies for deep exploration and mining.
  - Turning low- grade ores into exploitable resources.
  - Reducing the volume of mine waste and the need for large tailings facilities by converting the mine waste to useable products or reprocessing it to recover valuable minerals.

### 6. Conclusions

We have made here a non-exhaustive description of many projects related to R&D in the mineral resources field since the advent of the Raw Material Initiative (2008), partially financed with more than 80M€ by the EU Commission in successive programs, but we should take into account that these are only the tip of the iceberg of the EU's total expenditure on the raw materials knowledge base, as we are missing those which did not have the participation of the Geological Surveys.

It seem evident to us that such incredible efforts lack coordination, since we can see in the scope of the projects a certain serial repetition or superposition of objectives and products. The total amount of money used in the whole spectrum of mineral related R&D projects should probably be disclosed, but we estimate it ranges between 400 and 700M€. Many of these projects have ended up in a drawer and its products have seen no further use, despite the enormous cost to complete them.

Today we are seeing a succession of Raw Materials Initiative calls under the H2020 which are covering new aspects of the broad interest of the EU in this area, and we wonder if sometimes we are reinventing the wheel. Thus, now is the time to make use of the data available in the many portals and webs to produce substantial practical results that might benefit the industry and the citizens of Europe.

EuroGeosurveys, by means of its Mineral Resources Experts Working Group, is already working on compilation projects that will make use of INSPIRE-compliant databases and sources to improve data availability and access for the society and citizens of Europe, and to cope with the challenge of better understanding ore genesis and direct exploration at deeper, unexploited levels of the Earth's crust by developing and applying innovative exploration technologies (3D/4D) to locate deep-seated deposits. EGS is also participating in new projects to integrate EU mining policies, mining diplomacy, mineral economics and mineral intelligence, as well as in materials cycle analysis and an ample list of new ideas for the benefit of Europe, and we are doing this with the perspective of envisaging a future Geological Service of Europe.

# Reporting standards, codes, templates, and classifications: conversion, bridging, and mapping

Stephen Henley\*

When compiling databases or summaries of resources or reserves, with data drawn from different sources, an issue that must be addressed is the comparability of different classifications or reporting standards. Companies listed on stock exchanges generally report their resources and reserves using one or other of the CRIRSCO-aligned standards such as PERC or JORC, and many unlisted and private companies also follow the same standards though their data are not always published. However, in some jurisdictions other standards may be used, especially for reporting to national authorities (such as the Russian state classification and many other national systems that are derived from it). There is also the United Nations Framework Classification (UNFC-2009) which has been developed as a proposed international standard for compilation of statistics on energy and mineral resources.

The inter-relationships among these various standards and classifications may be complex, and the purpose of this paper is to clarify some of the issues involved.

## Terminology

Many terms are used rather loosely in the literature, especially in the trade press, but also quite often also in company reports and government publications.

It is important to understand the basic terminology, as the terms have clear and distinct definitions.

- A reporting standard is a combination of a classification and a set of rules for how it should be used. Examples are the PERC Reporting Standard or the SME Guide.
- A reporting code is a standard which

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is required to be used by law in one or more jurisdictions. Examples are the JORC Code and Canada's National Instrument 43-101.

- A template is a prototype for a standard or code, which can be used to create new standards. The CRIRSCO Template is based on the standards and codes developed by the member organisations of CRIRSCO.
- A classification consists of a set of rules for allocation of estimated mineral resources or reserves to a set of categories. UNFC-2009 is a classification. The CRIRSCO Template and the codes and standards aligned with it include a classification as an important component. However, a classification does not include any information or guidance on how it is to be used.

Mapping, bridging, and conversion are three terms which are often used interchangeably, but they have different meanings.

- Mapping is the process of matching categories between two classifications. Different classifications can be linked through mapping
- Bridging is a formalisation of such a mapping, accepted by the organisations responsible for both classifications defining a formal equivalence of categories between two classifications
- Conversion is the actual mechanism for transferring real data from one classification to another, which will often require the oversight of a Competent Person, especially where the two classifications are defined from different underlying principles

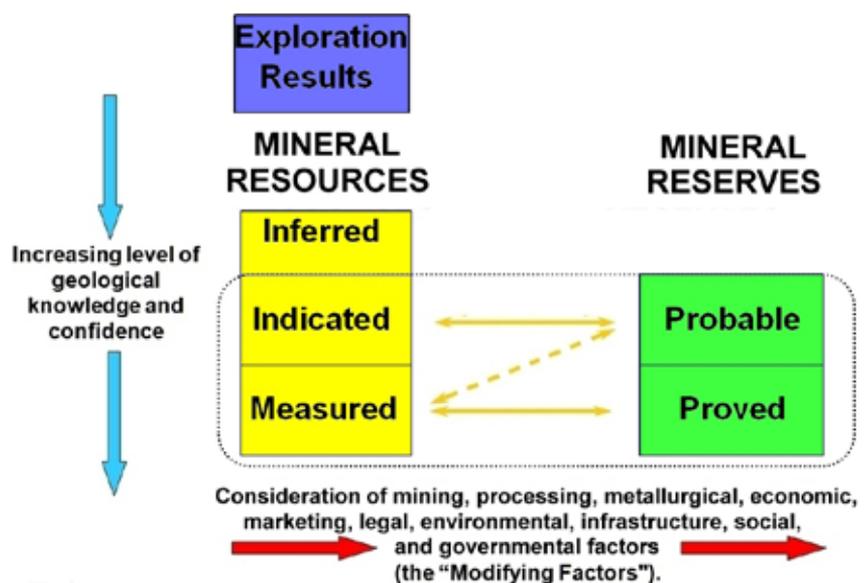


Figure 1: The CRIRSCO classification for exploration results, mineral resources, and mineral reserves.

**The CRIRSCO Template**

The CRIRSCO Template (Henley and Allington, 2013) includes standard definitions, sample text, and suggested guidelines to assist in developing new reporting standards. There are two main parts to it:

- (a) a classification of exploration results, resources and reserves estimates
- (b) specification of rules for use of this classification and preparation of reports of exploration results, mineral resources and reserves estimates

The CRIRSCO Template is the prototype for a set of standards and codes used for public reporting of mineral resources and reserves, principally by companies listed on stock exchanges. There are currently eight CRIRSCO-aligned standards & codes:

- JORC (Australia and New Zealand)
- CIM / NI43-101 (Canada)
- SME (USA)
- IMEC (Chile)
- SAMREC (South Africa)
- PERC (Europe)
- NAEN (Russia and Kazakhstan)
- MRC (Mongolia)

All standards and codes aligned with the CRIRSCO Template use the same set of standard definitions and the same classification.

The rules for using this classification are all based on the same underlying principles, but details of rules will vary depending on the requirements of different jurisdictions.

There are also differences in guidelines for particular commodities. For example, in Europe, industrial and construction minerals are of particular importance so more detailed guidance is provided for these in PERC than in other standards

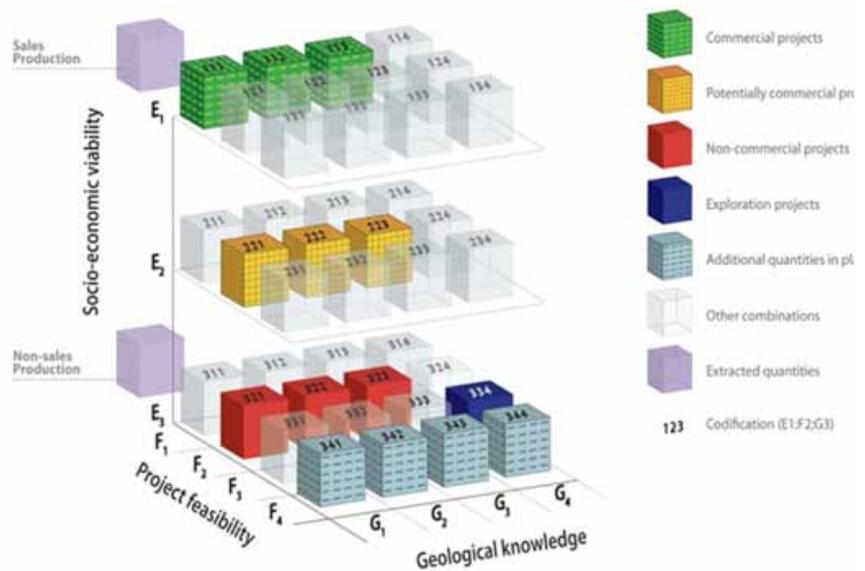
The CRIRSCO classification is shown in *Figure 1*.

The scope of CRIRSCO is all solid minerals. This classification shows increasing geological knowledge downwards, and increasing knowledge of socio-economic and technical modifying factors towards the right. Allocation of a particular estimate to one or other category is a matter for professional judgement of a Competent Person.

Transfer from resources to reserves will normally require a team of professionals in the different fields required for the various modifying factors.

**The UNFC-2009 classification**

The UNFC classification (UNECE, 2013) is defined on three axes, representing



*Figure 2: The UNFC-2009 classification.*

- E: economic factors
- F: technical feasibility factors
- G: geological confidence

Resources and reserves are mapped into one or other of the boxes. There are also very many boxes which remain unused because they do not represent real situations. The classification is shown in *Figure 2*.

**Bridging**

A bridging has been defined between CRIRSCO and UNFC-2009 (UNECE, 2013).

This is the default mapping between them, and for all categories in the CRIRSCO Template classification there is an exact match with a corresponding category in UNFC-2009. This is because the CRIRSCO Template classification has been accepted as the UNFC-2009 definitions for these categories.

This bridging has been tested in a series of case studies commissioned by UNECE in Dec 2013, to demonstrate bridging from CRIRSCO to UNFC-2009, and to identify any issues arising (Henley, 2014).

The case studies took a selection of public reports from mining companies. For most reports, the bridging appeared to work well. It was possible to obtain a consistent conversion from CRIRSCO classes to corresponding UNFC-2009 classes. However, there were some conceptual problems found in the exploration data category (E3 F3 G4 in UNFC), when using the UNFC-2009 Specifications document to attempt a

subdivision of the 334 class. The CRIRSCO classification does not subdivide this category, but UNFC-2009 does provide rules for subdivision.

For exploration data (class E3-F3-G4), according to the Specifications:

- Subdivision on the G axis is used for relative confidence levels from the same set of underlying geological data
- Subdivision on the F axis “technical feasibility” is used for differing relative amounts of geological data

Thus geological knowledge is mapped on the F axis, not the G axis. This seems to reflect a more general issue, not just for the exploration data category.

However, in the CRIRSCO classification, differing amounts of geological data are represented on the geological knowledge axis which for consistency with the bridging document this should map to the G axis in UNFC-2009. The UNFC-2009 specifications instead require use of the F axis for subdivision based on the amount of geological knowledge.

The UNFC-2009 specifications were prepared principally for use with oil and gas. The implication is that the G axis has different meanings for oil & gas and for minerals!

- Oil & Gas:
  - G axis = relative geological confidence or risk,
  - F axis includes relative geological knowledge

- Minerals:
  - G axis = relative geological knowledge,
  - F axis exclusively non-geological

They may look similar but these are different classifications. The axes have different meanings for the two different types of commodity. The issue remains under discussion, but we are confident that it will be resolved: a potential solution has been identified which would actually make it easier for UNFC-2009 to be used for a range of other commodities such as renewable energy or water resources in which geological factors may play a different role or may not be relevant at all.

### Other classifications

For solid minerals there is a more immediate problem – and there are other options. Within Europe, a number of EU member states have national reporting systems which derive ultimately from the old Soviet Union state reporting system.

If using a CRIRSCO standard such as the PERC Reporting Standard, there are guidelines for conversion from the present Russian state system, also derived from the old Soviet system. These guidelines are not a formal bridging document, but a practical set of guidance to be used. They were developed jointly by the Russian State Commission on Reserves (GKZ) and CRIRSCO, and published in 2010 with parallel Russian and English language text (CRIRSCO and GKZ, 2010).

The purpose was to allow mapping from existing Russian data to CRIRSCO-aligned standards without needing complete re-estimation from the raw geological data. The guidelines are based on the detailed

definitions of the categories in the two classifications – not subjective opinions as had previously been the normal process and which led to widely diverging opinions on the ‘correct’ mapping.

The guidelines have been summarised in a single diagram (Figure 3).

This is not a mechanical conversion but must be informed by professional knowledge and experience - in other words, by a Competent Person. It should be a relatively straightforward process to use this as a starting point for developing similar guidelines for conversion from other national classification systems.

### The INTRAW project

This is a new EU project, starting in February 2015, for development of a database for resources of non-fuel solid mineral raw materials in Europe.

To be useful this will require common reporting standards. It is proposed to use the PERC Reporting Standard with extensions and modifications as needed, in particular to include categories from UNFC-2009 which are required for governmental summaries on mineral potential but must not be reported by listed companies.

Bridging, mapping, and conversion from national standards will be a key requirement, and PERC, as a participant in the INTRAW project, will work with national representatives in member states to develop guidelines for such conversions. A key requirement will be not to duplicate effort either within the project or with other preceding or parallel projects, thus INTRAW will, where possible and appropriate, adopt recommendations and conclusions from the Minventory project as well as working closely with the parallel Minerals4EU project.

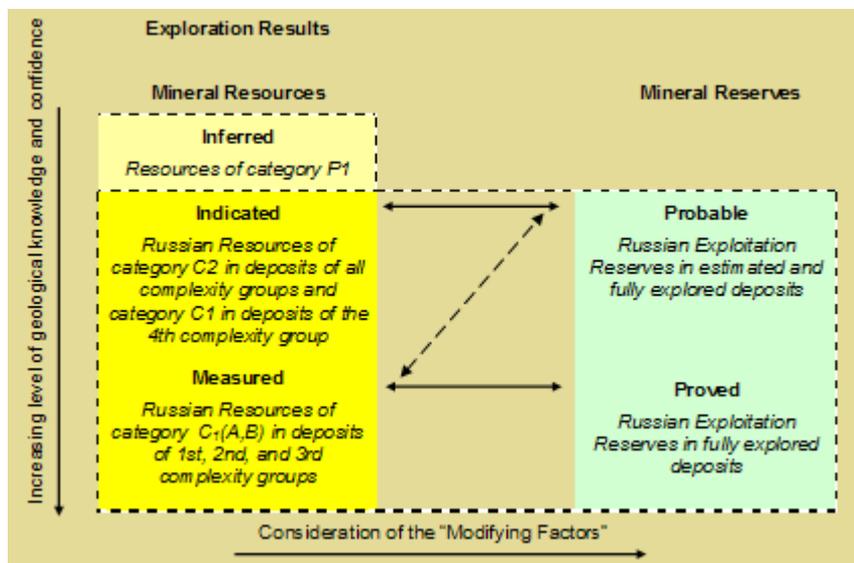


Figure 3: Guidelines for conversion from Russian (GKZ) to CRIRSCO classification.

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# Consolidating minerals classifications for better management: the UNFC initiative

Sigurd Heiberg\*, David G. MacDonald and Charlotte Griffiths

*The question to be answered by resource classifications has changed in the recent past from "What have we found (in the ground)?" to "What can we get (in the economy)?"*

*The community of stakeholders, both preparers and users, have developed the United Nations Framework Classification for Fossil Energy and Mineral Reserves and Resources (UNFC) to answer the latter question, focusing on viable extraction projects rather than the deposits. The aim of UNFC is to facilitate:*

1. International energy and mineral policy formulation;
2. Government resource management;
3. Industry business process management: and
4. Financial analyses and capital allocation.

*Projects are classified respecting contingencies in the scientific/technical/industrial domain and the economic/social domain, and reflecting the uncertainty of estimates. The competence behind the CRIRSCO family of codes and other commodity specific mineral classifications can be used to map current deposit inventories to UNFC project-based assets. The UNFC provides the capability for change.*

*This note explains how minerals classifications can improve minerals management when consolidated into the UNFC.*

*La question à laquelle il faut répondre au niveau classification des ressources a récemment changé, passant de "Qu'avons-nous trouvé (dans le sous-sol)?" à "Qu'est-ce que l'on peut en tirer (au niveau économique)?"*

*La communauté des parties prenantes, à la fois préparateurs et utilisateurs, a mis au point le cadre de Classification des Nations Unies (UNFC) pour répondre à la dernière question, mettant plutôt l'accent sur les projets d'extraction, viables, plutôt que sur les gisements. L'objectif de l'UNFC est de faciliter :*

1. L'élaboration d'une politique internationale concernant l'énergie et les ressources minières ;
2. La gestion gouvernementale des ressources ;
3. Le processus de gestion de l'activité industrielle ;
4. Les analyses financières et l'allocation des investissements.

*Les Projets sont classés en respectant les contingences liées aux domaines scientifique/technique/industriel et aux domaines économique/social, et en soulignant le côté aléatoire des estimations faites.*

*La compétence cachée derrière la famille de codes CRIRSCO et autres classifications spécifiques de référence, concernant les minéraux, peuvent servir à établir l'inventaire des gisements actuels, face aux projets de financement UNFC. L'UNFC fournit la possibilité de changement.*

*Cet article explique comment les classifications minérales peuvent améliorer la gestion des minéraux lorsque regroupées dans l'ensemble UNFC.*

*La pregunta a la que deben de responder las clasificaciones de recursos ha cambiado en el pasado reciente de "¿Qué hemos encontrado (en el suelo)?" a "¿Qué podemos conseguir (en la economía)?"*

*La comunidad de las partes interesadas, tanto de los productores y de los usuarios, desarrolló la Clasificación Marco de las Naciones Unidas (CMNU) para responder a esta última pregunta, centrándose en proyectos de extracción viables en lugar de en los depósitos. El objetivo de CMNU es facilitar:*

1. La formulación de la política energética y mineral internacional;
2. La gestión gubernamental de recursos;
3. La gestión industrial de procesos de negocio, y
4. Los análisis financieros y asignación de capital.

*Los proyectos se clasifican respetando contingencias en el dominio científico/técnico/industrial y en el dominio económico/social y teniendo en cuenta la incertidumbre de las estimaciones.*

*La competencia, familia de códigos CRIRSCO y otras clasificaciones de minerales de productos específicos, se puede utilizar para asignar los inventarios de los depósitos actuales basados en la clasificación CMNU. El CMNU proporciona la capacidad para el cambio.*

*En esta artículo se explica cómo otras clasificaciones de minerales pueden mejorar la gestión de los minerales si se consolidan con la CMNU.*

Resource classifications changed fundamentally in the 1990s. Up to then, the information carrier on which they were built was the amount of rocks observed in the ground, answering the question: What have we found? The new focus introduced the amount of a commodity that an effort would introduce into the economy, answering the question: What can we get?

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This change comes at the same time as globalisation has gained momentum, and reflects many of the same forces. The early classifications developed as the Industrial Revolution took hold in the first decade of the 20<sup>th</sup> century. At that time, there was no correlation between the New York and Chicago stock exchanges. Standardising resource classifications between regions was not an issue. Today, the Chicago Stock Exchange is gone and the New York Stock Exchange responds instantly to movements

on the Tokyo Exchange. In this global capital market, governments and industries act in a multitude of interrelated partnerships. At the same time, interdependence is growing between different commodities and sectors of the economy (McKinsey, 2011; Johansson & al., 2012). This calls for one global standard across geographies and industries. The United Nations Economic and Social Council mandated the UN Economic Commission for Europe to develop such a standard in 1997 and repeated

**Purpose:**

1. Resource policy formulation
2. Government resource management
3. Industry business process Management
4. Financing

*Made by and for preparers and users under a global UN mandate*

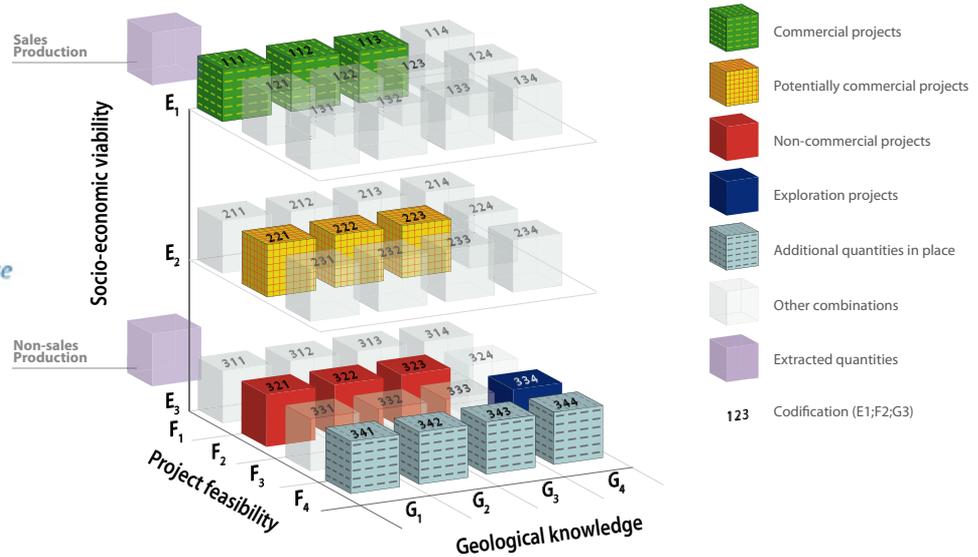


Figure 1: UNFC.

the call in 2004. It is now available as the United Nations Framework Classification for Fossil Energy and Mineral Reserves and Resources 2009 incorporating Specifications for its Application (UNFC) (United Nations Economic Commission for Europe, 2013). Europe is particularly dependent on applying a classification with broad international acceptance, considering that most of the extractive activities it depends on take place outside its own territory.

The professional societies of commodity specific classifications supporting UNFC are key to mapping current inventories into UNFC. They include the European Federation of Geologists (EFG), the Pan European Reserves and Resources Reporting Committee (PERC), the Committee for Mineral Reserves International Reporting Standards (CRIRSCO), the Society of Petroleum Engineers (SPE), the World Petroleum Council (WPC), the American Association of Petroleum Geologist (AAPG), the Society of Petroleum Evaluation Engineers (SPEE), The Society of Exploration Geophysicists (SEG), IAEA and NEA/OECD, the Russian Federal Government State Commission on Mineral Reserves (GKZ), the Norwegian Petroleum Directorate (NPD) and others. This allows future improvements to build on the excellent professional work done in the past.

**UNFC Principles**

UNFC builds on very simple principles, reflecting how we manage resources in the real world. To answer the “what can we get?” question, the information carrier is the project. This will be a physical project if a decision to carry it out is taken or a conceptual project if there are contingencies

to resolve before a decision can be taken. These contingencies may take a number of forms. UNFC standardises on contingencies that are in the scientific/technical/project progress domain and the ones that are in the economic and social domain respectively. It responds to two clear needs when it separates economic and social contingencies from the traditional field process contingencies:

- As societies develop and competition for resources, including land and water increases, the importance of resolving the economic and social contingencies in the best possible way increases. Europe is a case in point where the mining industries are dwindling, not for lack of geological resources, but more importantly because land and water is scarce and

the desire to avoid emissions and other environmental impacts creates a need to manage contingencies in the economic and social domain with diligence.

- In shaping an efficient “industrial ecosystem” through public-private partnerships, it is essential to expose the effect of alternative framework conditions -- fiscal, legal, contractual, infrastructural or other economic and social frameworks -- on the quantities of commodities available (Shuen, Feiler, Teece 2014; Garcia, Lessard, Singh 2014; Åm, Heiberg 2014, Lund 2014).

To see “what we get”, we distinguish between the sales quantities that the pro-

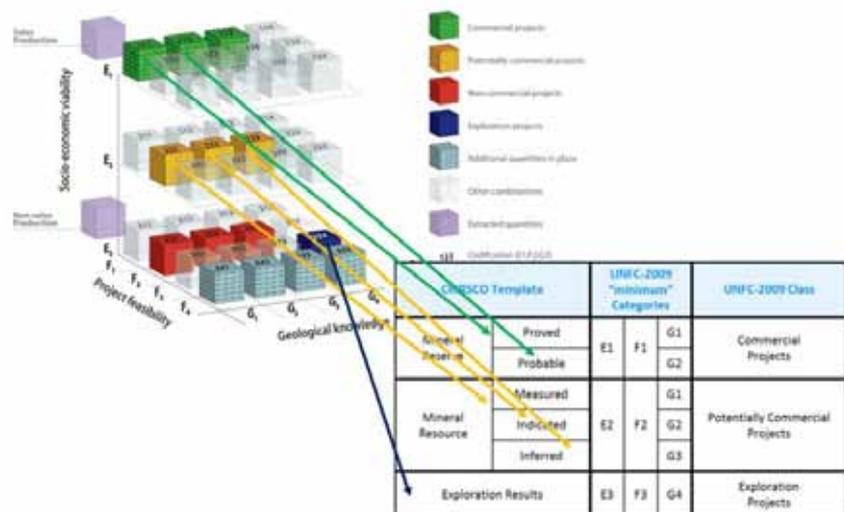


Figure 2: Mapping UNFC classes to the CRIRSCO Template using minimum categories.

ject is and will be producing and non-sales quantities. The latter covers not only commodities produced for household economies, but also emissions, tailings and other forms of what we associate with waste or pollution, but that also can be commodities in the wrong place and thus represent a potential for improved performance. UNFC therefore also provides for improved environmental decisions.

While focusing on what a project may produce, the concern for the source is retained, as the classification of a particular physical or conceptual project includes the answer to “what have we found?”. Quantities left in the ground have their place in the classification.

Finally, UNFC can express the uncertainty in the quantities.

Figure 1 shows how UNFC works. As we mentioned above, there are two categories of production -- sales quantities and non-sales quantities. We assign three category types to each project. One E-type category for economic and social maturity, one F-type category for field project technical maturity, and one G-type category, initially reflecting geologic uncertainty. With the change from the deposit to the project as the information carrier, the character of the uncertainty categories also changes. They now reflect both the geological uncertainties and all the other uncertainties affecting future production.

We conveniently present this in a compact three-dimensional form (although two-dimensional ones are also possible) numbering the categories with number 1 being the best. We always quote the category types in the same order: E, F and G. Their combination defines the classes of the classification. The classes are identified using Arabic numbers only, (the best being E=1, F=1 and G=1, or 1,1,1 for short). In this way, the classification becomes independent of language.

Although developed for fossil energy and mineral extraction projects, the pattern used applies to projects more generally. UNECE is currently facilitating applications to underground storage and renewable energy projects. With this in place, the UNFC stakeholders may also include water at some stage due to the interrelations between water, energy and mining.

**Similarities and differences between UNFC and the CRIRSCO family of classifications**

UNFC and the CRIRSCO family of classifications have developed from somewhat different points of departure into

	F1.1	F1.2	F1.3	F2.1	F2.2	F2.3	F3	F4
E1.1	1	2	3	4				
E1.2	1	2	3					
E2			4	4	5			
E3.1	12	12	12	12	12	12		
E3.2			6	6	6		8	
E3.3			7	7	7	7		11

		UNFC-2009 Sub-Classes	
Mineral Reserve	1	On Production	
	2	Approved for Development	
	3	Justified for Development	
Mineral Resource	4	Development Pending	
	5	Development On Hold	
Inventory (not defined in Template)	6	Development Unclassified	
	7	Development Not Viable	
	11	Additional Quantities in Place	
Exploration Results		8	
Special Cases	Classification not in Template	12	
	Less Common Mappings		

Figure 3: Relating UNFC classes to CRIRSCO Template classes.

one integrated classification. UNECE and CRIRSCO achieved this in the past decade by gradually adjusting both. This made it possible to publish a bridging document in 2013. This document (UNECE 2013) explains the relation between the UNFC and the CRIRSCO Template classes, as summarised in figures 2 and 3.

The initial aim of the two classifications differed initially. At UNECE, preparers and users were invited to develop UNFC for four principal applications:

1. Resource policy formulation;
2. Government resources management;
3. Industry business process management; and
4. Financing

The aim is to improve a complete fact base for decisions among partners. How much of this is disclosed, when and to whom is determined by regulation and if not by the owners of the information.

The CRIRSCO classifications are essen-

tially standards for the public reporting of exploration results, mineral resources and mineral reserves. It is less granular, and in some respects less complete than UNFC, see figure 3. Several of the UNFC classes map to single CRIRSCO Template classes. This makes going from UNFC to the CRIRSCO Template an exact exercise. To go the other way, from the CRIRSCO Template to UNFC without loss of the detail that UNFC can provide requires additional information. The CRIRSCO classifications, and PERC in particular have recently addressed highly contingent quantities (exploration results), shown as inventory in Figure 3.

While UNECE and CRIRSCO have aligned their respective classifications, professionals may from time to time still understand them differently, depending on the nature of the extractive activities they are exposed to. An example of this is the interpretation of the G-axis reflecting uncertainty. When dealing with fluids such as natural gas, oil, subsurface leaching

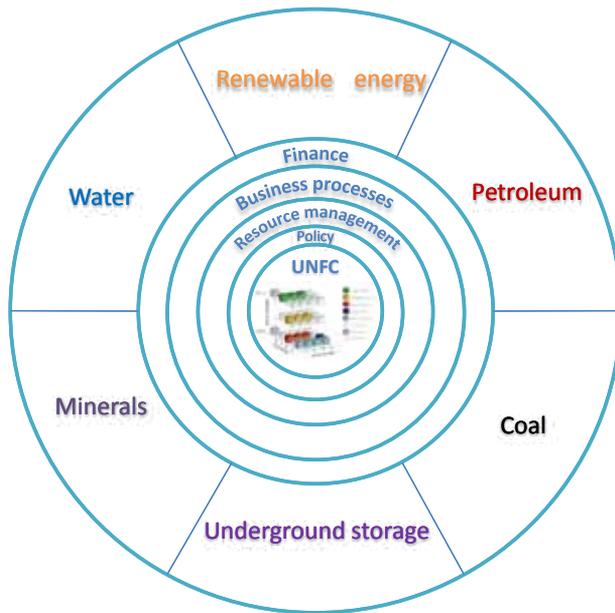


Figure 4: Domains of application of UNFC.

operations etc., we may wish to describe uncertainty in terms of indicators of a probability distribution, such as a certain probability of exceedance. At some stage, we may judge the probability of not extracting a sufficient quantity to justify the project to be low enough to sanction the project, moving the quantities to “reserves”, or E1,F1 in UNFC terms. We then estimate the uncertain outcome of that decision and prepare real options to handle the worst and the best to the extent that these options have value.

When dealing with solids, where there is better control, confidence level may be preferred. We may wish to demand that a quantity is determined within a band of uncertainty, of say 20%. The high end of the probability density function will correspond to a quantity with a rather large band of uncertainty. With this perspective, CRIRSCO does not allow it in the mineral reserves. With the “fluids” perspective, it would remain as E1, F1, G3 in UNFC if it were an uncertainty in the outcome of a “sanctioned” project. If extraction requires further definition and a new decision, it would be a contingent resource also there.

We can summarise this difference by stating on the one hand: “I want to know I have got enough to go ahead” (and may object to investing additional resources in information unless it affects my decisions). Extracting salt from the ocean would be an extreme case illustrating the point. On the other hand, we may state: “I want to be confident of exactly what I will get so that I can design my project for it”. The choice is a value judgement. We must make it recog-

nising that the future is not predetermined, and what we will get depends on more than geology.

#### Securing quality

Quality resource inventories rely on preparers who deliver the required quality analyses and on accurate reporting processes. UNFC contains a functional requirement regulating this:

*“Evaluators must possess an appropriate level of expertise and relevant experience in the estimation of quantities associated with the type of deposit under evaluation. Specifications that are more detailed can be found in relevant commodity-specific systems that have been aligned with UNFC-2009. In addition, regulatory bodies may explicitly mandate the use of a “competent person”, as defined by regulation, with respect to corporate reporting.”*

The efforts that the European Federation of Geologists is making to maintain and raise the capabilities to analyse commodities is one of several important contributions in meeting the requirement for quality. The CRIRSCO family of classifications contains detailed specifications, building heavily on British Commonwealth traditions. Here, a Competent Person has considerable definition power. A reputed organisation manages and protects the Competent Person title, ensuring that the holder is qualified, much like the guilds once did. By remaining strictly functional, UNFC is open to this and other schemes to meet the needs for quality. The United Nations does not assume a licensing authority through the

classification. Classification and quality assurance of the work are separate issues.

#### Supporting decisions

UNFC supports decision analyses within and across commodities in the four domains mentioned above. Figure 4 shows the elements currently in place and being prepared, except for water. Water is not yet on the UNECE agenda for UNFC.

#### Policy formulation

UNFC facilitates policy formulation by its ability to cover several interrelated commodities in a common classification framework. It does this in a complete manner, covering the full range of projects from those that are in operation to the conceivable future projects within the resource base. This allows policy makers to address policies in an atmosphere where conflicts between the resources are visible, and to do so from the immediate to the long term,

When policy makers formulate policy using UNFC, it is essential to address uncertainty relevantly. Summing up low estimates or measured resources will for the most part be irrelevant in the sense that the law of large numbers will cause the sums to fall below and outside the range of interest in policy formulation. The same holds true for the sum of the high estimates or the measured+indicated+inferred estimates. The sum of the expected values will generally also be the expected values of the sums. To define the expected values well is therefore of extreme importance for large portfolios such as the ones we work with when formulating policy. Dependencies and/or correlations between probabilities are both important and hard to assess in order to estimate the uncertainty in the aggregated portfolio. Preparers need to do this properly.

#### Government resources management

When Governments manage resources, under given general policies, two concerns stand out. The first is to develop framework conditions that give the commodities a sufficiently high value at the source to justify extraction. The second is to align the interests in the public-private partnership in such a way that the wanted extraction will take place, balancing costs and benefits to what is economically correct for the project as well as its participants.

The F-axis facilitates considerations of activity levels relative to enterprising capacities and infrastructure. Any deviation from

the overall optimal level in these respects will drive up costs and reduce the values at the source. Licensing new exploration potential, developing common physical, intellectual and social infrastructure etc. are instruments that Government can use to make the public-private partnership more efficient. Excelling along the F-axis will allow “physical” transfer of market values to the source without losses due to scientific, technical or project related deficiencies.

The E-axis facilitates a rational development of the economic and social framework conditions. The shaping of legal, fiscal and contractual conditions affects the distribution of costs, revenues, risk among participants in the public-private partnership, and thus affect value at the source, not necessarily for the project, but for the participants in the project. By not aligning interests through these instruments, Governments reduce the extractable quantities and with it, their value for all parties.

Government resources management is also about balancing conflicting needs for land, for the environment generally including air pollution, for water, for labour and between commodities. The E-axis hold

**Abbreviations**

- CRIRSCO: Committee for Mineral Reserves International Reporting Standards
- ESMA: European Securities and Markets Authority
- JORC: Joint Ore Reserves Committee
- PERC: Pan-European Reserves & Resources Reporting Committee
- SEC: United States Securities and Exchange Commission
- UNECE: United Nations Economic Commission for Europe
- UNFC: United Nations Framework Classification for Fossil Energy and Mineral Reserves and Resources

the potential for making the effects of the restraints involved visible.

In spite of best efforts on the issues mentioned above, the markets may simply not support the resulting cost of extraction. This situation will invariably arise for all projects as they approach their economic limits. We can reflect this on the E-axis, or look to the F-axis – current technologies do not produce low enough costs. The E- and the F-axes interfere in this domain. Other classifications, including the CRIRSCO type classification therefore do not distinguish between contingencies in the E- and F- domains. When we map these classifications to one another, we emphasise this

common interrelation, by mapping to the E2 – F2 combination (projects contingent on both project and economic/social conditions) as a minimum combination. This does not exclude an E2-F1 (contingent on economic and social conditions only) or E1-F2 (contingent on project progress only) combinations.

By excelling along the E-axis users of UNFC may improve the values at the source and the extractable quantities while striking the correct balance between activities that compete for the same resources, including general environmental resources.

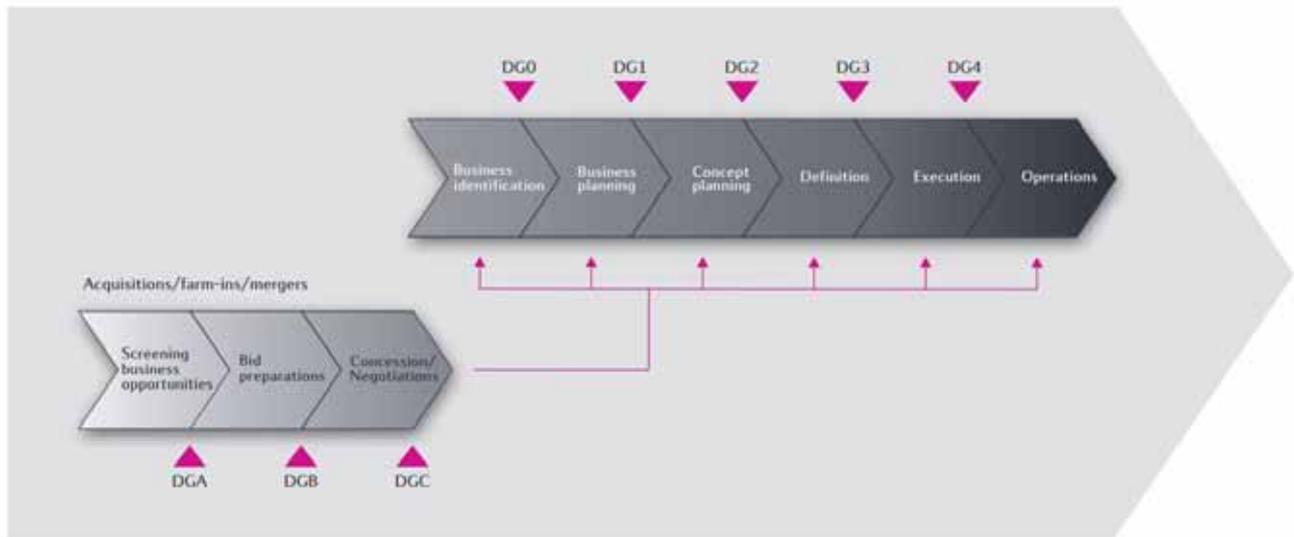
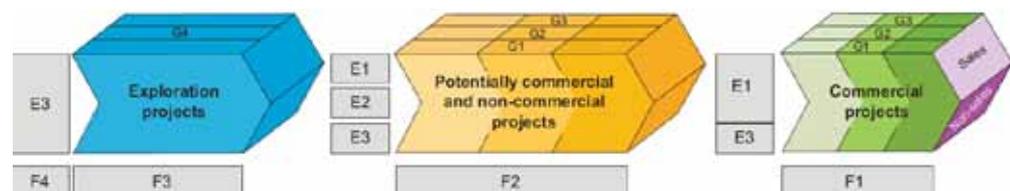


Figure 5: The capital value process used by Statoil.



**Mineral law:** Exploration                      Extraction right                      Operating concession

Figure 6: UNFC presented in the format of a capital value process and relative to elements of the Mineral Law in Norway.

## Industry Business process management

In industries, firms play importantly on the F-axis by applying capability in science, technology and project execution, and in transferring these capabilities between projects, assets and countries to improve the value of the commodities at the source. To illustrate this, *Figure 5* shows a typical value process followed in industry, here by the oil company, Statoil. *Figure 6* shows UNFC in the same format. It also shows how it relates to the main elements of the Mineral Law of Norway.

Here, we also show the play long the E-axis in shaping portfolios, and optimising them relative to capability and financial structure. License application, building asset value, acquisition, merging and divestiture are all activities in the asset market that benefit from categorisations along the E-axis.

In applying capabilities to capture the opportunities and mitigate the risks hidden in uncertainty, firms need to excel on both axes. The contingent resources often represent real options that we must exercise when conditions change. The change can come from the project domain, i.e. a project in the asset does not perform as predicted, requiring an additional decision to either capture an upside or avoid a downside. It can also come from the economic and social domain when opportunities open or close due to changes in the markets or other social and economic conditions. To keep an inventory of these real options in the portfolio is valuable. To disclose them publically can at times be difficult, not because they necessarily are confidential (they may be), but they may also change too frequently for the public to follow.

## Financing

Well-diversified investors such as pension funds; sovereign wealth funds, insurance

institutions, banks and governments finance the lion's share of extractive activities. Their economic interests relate to value calculated at discount rates with low risk premiums, reflecting how the projects add to the risk of their investment portfolios. These investors have long-term interests.

Investors can serve their interests, using UNFC as one of several instruments by showing how the project classification changes when we add value to legal rights through information at first, and then later by taking decisions on adding plant and equipment before investors harvest through production. We will see the effects in aggregate through a movement through the classes.

Current financial disclosures of resources provide this information indirectly, through limited disclosure of short-term production potentials (reserves and other quite mature resources). The deficiency in this practice is multifaceted. Costs, taxes, contractual conditions and non-linear economies of scale affect the value at the source and the portion of costs and revenues that accrues to the reporter. Investors occasionally see the asset values, when required by legal authorities, and when assets are bought or sold.

The variety of classifications allowed by the aggregate of financial regulators does little to create comparability between international investment opportunities (European Securities and Markets Authority, 2013). The mining industry mends this deficiency to some extent by standardising on listing at the London Stock Exchange, using the JORC code (Joint Ore Reserves Committee of the Australasian Institute of Mining and Metallurgy, Australian Institute of Geoscientists and Minerals Council of Australia (JORC), 2012).

The International Accounting Standards Board (IASB) has prepared for the inclusion of an International Financial Accounting Standard (IFRS) on extractive activities into its active agenda (IASB 2010). This would

aim to mend current deficiencies. They have not yet given a date when this may happen.

## Conclusions

In summary, to secure affordable and sustainable supplies of energy and mineral resources, Europe needs to inform its decisions from an inventory based on a single global classification designed for the purpose, the United Nation Framework Classification for Fossil Energy and Mineral Reserves and Resources (UNFC). To achieve this, the EFG and PERC organisations and others must play an important role with respect to developing commodity specific guidance for the UNFC that is relevant to Europe's situation and by training evaluators to excel in their application of them.

## Acknowledgements

This paper is an expansion of a presentation given the Min-Win-Win conference of the European Federation of Geologists and PERC in 2014 (Heiberg, 2014). We thank the European Federation of Geologists and the Pan European Reserves and Resources Reporting Committee for raising the issue of resource classification on the agenda so well and for inviting and inspiring us to contribute to the discussion.

We also thank Professor Donald Lessard of the Sloan School of the Massachusetts Institute of Technology for his long time contributions to branches of strategy relevant for this paper, and for his encouragement and comments.

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# Geology amongst people

Cristina Sapalski\*

## Ilustre Colegio Oficial de Geólogos (ICOG), Spain



ICOG was established in 1978. Its basic aims are the management, within its competence, of the activity or practice of the profession of geology; and exclusive representation and advocacy of professional geologists. The Association has 2794 individual members. They organise a general assembly and conference annually and workshops occasionally. They regularly prepare documents for national authorities in order to promote the recognition of the profession and have a bi-monthly magazine, *Tierra y Tecnología*, which reaches 4000 readers. ICOG also issues a weekly newsletter, *Boletín Planeta Tierra* with 6.000 readers.

More information: <http://www.icog.es>

In order to spread the knowledge of geology amongst people, every first Saturday of the month the ICOG organises a market of fossils and minerals together with a lecture and free workshops for children.

Coinciding with the International Year of Crystallography, children from 6 to 14 participate in workshops where crystal growth is explained. After the 40-minute workshop participants take home the results of experiments they have done by themselves. They also observe insects, arachnids and crustaceans in amber. After this there is a lecture for parents, children, neighbours, etc.

The ICOG also organises a three-day fossils and minerals market where 20% of the benefits are donated to the NGO World Geologists.

\* 2<sup>nd</sup> Vice-President ICOG,  
Calle de Raquel Meller, 7 (Local)  
28027, Madrid, Spain

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Niños de 4 a 12 años. Confirmar asistencia.

12:00h - 12:45h Conferencia: *El poder de los cristales y la Cristalografía.*

Cristóbal Viedma, Facultad de Ciencias Geológicas de Madrid.



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# 100 Great Geosites in the UK and Ireland

## An initiative to celebrate the diverse and beautiful geoh heritage of the UK and Ireland

Florence Bullough\* and Nic Bilham

### What is a geosite?

The UK and Ireland feature some of the most diverse and beautiful geology in the world, spanning most of geological time, from the oldest Pre-Cambrian rocks to the youngest Quaternary sediments. As part of Earth Science Week in October 2014, The Geological Society of London and partner organisations, including the Institute of Geologists of Ireland, celebrated this unique geoh heritage by launching a list of 100 Great Geosites (<http://www.geolsoc.org.uk/100geosites>).

The launch of the list was the culmination of many months of engagement with professional and amateur geoscientists, school and university students and the wider public. As well as documenting the rich variety and stunning beauty of our nations' geology, it also raised awareness of the many ways in which geoscience and the geosphere underpin and enrich our lives – from enjoyment of landscapes and recreational activities to provision of resources (water, energy and raw materials), delivery of vital services, support for infrastructure and generation of economic growth.

In order to highlight the enormous contribution geology makes to society and culture, which often goes unnoticed by much of the population, we decided that the definition of a 'geosite' should be as broad as possible. The list celebrates classic geological outcrops and landscapes, but also shines a light on extraordinary examples of engineering the subsurface to provide public benefit such, as the Channel Tunnel and Farringdon Underground Station, and the long history of resource extrac-

tion which has fuelled social and economic development throughout our islands. The list also illustrates the powerful influence of geomorphology and landscapes on the history of human habitation. Examples of this include the Great Whin Sill in northern England which was exploited as the location for much of Hadrian's Wall two thousand years ago, to take advantage of the strategic position it affords. Geology is also responsible for the historical siting of resource-based industries, such as the mining of tin at Geevor and lead at Allenheads, which in turn gave rise to the settlements and infrastructure found in these areas. Our varied geology is also exhibited in attractive building stones at famous sites such as Westminster Abbey and Durham Cathedral. These provide an opportunity not only to observe some wonderful and ornate rocks up close but also to understand their use as a decorative stone in a historical context.

### Conservation and protection

We also wanted to highlight the importance of protecting and conserving the geodiversity of the UK and Ireland. The Geological Society of London is committed to raising public awareness of the need for statutory protection of geologically important sites, and to working with the organisations responsible to ensure that sites which currently lack any protection are appropriately designated. The 100 Geosites include local sites which may not be widely known, but which are of scientific, industrial or cultural significance, which we labelled 'Unsung Heroes'. One of these is Portrush (*see below*), which has an important place in the history of geology but was recently subject to vandalism when rock cores containing important fossils were removed from the site. Listing and highlighting such sites has encouraged local

### Portrush – Historical and Scientific Importance

Portrush is a site near the seaside town of the same name in County Antrim in Northern Ireland. It featured in the Historical and Scientific Importance category because the rocks at this site inspired debate in the early days of geology between the 'Neptunists' and the 'Vulcanists' regarding the origin of igneous rocks. The so-called 'Portrush Rock' was first discovered and described in 1799 as a 'fossiliferous basalt'. The Neptunists thought that rocks were chemical precipitates from seawater while the Vulcanists thought that igneous rocks owed their origin to the crystallisation or solidification of molten material. The rocks found at Portrush seemed to support the Neptunists' theory since it was a basalt bearing fossils. Today these rocks are known to be mudstones of Jurassic age that have been intruded into and cooled to form the igneous rock, dolerite. This site was included because of its importance in the history of geology and is also designated an 'Area of Special Scientific Interest'. Another reason for including Portrush in the list was to highlight the importance of appropriate protection of sites, and to raise awareness among geologists and non-geologists about the need to adhere to codes of conduct when collecting samples. In 2014, rock samples containing ammonite fossils were stolen from the site, diminishing future researchers' and visitors' experience of the site.

Adapted from text provided by Kirstin Lemon.



Portrush © Kirstin Lemon



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communities and others to think about the outstanding geology on their doorstep, and is helping to make them a source of local pride – one of the keys which allowed us to engage successfully with individuals and local groups right across the UK and Ireland about sites in their area.

### How was the list put together?

From March to July 2014, we invited geologists, students and members of the public to nominate their favourite geosite, and to tell us what it meant to them. Through email, Twitter, Facebook and nomination forms distributed at external events such as the Lyme Regis Fossil Festival, we gathered nominations for over 400 geosites. Our contributors sent us a wonderful array of photos of these sites, all of which were made available on Flickr. Outreach for the project took many forms including the popular 'Great Geobakeoff', in which participants recreated their favourite geosites in cake and biscuit form (see <http://blog.geolsoc.org.uk/tag/geobakeoff/>), and regional 'Geobingo' games which encouraged people to take a self-guided geological tour of their region, ticking off geosites as they went.

The nominated sites were grouped into ten broad categories, shaped by the reasons people had given for their nominations, and in September we invited geologists and public alike to vote for their favourite site in



Liz Laycock created the Giant's Causeway in biscuit form for the 'Great Geobakeoff'.

### Dinorwig Power Station and Slate Quarry – Industrial and Economic Importance

The Dinorwig Power Station is a pumped-storage hydroelectric scheme near Dinorwig, Llanberis in North Wales that featured in the Industrial and Economic Importance category. The construction of the power plant was not only a feat of engineering geology, but it is also located in a former slate quarry. The hydroelectric plant is a Short-Term Operating Reserve, used to store energy for when it is needed rapidly. With an output of 1,720 megawatts, it helps to meet spikes in demand for power – for example when millions of people switch their kettles on at the same time at the end of a television programme! The former Dinorwic Slate Quarry was once the second largest slate quarry in Wales, and was in operation from the early 19<sup>th</sup> century until its closure in 1969. At its peak it produced 100,000 tonnes of slate a year. Development of the hydroelectric scheme began in 1974. In order to preserve the natural beauty of the Snowdonia National Park, where it is located, the power station and associated infrastructure was built largely inside the mountain 'Elidir Fawr'. The project took 10 years to complete and was the largest civil engineering contract ever awarded by the UK government at the time. Construction involved 12,000,000 tonnes of rock being removed from inside the mountain and the excavation of an enormous cavern 51 metres tall and 180 metres long. The station is now also promoted as a tourist attraction as 'Electric Mountain', where visitors can take tours and explore the underground workings. *Text adapted with permission from the Electric Mountain Website.*



Dinorwig Power Station and Slate Quarry, Gail Johnson/Shutterstock

each category. More than 1400 people took part. The sites with the most votes in each category were automatically included in the final list as 'People's Favourites', and the 10 winning sites and the categories in which they appeared are listed below:

- Landscape  
*The foreland mountains, Assynt*
- Industrial and Economic Importance  
*The Ironbridge Gorge*
- Historical and Scientific Importance  
*Siccar Point*
- Educational  
*Rotunda Museum*
- Adventurous  
*Staffa*
- Human Habitation  
*Stonehenge*
- Coastal  
*Hunstanton Cliffs*
- Outcrops  
*Coast around Craster*
- Faulting and Folding  
*Millook Haven*
- Fire and Ice  
*Glencoe*

The remaining 90 sites in the final list were selected from the remaining nominations by a panel, based both on sites' popularity in the public vote and on panel members' own wide knowledge and experience.

### Rotunda Museum – People's Favourite in the Educational category

The Rotunda museum in North Yorkshire is a natural history museum that was purpose-built in 1829. Situated in the pretty seaside town of Scarborough, the museum is home to one of the foremost collections of Jurassic geology in the country. The rotunda design of the building was suggested by William Smith himself, often referred to as the 'Father of English Geology', and was used to create the unique display of fossils that illustrated his ideas – an exhibition that remains today. Smith's understanding of the significance of these fossils was essential to the creation of his Geological Map of England and Wales – the first national geological map in the world – in 1815, the bicentenary of which the UK geoscience community is celebrating throughout this year. The rotunda display also features a section of rocks along the coast, drawn onto the inside of the dome. The museum has recently undergone a 2-year refit including the reinstatement of cabinets dating back to 1850 that were originally designed to showcase the work of Smith. The museum, though not an in situ example of the geology of the UK, provides visitors young and old with a fantastic opportunity to learn about geology and the world around them. It also houses scientifically and educationally important collections with significant heritage value, and its popularity in the public vote highlights a need to protect these collections. Many local and national museums were nominated, highlighting their value to the public. *Text adapted with permission from the Rotunda Museum Website.*



Rotunda Museum William Smith Exhibit ©Rotunda Museum

### Cwm Idwal and Darwin's Boulders – Fire and Ice

Cwm Idwal is situated in the stunning mountains of Snowdonia in North Wales and is home to some incredible volcanic and glacial geology that has attracted renowned scientists and been used as an educational field site for generations. The rocks found here were formed 400 million years ago during the Ordovician, when North Wales was underwater and experiencing periodic volcanism. Eruptions in this area created dark basaltic and pale silica-rich rhyolitic rocks, some of which were deposited by explosive processes. The rocks exposed at Cwm Idwal contain a number of deposits that record caldera-related explosive volcanism. These rocks are interbedded with shelly marine sediments formed during the breaks in volcanism, and together they record a dramatic history of the interaction between explosive volcanism and an ancient ocean. Cwm



Cwm Idwal and Darwin's Boulders ©Tom Pennington Source -

Geograph.org.uk

Idwal is also where Darwin made his famous observations about the impact of glaciers on a landscape. He visited Cwm Idwal in 1831 where he observed scattered boulders at Llyn Idwal containing marine seashells. He realised that these rocks had been uplifted to the surface by forces in the Earth's crust. On a later visit, Darwin observed that the landscape of the area was shaped by glaciers at time when Wales was much colder than it is today, which had created the striking hanging valleys seen in the area. The combination of striking geology and historical importance makes this site an excellent 'laboratory' for undergraduates studying caldera-volcanism and interaction with water and ocean sediments, as well as the influence of glaciers on the modern landscape. Adapted from text provided by Natasha Smith.

### Earth Science Week – 'Our Geoheritage'

Earth Science Week 2014 in the UK and Ireland ran from 13-19 October, with the theme of 'Our Geoheritage'. The launch of the list of 100 Great Geosites marked the start of the week. As well as creating a page for each site in the list at <http://www.geol-soc.org.uk/100geosites>, featuring photos, geological descriptions, historical and cultural background and information for visitors, we worked with the GIS software company Esri UK to develop an interactive map of the sites – see <http://www.geol-soc.org.uk/Education-and-Careers/100-Great-Geosites/Interactive-Map>.

The launch attracted extensive national, regional and local media coverage. The BBC News website carried a report of the project featuring stunning images of a number of sites (<http://www.bbc.co.uk/news/science-environment-29572008>), which was the most widely shared item on the site through social media that day. National newspapers such as The Daily Telegraph and the Scotsman also carried the story, and Professor Rob Butler (University of Aberdeen) who chaired the selection panel was interviewed on BBC TV News and on several regional radio stations. Perhaps most encouraging of all, many local newspapers and websites throughout the UK and Ireland covered the story, celebrating the inclusion of geosites in their area in the list and drawing them to the attention of a large proportion of the population.

Throughout Earth Science Week, regional organisations, groups and volunteers held events that celebrated nominated geosites, including those that were included in the final list. Events of note included a tour of the 'Stones of Durham Cathedral' which featured in the Human Habitation category, Lochaber's 'Rock Safari' taking in People's

Favourite Glencoe, and a walk through London to discover Urban Geology.

### Looking back and looking forward

The 100 Great Geosites has been successful in a number of ways so far. As well as providing rich opportunities for engagement with existing audiences in the months running up to the launch, and reaching new audiences through the extensive media coverage achieved during Earth Science Week, the images and text we have gathered for the site constitute an enduring resource. This will be of value for education and outreach projects, and also for continuing to promote the need for proper protection of scientifically important sites. The diverse nature of the final list has broadened people's view of what a geosite is, even among specialist communities, and has helped raise awareness of wider public audiences of the valuable role geology plays in their

lives. We are now continuing to work with Esri UK to produce a 100 Great Geosites mobile app, to be launched in spring 2015, and are at the early stages of planning for other ways in which we can develop the 100 Great Geosites resource.

Several factors have helped to make the project a success. Interest in it built over many months, especially through social media, and the various opportunities for people to get involved in the project at different stages in its development meant that there was a real buzz about it by the time of the launch. To a great extent, it was a 'bottom up' initiative, shaped by those who took part in it, and the involvement of a wide range of partner organisations was invaluable. Finally, the fact that all geosites are inherently local was key to attracting the interest of local groups and communities and securing widespread local media coverage.

### Trotternish - Historical and Scientific Importance



Trotternish, Jan Holm/Shutterstock

Trotternish is situated on the beautiful island of Skye, in Scotland's Inner Hebrides, known by hikers, tourists and amateur geologists alike for its picturesque landscapes and dramatic geology. The site is famous for its large-scale landslides and five successive movements have been identified. One movement at Quirang, which is the largest mass movement slide in Britain, extends over 2km in width. The geology of Skye is dominated by Jurassic sedimentary rocks and Palaeogene lavas which were later intruded by Tertiary dolerite sills. Trotternish is one of the most complete exposures of Jurassic rocks in the country. Trotternish appeared in the Historical and Scientific Importance category, but was also singled out for its spectacular rocky scenery which draws visitors from all over the world. Text adapted with permission from the Scottish Geology website.

Book review:

### Logging the chalk

Manuel Regueiro y González-Barros, *Geological Survey of Spain*

#### Logging the chalk

by Rory N. Mortimer

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Chalk is a type of material that has both technological and industrial uses and that poses geotechnical challenges, specifically during the drilling process. This dual life of the material and its ample geological distribution in Europe have always puzzled geologists and geotechnical engineers.

This book deals with understanding the stratigraphic significance of chalk through a detailed survey of an incredible record of loggings around the areas of Europe where Cretaceous chalk significantly crops. The Northwestern Europe “Chalk Country”, as we may call it, which is dealt with in the book covers onshore and offshore territories in continental Denmark, Germany, the Netherlands, Belgium, France and the UK, specifically the Paris Basin, the German Cretaceous Basin, the London Basin and the Hanbury and Mons regions.

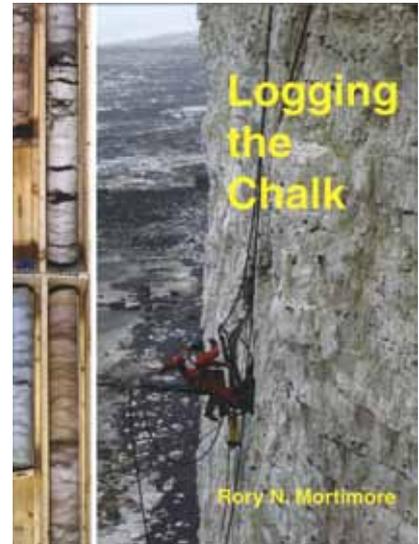
Chalk is also a very variable rock in terms of consistency, as it can range from soft to very hard, and its stratigraphy is also extremely variable. The book has a very useful first chapter about the description, classification and interpretation of chalks

for engineering purposes using both outcrops and drill cores.

Chapters 2 to 5 describe in detail the geology and sedimentology of the different Chalk Provinces: Southern Province, Transitional Province, Northern Province and Central Graben and Northern North Sea zones. The detail includes stratigraphic correlations among the various formations and units using surface outcrops and drill cores logs. These chapters include a wealth of maps, stratigraphic columns, correlation figures and core logs, as well as many photographs and schematic diagrams of myriads of subtle details discussed in the descriptive chapter.

Chapter 6 is devoted to describe the weathering process of chalk using the different classification systems. This again is an extremely useful chapter for the engineering geology practitioner as it includes a substantial number of photos overlaid with very practical and indicative explanations which very much clarify the significance of the photos.

The book includes a chapter about the future, which deals with what the author thinks will be the probable trends in logging the chalk in general. He points to much frequent use of downhole cameras using the advances in digital technology already avail-



able on the market and describes the geophysical borehole wireline logs that can be used, their significance and interpretation.

In summary, “*Logging the Chalk*”, the first ever book exclusively dedicated to this geological material, includes excellent and detailed information for geologists and geological engineers who might have to work in the field with chalk in any geological or construction project.

News corner:

Compiled by Isabel Fernández Fuentes and Anita Stein, EFG Office

### EFG strategy and Horizon 2020 projects

Horizon 2020 is the biggest EU Research and Innovation programme ever, with nearly €80 billion of funding available to

#### INTRAW, fostering international raw materials cooperation



On 10 and 11 February 2015, the INTRAW project consortium held its kick-off meeting in Brussels. INTRAW is a three-year EU-funded project in the frame-

secure Europe’s global competitiveness in the period 2014-2020. Following its Initiative Looking Forward, the EFG Board put a lot of energy in developing and participating in several project proposals within the Horizon 2020 programme. EFG is glad

work of the Horizon2020 programme. The European Federation of Geologists (EFG) is the coordinator of a consortium of 15 partners from different countries including Australia, the United States and South Africa. Most of EFG’s members are also part of the consortium as EFG third parties.

The INTRAW project aims to map and develop new cooperation opportunities related to raw materials in Australia, Canada, Japan, South Africa and the United States, addressing:

- Research and innovation;
- Raw materials policies and strategies;

to report that its efforts have been fruitful. Since the beginning of 2015, the Federation is involved in four Horizon 2020 projects: INTRAW, KINDRA, MINATURA2020 and ¡VAMOS!

- Joint educational and skills programmes;
- Licensing and permitting procedures;
- Data reporting systems;
- Exploration, extraction, processing and recycling practices;
- Management and substitution of Critical Raw Materials.

The outcome of the mapping and knowledge transfer activities will be used as a baseline to set and launch the European Union’s International Observatory for Raw Materials.

More information: [www.intraw.eu](http://www.intraw.eu)

## MINATURA2020, Safeguarding Mineral Deposits of Public Importance



MINATURA2020 is a 3-year EU-funded project that relies on the strength of an international consortium of 24 partners. The overall objective of MINATURA2020 is to develop a concept and methodology (i.e. a harmonised European regulatory/guidance/policy framework) for the definition and subsequent safeguarding of (access to) “mineral deposits of public importance” in order to ensure their “best use” in the future, given the competing public interests.

Providing a policy-planning framework that comprises the “sustainability principle” for mining, as for other land uses, is the key driving force behind MINATURA2020. EFG is involved in the establishment of the Council of Stakeholders and leads the Work Package on Dissemination. The project kick-off meeting was held in Vienna on 3 and 4 March 2015.

More information: [www.minatura.eu](http://www.minatura.eu)

## ¡VAMOS!, Developing a Revolutionary Underwater Mining System

The aim of the EU-funded ¡VAMOS! (Viable Alternative Mine Operating System) project is to design and build a robotic,

underwater mining prototype with associated launch and recovery equipment, which will be used to perform field tests at four EU mine sites.

EFG will support the project consortium through stakeholder engagement and dissemination activities.



More information: <http://vamos-project.eu>

## Geoethics for Society: new inputs from the EGU General Assembly 2015

The growing interest of geoscientists in the debate on the ethical and social implications of geosciences is demonstrated by the attention aroused by the session on geoethics at the last European Geosciences Union's

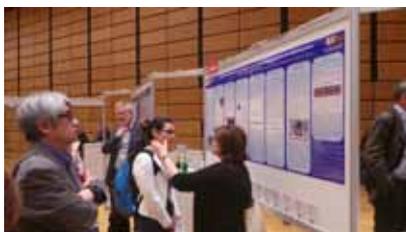
(EGU) General Assembly in Vienna. Twelve oral presentations and 30 posters brought new ideas and reflections to the geoscience community and informed geoscientists all over the world on ethical issues and initiatives in order to make them more aware of their fundamental role in serving society. For the third consecutive year, the session has been organised by the IAPG – International Association for Promoting Geoethics (<http://www.iapg.geoethics.org>) – and has been convened by Silvia Peppoloni (IAPG Secretary General), Nic Bilham (The Geological Society of London; IAPG Corresponding Citizen Scientist on Geoscience Communication) and Eduardo Marone (IAPG-Brazil Coordinator). Among the speakers were David Mogk (Montana State University; IAPG Corresponding Citizen Scientist on Geoeducation and Teaching Geoethics), Edmund Nickless (Executive Director of the Geological Society of London), Ruth Allington (Chair of the IUGS Task Group on Global Geoscience

Professionalism) and Stefano Tinti (IAPG President).

The first part of the session, titled “putting geoethics at the heart of geosciences”, was an overview on general topics such as geoeducation, geoscience professionalism, scientific ethics, and exploitation of georesources. The second part was focused on “Geoethics and geohazards”, with particular attention to preparedness strategies, mitigation policies, probabilistic-deterministic views, social impacts, risk communication and management.

The poster session enlarged and completed the debate started during the oral session. The large audience, the huge number of papers received and the quality of their content has been encouraging and demonstrate the strengthening of geoethics among the scientific community, as a fundamental part of the training of geologists.

All presentations given in this session will shortly be available at <http://iapgeoethics.blogspot.it>



## EAGE/EFG Photo Contest 2015



After the success of last year, EFG and the European Association of Geoscientists and Engineers (EAGE) are again jointly organising the Photo Contest 2015. Once again, the theme is ‘Geoscientists at work’ and members of EFG and EAGE were invited

to submit their photos in the following sub-categories:

1. Education & training
2. Landscapes & environment
3. Fieldwork
4. Energy

A huge number of photos was submitted by the deadline for participation and a vote determined the 12 most popular photos, which will now be printed and included in a travelling exhibition that will visit several

EAGE and EFG events throughout Europe. During the travelling exhibition EFG and EAGE members may cast their votes online for one of the top 12 photos until 31 August.

Great prizes will be awarded to the top three photographs, to be announced in October 2015.

More information: <http://houseofgeoscience.org/photocontest>

### International collaboration

In November 2014, EFG signed cooperation agreements with both the Australian Institute of Geoscientists (AIG) and the Geological Society of South Africa (GSSA). The signing organisations recognise that their objectives with respect to the professional practice of the geological sciences are similar and further recognise the importance of cooperation as the practice of the geological sciences transcends international borders.

The International Association for Promoting Geoethics (IAPG) and the European

Federation of Geologists (EFG) signed a Memorandum of Agreement (MoA) on 12 December 2014 to collaborate on issues of common interest. The International Association for Promoting Geoethics (IAPG) is a multidisciplinary, scientific platform for widening the debate on problems of ethics applied to the geosciences. EFG and IAPG shall collaborate in defining ethical problems affecting professional geologists, also through case-studies, and in promoting geoethical principles and best practices in geosciences among their networks.

In March 2015, the European Federation of Geologists (EFG) and the Geological

Society of Africa (GSAF) signed a memorandum of understanding in Brussels to increase their mutual cooperation. Given the similar objectives and common benefits of its members, EFG and GSAF agree to promote activities fostering cooperation in scientific research and promote scientific opportunities between members of both organisations.

More information: <http://eurogeologists.eu/global-network/>

## The KINDRA project: a European groundwater research inventory

Marco Petitta\* and Adrienn Cseko



**W**ater-related research activities cover a wide spectrum of research areas at EU and national levels. This fact is a result of the intrinsic nature of the topic “water”, which symbolises a key aspect of modern society: not only it is a pivotal human, biological and environmental requirement, it also represents the engine for several research topics which are interconnected, and it has a fundamental impact on urban systems. **Groundwater is the hidden component** of the water cycle, difficult to assess, evaluate and communicate, but at the same time it plays a fundamental role by sustaining the health of our ecosystems, ourselves and our industrial and agricultural production. For these reasons, the groundwater topic must be inserted and highlighted in the EC agendas.

In this framework, the KINDRA project ([www.kindraproject.eu](http://www.kindraproject.eu)) has received fund-

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ing from the European Union’s Horizon 2020 Research and Innovation programme under grant agreement No. 642047. KINDRA seeks to help achieve a better understanding of the groundwater topic by providing an overall view of the scientific knowledge that exists across Europe. With respect to the water cycle, the management of groundwater brings additional challenges to the implementation of the Water Framework Directive (WFD) and climate change adaptation (such as integrated transboundary management of groundwater resources). In general, groundwater has been considered mainly for its relationships with surface waters, influencing river flow, environmental flows, GDE (groundwater-dependent ecosystems), pollutant fate, agricultural practices, water scarcity and others. In this framework, the importance of groundwater inside the WFD has been reinforced by the daughter directive on groundwater since 2006. In the last years, particular insights have been developed on surface waters/groundwater interactions and several related research projects have been carried out.

Nevertheless, a specific focus on hydrogeology, the branch of science studying groundwater, has been overlooked until now, despite the utmost importance of groundwater as a renewable, high-quality, naturally protected (but still vulnerable) resource. At the same time the European knowledgebase that has been acquired on this important topic is spread amongst several projects, plans, actions, realised at national levels and fragmented into wider programs generally related to water, environment or ecology. **In order to have a comprehensive understanding on the groundwater theme, it is necessary to create a “snapshot” of our scientific knowledge as of 2015/2016, covering as many European countries as possible.** Such comprehensive coverage will result in an accurate assessment of the state of the art in hydrogeology research in various geographical and geo-environmental settings, allowing for direct comparison and the exploitation of synergies.

Furthermore, KINDRA seeks to create a critical mass for scientific knowledge exchange of hydrogeology research, to ensure wide applicability of research results, including support of innovation and development, and to reduce unnecessary duplication of efforts. The project started in January 2015 with the overall objective to take stock of our contemporary knowledge of hydrogeology with the help of an



KINDRA activities flow chart

inventory of research results, activities, projects and programmes, and then use the inventory to identify critical research challenges and gaps, with a view to avoiding overlaps. This approach takes into account the implementation of the WFD and new innovation areas within integrated water resources management, allowing at EU scale the future correct management and policy development of groundwater.

As mentioned before, practical and scientific knowledge related to groundwater research and innovation is scattered amongst various actors throughout Europe. KINDRA will develop an inventory of this groundwater knowledgebase, following a new **Harmonised Research Classification System (HRC-SYS)**. This requires an effective assessment of the state-of-the-art of hydrogeology research across different geographical and geo-environmental settings, allowing for direct comparison and identifying synergies in groundwater research. After compiling a common clas-

sification system, a new **European Inventory of Groundwater Research results (EIGR)** will be compiled, including survey results and research activities, projects and programmes, all of which are essential to identify and determine future trends, critical challenges and research gaps. The objective is to improve the management and policy development of groundwater resources at EU level, coherently with the Water Framework Directive (WFD) and the Groundwater Directive (GWD). At the end of the project, following the adopted classification, **the inventory will provide a public-access service for European hydrogeological research in progress.**

At the same time, in parallel with technical implementation, the project previews various forms of communication and dissemination activities for raising awareness on the importance of groundwater. KINDRA will work in close cooperation with the technical and scientific community, stakeholder groups and without constrain to the general public. In addition, KINDRA counts on the direct

involvement of the European Federation of Geologists (EFG), which will provide the technical expertise of its national members actively cooperating within the project. A general orientation meeting for national representatives is scheduled for the autumn of 2015, while specific national workshops will be realised during 2016 in many member states, organized by National Associations of EFG. Furthermore, project implementation will be strongly supported by an expert group of the JPE (Joint Panel of Experts), thus work will be carried out in close interaction with different EU ground-

water associations, networks and working groups. This will also facilitate community involvement and dissemination. Last but not least, the majority of KINDRA's technical content and results will be adapted into outreach materials that will help the general public to better know and understand the relevance and importance of groundwater in daily life.

**The KINDRA Partnership:**

Project Coordinator: Earth Sciences Department, Sapienza University of Rome, Italy

EFG – European Federation of Geologists  
REDIAM – Environment and Water Agency of Andalusia, Spain

LPRC – La Palma Research Centre for Future Studies S.L., Spain

UM – Faculty of Earth Science and Engineering, University of Miskolc, Hungary

GEUS – Geological Survey of Denmark and Greenland, Denmark

**Project Coordinator:**

Marco Petitta, Associate Professor of Hydrogeology  
Earth Sciences Department, Sapienza University of Rome  
Email: [coordinator@kindraproject.eu](mailto:coordinator@kindraproject.eu)

For more information and regular updates on KINDRA, please visit the **project website: [www.kindraproject.eu](http://www.kindraproject.eu)** or follow us on: **Facebook: [KINDRA Project](#)** **Twitter: [@kindraproject](#)** or join our **Linkedin group: [KINDRA Project](#)**



KINDRA consortium members and the JPE, Sapienza University of Rome, 27 March 2015.

# Submission of articles to European Geologist journal

## Notes for contributors

The Editorial Board of the European Geologist journal welcomes article proposals in line with the specific topic agreed on by the EFG Council. The call for articles is published twice a year in December and June along with the publication of the previous issue.

The European Geologist journal publishes feature articles covering all branches of geosciences. EGJ furthermore publishes book reviews, interviews carried out with geoscientists for the section 'Professional profiles' and news relevant to the geological profession. The articles are peer reviewed and also reviewed by a native English speaker.

All articles for publication in the journal should be submitted electronically to the EFG Office at [info.efg@eurogeologists.eu](mailto:info.efg@eurogeologists.eu) according to the following deadlines:

- Deadlines for submitting article proposals (title and content in a few sentences) to the EFG Office ([info.efg@eurogeologists.eu](mailto:info.efg@eurogeologists.eu)) are respectively 15 July and 15 January. The proposals are then evaluated by the Editorial Board and notification is given shortly to successful contributors.
- Deadlines for receipt of full articles are 15 March and 15 September.

## Formal requirements

### Layout

- Title followed by the author(s) name(s), place of work and email address,
- Abstract in English, French and Spanish,
- Main text without figures,
- Acknowledgements (optional),
- References.

### Abstract

- Translation of the abstracts to French and Spanish can be provided by EFG.

- The abstract should summarise the essential information provided by the article in not more than 120 words.
- It should be intelligible without reference to the article and should include information on scope and objectives of the work described, methodology, results obtained and conclusions.

### Main text

- The main text should be no longer than 2500 words, provided in doc or docx format.
- Figures should be referred in the text in italic.
- Citation of references in the main text should be as follows: 'Vidas and Cooper (2009) calculated...' or 'Possible reservoirs include depleted oil and gas fields...' (Holloway *et al.*, 2005). When reference is made to a work by three or more authors, the first name followed by '*et al.*' should be used.
- Please limit the use of footnotes and number them in the text via superscripts. Instead of using footnotes, it is preferable to suggest further reading.

### Figure captions

- Figure captions should be sent in a separate doc or docx file.

### References

- References should be listed alphabetically at the end of the manuscript and must be laid out in the following manner:
- Journal articles: Author surname, initial(s). Date of publication. Title of article. Journal name, Volume number. First page - last page.
- Books: Author surname, initial(s). Date of publication. Title. Place of publication.
- Measurements and units
- Measurements and units: Geoscientists use Système International (SI) units. If the measurement (for example, if it was taken in 1850) was not in SI, please convert it (in

parentheses). If the industry standard is not SI, exceptions are permitted.

### Illustrations

- Figures should be submitted as separate files in JPEG or TIFF format with at least 300dpi.
- Authors are invited to suggest optimum positions for figures and tables even though lay-out considerations may require some changes.

## Correspondence

All correspondence regarding publication should be addressed to:

EFG Office

Rue Jenner 13, B-1000 Brussels, Belgium.

E-mail: [info.efg@eurogeologists.eu](mailto:info.efg@eurogeologists.eu)

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Rue Jenner 13, B-1000 Brussels, Belgium.

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Our different communication tools are the:

- EFG website, [www.eurogeologists.eu](http://www.eurogeologists.eu)
- GeoNews, a monthly newsletter with information relevant to the geosciences community.
- European Geologist, EFG's biannual journal. Since 2010, the European Geologist journal is published online and distributed electronically. Some copies are printed for our members associations and the EFG Office which distributes them to the EU Institutions and companies.

By means of these tools, EFG reaches approximately 50,000 European geologists as well as the international geology community.

With a view to improving the collaboration with companies, EFG proposes different advertisement options. For the individual prices of these different advertisement options please refer to the table.

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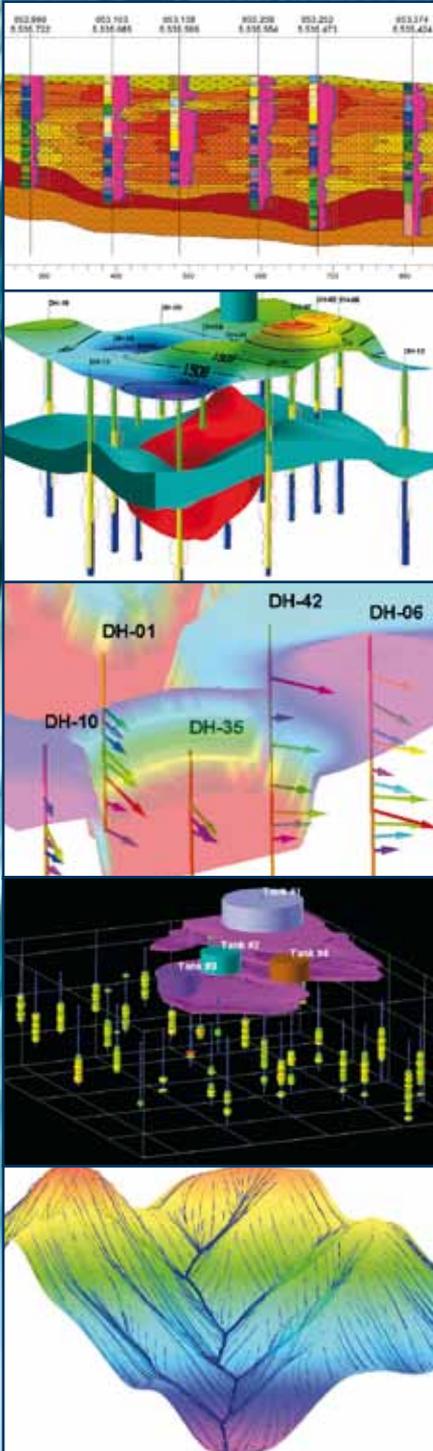
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