The Geological Surveys of Europe, for Europe

The EuroGeoSurveys vision towards a Geological Service for Europe
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Strategic Vision of the Geological Surveys of Europe
united in EuroGeoSurveys

Executive Summary

Europe is facing a number of grand challenges. For many of them knowledge of the subsurface is of vital importance. The need to stimulate economic growth and recovery poses the question to what extent Europe’s industries will remain dependent on imports of critical raw materials. To answer this question we have to know if we can cover this demand from own resources. Europe’s need for reliable, clean and efficient energy asks for a sound, seamless overview of energy resources in Europe. To develop a European strategy to mitigate the effects of climate change it is important to understand the relationship between climate and natural hazards like floods, draughts, land subsidence, landslides etc. To reduce the release of CO2 to the atmosphere it is necessary to know where, and to what extent, CO2 can be safely stored in the subsurface. To guarantee a sufficient supply of food and water Europe needs to know the location, quantity and quality of its groundwater resources and soils. The need to provide EU’s citizens with a healthy and clean living environment asks for a clear, unambiguous understanding of the resilience and vulnerability of Europe’s subsurface to human interference. To protect EU’s citizens against natural hazards it is important to know under which geological conditions areas are subject to risks.

The economic significance of the subsurface\(^1\) is enormous: sectors worth € 1 324 billion and 30 million jobs in Europe rely on the steady supply of non-energy minerals derived from the subsurface. For energy derived from the subsurface the figures are similar. At the same time, reinsurance costs to cover damages caused by natural disasters have steadily increased over the last decades, to up to 119 billion US$ (99 billion €) in 2011 (Source: Munich Re). Recent examples, such as the soaring prices of critical raw materials, or the shale gas revolution in the US, demonstrate that geological data and knowledge have the potential to significantly stimulate innovation, growth and economic recovery.

Geological data, information, knowledge and expertise are needed to address the challenges raised above. As recently noted by a.o. the European Parliament in the framework of the Raw Materials Initiative\(^2\), there is clear and urgent need for a common European Geological Service to support national and EU institutions in effective policy- and decision making and strategic planning related to the subsurface. It is currently not possible, or extremely difficult to get answers to the above mentioned questions.

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1 Critical Raw Materials for the EU, Report of the ad-hoc working group on defining critical raw materials, 2010

2 Proposal for a European Innovation Partnership on Raw Materials” (COM(2012) 82)
The national custodians of geological information and knowledge are the National Geological Surveys (NGSs). These organisations have a long tradition (more than 100 years) in collecting data, preparing information and conducting research focused on their national subsurface. Through their umbrella organisation EuroGeoSurveys, Europe’s NGSs have over the past decades developed good relationships and a growing cooperation, notably within numerous transnational R&D and policy support projects aimed at harmonizing and sharing data or developing new knowledge. Due to geological, economic, political and historical circumstances however, there are still large differences between NGSs in Europe. For this reason there are still a number of gaps and bottlenecks that need to be resolved to allow the creation of a common European Geological Service. These include:

- The need for a common vision and approach towards organising geological knowledge on a European level, as well as a mechanism to align national responsibilities of geological surveys and integrate national research programmes in applied geology on a European level;
- The need for complete, up-to-date, pan-European interoperable data services as well as a joint, sustainable infrastructure to guarantee their continued availability and accessibility;
- The need for a clear organizational framework as well as sufficient capacity in all European countries to provide independent and sustainable policy support to EU institutions and other stakeholders.

In this document and the accompanying position and vision paper, the Geological Surveys of Europe united in EuroGeoSurveys present their joint vision and action plan towards establishing, by 2020, a common European Geological Knowledge Base and to jointly provide a Geological Service for Europe. This Service will guarantee Europe access to objective and seamless data and knowledge on geology and wider geosciences. It will be developed through an integrated geological research and innovation agenda aimed at filling critical gaps. The vision is based on three main pillars:

**Pillar 1:** A joint research programme with a focus on EU policy level describes the development of a coordinated common programme of geoscientific research for the next 7-10 years, with focus on tackling Societal Challenges and Needs that
require knowledge of Subsurface Properties and Conditions.

**Pillar II: Completing, harmonizing, sharing and providing pan-European geological data** addresses the need for pan-European, interoperable geoscientific information. It will focus on building a common **European Geological Data Infrastructure.** This infrastructure will form the backbone for delivering multinational, distributed, derived spatial and temporal datasets, in line with INSPIRE and other international standards.

**Pillar III: Sharing knowledge, capacities and infrastructure** addresses **capacity building** through training and participation in multinational and multidisciplinary research; multinational exchange of researchers and of best practices; and **sharing of laboratories, facilities and infrastructures.** It addresses the very different starting points and capabilities which currently seriously hamper some Member States and regions to unlock their scientific and innovative potential; the need for sufficient professionals in the field; and the need for optimisation of the European applied geoscience research area.

The **action plan** to implement the vision includes the following main elements:

- **An ERA-NET on Applied Geoscience** as a preparatory step towards developing an **Article 185 initiative,** integrating national applied geology research programmes in analogy with the European Metrology Research Programme;
- Establishing the **European Geological Data Infrastructure,** building on an on-going feasibility study (EG-Di-Scope) as well as several other on-going initiatives;
- A series of measures and activities to mutually open up capacities and infrastructure, and to train professionals.
The need for a European Geological Knowledge Base

Geological data, information, knowledge and expertise underpin our responses to many of the key social and economic challenges facing the European and global communities in the 21st century. The composition, properties and dynamics of the subsurface (including the (sub)sea floor) determine a.o. the distribution of vital earth resources (including energy, mineral resources, soil and groundwater); its suitability for safe and sound underground storage of e.g. energy resources, CO2 and nuclear waste; the vulnerability of citizens and vital infrastructure to geological hazards; and the vulnerability of soils, groundwater and other subsurface ecosystem services to pollution and degradation.

At this time of unprecedented economic stresses within Europe and globally, geological data and knowledge have the significant potential to provide new impetus to existing industry and commerce, and to stimulate innovation and growth in the knowledge economy\(^3\). To fully benefit from this potential there is clear need for a common European Geological Knowledge Base, allowing a common European exploration effort for natural resources as well as effective policy- and decision making related to the subsurface. Although the need for such a Knowledge Base, or at least for information related to the subsurface, is recognized by EU institutions in several policy areas (e.g. the Raw Materials Initiative, Groundwater Directive, CCS Directive), much is to be gained by approaching geology as a horizontal theme addressing a wide range of topics. However, there is currently no permanent structure with sustainable funding and capacity to provide the European Union with access to objective and seamless data and knowledge on geology and wider geosciences.

EuroGeoSurveys and the Geological Surveys of Europe

The National Geological Surveys (NGSs) are the institutions responsible for the collection, management, interpretation and delivery of data and information relating to the land and marine subsurface. NGSs have gathered those data over many decades, resulting in vast and unique databases and physical collections. These data underpin the authoritative national geological knowledge bases. These core tasks of data collection, interpretation (in the form of geological maps and models) and dissemination (to industry, policy makers and the public) are highly knowledge and applied research intensive. Consequentially, most geological surveys are research organisations, providing expert knowledge and technical advice to their stakeholders.

Geological information can be of very sensitive nature, for instance in the case of competitive information on energy and natural resources, or information on geological risks or environmental contamination. Such information is also crucial to inform many national and EU policies (see table 1 for an overview). The Geological Surveys of Europe are thus the
key players – together, in certain countries, with national and regional sister organisations that have partial or full responsibility for specific (e.g. marine, soil, groundwater, minerals) geological data types – to build a common European Geological Knowledge Base.

EuroGeoSurveys (EGS), a not-for-profit organization based in Brussels, represents 33 NGSs 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”.

What have we done so far?

EGS coordinates a number of Expert Groups and temporary Task Forces that integrate information, knowledge and expertise deriving from the member NGSs in fields including natural hazards, water, soils, energy, mineral resources, marine geology, spatial data, carbon capture and storage, geochemistry, Earth observation and international cooperation. These Expert Groups have contributed significantly – as has been recognised by the European Commission - to the definition of some fundamental legislative initiatives and policy provisions, such as the INSPIRE Directive; the Raw Materials Initiative; the Directive on the geological storage of CO2; the EC’s Maritime Policy; the Soil Thematic Strategy; the Water Framework Directive; the Mining Waste Directive; the Resource Efficiency Policy; the Coastal Zone Policy.

NGSs have also participated in a substantial number (over 250 since 1998) of EU funded R&D and policy support projects that contributed to solving important societal challenges and promoting sustainable and competitive growth. A number of notable and recent examples are given in table 1 below.

Gaps and Bottlenecks

Despite the important work already carried out by the NGSs, both separately and collaboratively, there are still a number of gaps and bottlenecks that need to be resolved to allow the creation of a common European Geological Knowledge Base and associated specific services in support of EU policies, possibly in the form of a permanent network structure - ‘the European Geological Service’:

- A common European Geological Knowledge Base is crucial to a wide range of societal issues, including resource security/sustainability (energy, minerals, water), environmental monitoring, health and safety of citizens, and the development of secure infrastructure (natural hazards). Currently, geological data and knowledge relevant to these issues are fragmented and thus not easily and interoperably available for interpretation. There is a need for a common vision and approach towards organising geological knowledge on a European level;

- NGSs have widely differing mandates (areas of activity/responsibility as well as freedom to operate), levels of embedding (within ministries of environment, economy, research, or otherwise), legal frameworks (including accessibility of data), resources, capacities, and more. EGS and its expert groups have successfully bundled these institutions, identified geoscientific topics important for European policies, and initiated pilot actions to address these. However, this effort is still voluntary and largely depends on research projects which are usually concentrated on test areas rather than the entire EU (although regional area covering assessments exist); data and experts are usually not available after these projects have been finalised. Thus, available data for all of Europe and the response time by experts to policy demand still lag behind its potential for Europe

- The mandate of NGSs is strictly national, meaning that they do not themselves have the freedom to make resources and manpower available to durably integrate their activities on a European level. A mechanism is needed to align the national responsibilities of geological surveys and to integrate national research programmes in applied geology on a European level, building on the knowledge, expertise, infrastructure and data of the National Geological Surveys and related organisations.

- Geological Surveys have an indispensable role to play
in the common geological knowledge base, but there are many other national organisations (universities, research institutes, other governmental and non-governmental institutions, industry) that hold important information and expertise as well. The network needs to be expanded to include these as appropriate.

- Although the NGSs have very actively contributed to the development of INSPIRE, and have successfully performed a number of projects in the areas of spatial data harmonisation and dissemination (modelling, infrastructure, web services), much remains to be done as there is:
  - incomplete geographical coverage of interoperable data services, since most projects have involved only a limited number of surveys;
  - no continuity of EU project results (maintenance and updating of portals and data services) as there is no mandate or funding for structural support;
  - no joint, sustainable information infrastructure to facilitate continuity of EU project results.

- The current operative model of EGS does not constitute a central organization but a loose association facilitating dialogue and cooperation between NGSs. It does not have the capacity to coordinate joint projects and programs. There is a need for a clear organizational framework that fulfils the following roles and demands:
  1) maintenance of the national mandates of NGSs and strengthening of link to European policies;
  2) identification of pan-European research challenges and responding programmes and overseeing joint research programming;
  3) providing a platform for data storage and dissemination;
  4) providing independent and sustainable policy support to EU institutions and other stakeholders. In short, a “European geological service”.

**Conclusion**

Europe’s NGSs vary in size, capacity, expertise, resources and infrastructure, and operate under different mandates and remits. Thus their abilities to support the common European Geological Knowledge Base differ. Further, existing national resources and infrastructures are under pressure because of the current economic crisis. Since national data coverage as well as national geological knowledge is indispensable for the objectives of establishing the common European Geological Knowledge Base with the purpose to serve European citizens, measures are needed to address this, and to provide support and best utilise limited resources at European Level.
Next steps

This document addresses stakeholders with the need for geoscience knowledge in Europe. Based on their feedback a separate vision statement will follow which will focus on a European Geological Service in more detail.

Any feedback is welcome at info@eurogeosurveys.org

Table 1: overview of recently finished, on-going and recently submitted or granted projects of direct relevance to various activity areas and involving a significant number of National Geological Surveys as project partners.

<table>
<thead>
<tr>
<th>Topic</th>
<th>Short name &amp; link</th>
<th>Main objective / deliverable</th>
<th>Period</th>
<th>EU Programme</th>
</tr>
</thead>
<tbody>
<tr>
<td>Geology</td>
<td>OneGeology -Europe</td>
<td>Creation of a geoportal serving 1:1 million scale harmonised geological map data from 20 European countries in 18 European languages.</td>
<td>2007-2010</td>
<td>CIP ICT-PSP</td>
</tr>
<tr>
<td></td>
<td>EGDI-Scope</td>
<td>Designing a sustainable e-infrastructure for serving pan-European geological datasets.</td>
<td>2012-2014</td>
<td>FP7 Capacities</td>
</tr>
<tr>
<td>Minerals &amp; Energy</td>
<td>Pro-Mine</td>
<td>Pan-European GIS-based database containing known and predicted metalliferous and non-metalliferous resources, which together define the strategic reserves (including secondary resources) of the EU.</td>
<td>2009-2013</td>
<td>FP7-NMP</td>
</tr>
<tr>
<td></td>
<td>EuroGeoSource</td>
<td>Data portal, allowing access to aggregated geographical information on geo-energy and mineral resources in 10 EU countries.</td>
<td>2010-2013</td>
<td>CIP ICT-PSP</td>
</tr>
<tr>
<td></td>
<td>EURARE</td>
<td>Characterize the potential REE resources in Europe, and research, develop, optimize and demonstrate technologies for the efficient and economically viable exploitation of currently available European REE deposits with minimum consequences to the environment.</td>
<td>2013-2016</td>
<td>FP7-NMP</td>
</tr>
<tr>
<td></td>
<td>SARMa / SNAP-SEE</td>
<td>Develop and disseminate tools for primary and secondary aggregates management planning in South-east Europe</td>
<td>2009-2011/2012-2015</td>
<td>SEE</td>
</tr>
<tr>
<td></td>
<td>Minerals4EU</td>
<td>Develop a user-centred intelligence network structure for delivering data, information and knowledge on mineral resources in the European Union and on a global scale</td>
<td>2013-2015?</td>
<td>FP7-NMP</td>
</tr>
<tr>
<td>Topic</td>
<td>Short name &amp; link</td>
<td>Main objective / deliverable</td>
<td>Period</td>
<td>EU Programme</td>
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<tr>
<td>Marine Geology</td>
<td></td>
<td>Assemble fragmented marine geology data into interoperable, contiguous and publicly available data-sets for whole maritime basins</td>
<td>2009-2020? (phase 1 finished, phase 2 approved)</td>
<td>DG MARE</td>
</tr>
<tr>
<td>Geo-Seas</td>
<td></td>
<td>e-infrastructure enabling users to identify, locate and access pan-European, harmonised and federated marine geological and geophysical datasets and derived data products through a single common data portal.</td>
<td>2009-2012 (finished)</td>
<td>FP7 Capacities</td>
</tr>
<tr>
<td>Geo-Hazards</td>
<td>PanGeo</td>
<td>Provide information on ground stability hazards in urban areas in all EU countries</td>
<td>2011-2014</td>
<td>FP7 Space</td>
</tr>
<tr>
<td></td>
<td>SubCoast</td>
<td>Developing a GMES-downstream service for assessing and monitoring subsidence hazards in coastal lowland areas around Europe.</td>
<td>2010-2013</td>
<td>FP7 Space</td>
</tr>
<tr>
<td></td>
<td>SAFELAND</td>
<td>Develop generic quantitative risk assessment and management tools and strategies for landslides at local, regional, European and societal scales</td>
<td>2009-2012</td>
<td>FP7 ENV</td>
</tr>
<tr>
<td></td>
<td>DORIS</td>
<td>Advanced downstream service for the detection, mapping, monitoring and forecasting of ground deformations, including landslides and ground subsidence, at different temporal and spatial scales and in various physiographic and environmental settings.</td>
<td>2010-2013</td>
<td>FP7 Space</td>
</tr>
<tr>
<td>CCS</td>
<td>GeoCapacity</td>
<td>Assess the European Capacity for Geological Storage of Carbon Dioxide</td>
<td>2002-2006</td>
<td>FP6</td>
</tr>
<tr>
<td></td>
<td>ECCSEL</td>
<td>Preparatory project aimed at forming a new distributed research infrastructure devoted to world-class experimental research pertaining to CCS (phase 1 finished; phase 2 started 01-01-2013).</td>
<td>2011-2014</td>
<td>FP7 Capacities</td>
</tr>
<tr>
<td>Water</td>
<td>e-Water</td>
<td>Multilingual cross-border access to groundwater databases</td>
<td>2006-2008</td>
<td>e-Content-plus</td>
</tr>
<tr>
<td>Geochemistry &amp; Soils</td>
<td>GEMAS</td>
<td>Comprehensive mapping of the geochemical properties of agricultural soil and grazing lands throughout Europe</td>
<td>Na</td>
<td>Self-Funded</td>
</tr>
</tbody>
</table>
Vision Paper of the Geological Surveys of Europe united in EuroGeoSurveys

Developing a joint Geological Service for Europe

Introduction

Geology aims to provide a detailed understanding of our solid Earth (the geosphere): its origin and history; its physical and chemical structure and dynamics; and its interaction with the hydrosphere, biosphere, cryosphere, atmosphere and increasingly the anthroposphere. A good understanding of the solid Earth is key to managing wealth generation and promoting well-being. It provides knowledge on the occurrence and exploitability of natural resources, as well as on risks and impacts of natural and human-induced processes. The fast-growing global population places ever more demands on limited natural resources and ecosystem services. As a result, European society faces great challenges for which ecologically, economically and socially sound solutions and scientific advice are required. In particular, these challenges include geo-energy, raw materials, groundwater, and geohazards.

The National Geological Surveys (NGSs) are national entities responsible for policy support in all subsurface-related survey and management activities, including mitigation and exploration research, vulnerability and risk assessments, forecasts and statistics. The NGSs of Europe, united in EuroGeoSurveys (EGS), jointly represent the critical mass of knowledge, research capacity and capability, data and facilities needed to fulfil that same role on a European level.

This vision paper provides the strategic framework for the development of a European Geological Service, building on the EU’s public-public partnering initiatives. It supports the premise that integrated and transnationally accessible geological knowledge and information will serve Europe’s needs to manage its resource potential in such a way that the ability of future generations to meet their own needs is not compromised, safeguarding vulnerable resources and environments. It will allow the existing network of the national surveys, EGS, and their partner institutions in research, to combine and coordinate existing national research and policy activities concerning the subsurface.

1. Scope

This paper presents the joint vision, mission and action plan of the Geological Surveys of Europe united in EGS for the period of 2013-2025. The action plan aims to develop knowledge and information to support policy makers, industry, academia and the general public, covering all transnational issues related to the subsurface and the geosphere thus delivering the EGS mission:

‘EGS provides public Earth science knowledge to support the EU’s competitiveness, social well-being, environmental management and international commitments’.

In realising this vision, EGS and the NGSs will align with other relevant initiatives and work with all interested stakeholders.

The area of competence of NGSs encompasses the geosphere (the solid parts of the Earth), both on- and offshore, with a focus on the “zone of human interaction” (Figure I): the upper 5-7 km of the Earth’s crust.
This Vision Paper builds on the Position Paper “State-of-the-Art of The European Geological Knowledge Base”. The latter document describes the need for developing a common European Geological Knowledge Base, the current state of collaboration between Europe’s NGSs, and the gaps and bottlenecks that need to be overcome to optimise that collaboration. This paper describes the vision of the Geological Surveys of Europe towards overcoming existing bottlenecks, and thus improving knowledge, infrastructure and data bases in support of European policies, directives and research & development related to the Earth’s subsurface.

2. The changing role of Geosciences: Opportunities and Challenges

Geological data, information, knowledge, intelligence and expertise underpin the responses to many of the key social and economic challenges facing the European and global communities in the 21st century. Innovations in the field of geology have the significant potential to provide new impetus to existing industry and commerce, and to stimulate innovation and growth in the knowledge economy⁴.

New geological knowledge can lead to the discovery and safe and sustainable exploitation of new energy, mineral and other resources. At the same time, knowledge and information on the dynamic geosphere are indispensable in helping European citizens cope with anthropogenic pressures, climate change and natural hazards. They are also key elements in protecting the European environment. The subsurface, including soils and groundwater, is increasingly used and therefore under pressure. Many human activities have positive effects, increasing safety, generating renewable energy or creating valuable habitats. Some others affect the Earth negatively. Essential parts of Europe are facing pollution, erosion, soil sealing and loss of fertility as a result of urbanization, industrialization and land-use change. These affect the availability and access to food, drinking water, clean air and other benefits from resources and processes that are supplied by ecosystems (ecosystem services) for Europe’s citizens. Exposure to naturally occurring toxic substances like arsenic, mercury or radioactive materials (e.g. radon) or harmful minerals (e.g. asbestos) may also endanger human health. In short, geological knowledge and information are essential to allow us to make optimal use of the geosphere without compromising it for future generations.

Specific challenges and opportunities are worked out in

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⁴ This is recognized a.o. in the European Competitiveness Report 2011 (SEC(2011) 1188).
more detail below:

**Non-energy raw materials**: The Earth’s crust contains the vast majority of all non-biological resources, and the economic and strategic significance of the subsurface domain is tremendous. Sectors worth €1 324 billion and 30 million jobs in Europe rely on the steady supply of non-energy minerals. For some of these minerals Europe is 100% import dependent. These include some base metals (e.g. magnesium, tin), as well as rare earth elements (REE), platinum group elements and other elements that are crucial for green technology, mobility, communication and high-tech products (ICT hardware, batteries for electrical cars, windmills, etc.).

Bulky raw materials such as industrial minerals and aggregates (sand, clay, gravel) are of significant importance for national and local economies, industry and infrastructure. Although mainly produced locally, for some of these materials European Countries are among the top ten global producers (e.g. feldspar, gypsum and anhydrite, magnesite, potassium, perlite). Apart from producing such materials, Europe is also leading in associated technologies, such as marine extraction of sand e.g. for harbor extensions and coastal nourishments.

There is still high potential for exploration of new European resources, both onshore and especially offshore as appropriate technology becomes available. Geological knowledge will facilitate the discovery of new European resources, and innovation in exploration and green mining technologies will contribute to their safe and environmentally sound retrieval. Reliable mineral resource statistics and mineral intelligence are needed for policy making and raw materials strategy development.

**Energy**: Fossil fuels contained in the Earth’s crust (oil, gas, coal, peat, gas hydrates) still provide roughly 80% of the world’s energy, and are projected to remain the main global energy source at least until 2050. Technological innovations will allow much more efficient use of known reserves and will make the exploitation of unconventional reserves (e.g. shale gas, coal bed methane, gas hydrates) possible and economically viable. This will make a significant contribution to resource efficiency, and potentially shift “peak oil” further into the future, thus safeguarding existing resources for future generations. Simultaneously, the geosphere provides a potential storage space for CO2, as well as a source of renewable geothermal energy. Nuclear fuels (U, Th) are also sourced from the subsurface, and geological storage of spent radioactive fuels is the only realistic option for long term disposal at present. Finally, innovative technologies are being developed to use subsurface space for temporarily storing other forms of sustainable energy (e.g. compressed air in salt caverns).

**Environmental impact of resource exploitation**: Although the Earth’s resources are necessary for everyday life and of enormous economic significance, there is increasing concern among Europe’s population over the safety and environmental impact of their exploitation. These concerns have recently surfaced particularly in the fields of storage of CO2 and the exploration for shale gas, but also in connection to mining and industrial facility accidents such as the red mud spill in Hungary and the Baia Mare disaster in Romania. These issues highlight the need for developing a detailed geological knowledge base on these topics, to support the development of much more severe risk assessments, and for developing new mining technologies for safe exploitation, production, monitoring, inspection and restoration. Better communication of geological knowledge to the general public and improved public involvement in decision making processes are of great importance as well.

**Underground spatial planning**: The multiple uses of the subsurface for geological storage, exploitation of both fossil and sustainable energy, and exploitation of other resources, results in potential conflicts for the use of subsurface space. There is an increasing need for the development of subsurface spatial planning policies, as well as the data, knowledge and tools to underpin them. This is particularly the case in densely populated areas, where e.g. near surface mining, waste deposition, geothermal energy applications, underground building and storage may conflict with environmental issues, nature protection, agriculture and water supply and
Other infrastructure. Resources may also be effectively sterilised (become inaccessible) by urban – residential – land use.

**Environmental pressures on near-surface geology:** Soils are the most important substrate for agriculture, farming and forestry. Without soils, most life on land would not be possible. Moreover soils play an important role as filter and storage space for groundwater, which itself is the most critical raw material worldwide. Seabed sediments are also of great importance as they form the basis supporting marine habitats. Pressures on the seabed include large scale sand movements, fisheries that directly disturb the seabed, beach heads, etc.

Soils and groundwater are increasingly under pressure. They are threatened by pollution, erosion, soil sealing and loss of organic carbon and fertility as a result of urbanization, industrialization and land use change. These threaten the availability and access to food, drinking water, fresh air and ecosystem services of Europe’s citizens. In addition, soils and shallow deposits may contain naturally occurring toxic substances like arsenic, mercury or radioactive materials (e.g. radon), or harmful mineral shapes (e.g. asbestos). The exposure to these substances may endanger human health.

**Natural and man-made hazards:** The socio-economic impact of natural and man-made hazards has increased significantly over the last decades – to a large extent as a result of increasing urbanisation and concentration of population and infrastructures, particularly in vulnerable regions such as coastal lowland areas and along fault zones. Reinsurance costs have increased significantly, to up to 119 billion US$ (99 billion €) in 2011 (Source: Munich Re). In addition, and partly due to the instantaneous diffusion of images of disasters in the media, the sensibility of citizens to such hazards has increased. There are new demands for detailed hazard and risk mapping, as well as mitigation and adaptation measures to optimise security, respond to emergencies and manage disasters. These in turn require better understanding of natural and man-made processes and related geohazards, New and more effective tools are required to improve mitigation and resilience policies. And adequate legislation for building resilient housing and infrastructures needs to be based on up-to-date risk assessments.

**Climate change:** A significant reduction of greenhouse gas emissions – as expressed e.g. in the “20-20-20” reduction targets of the EU’s Climate and Energy Package – is needed to prevent climate change from transgressing critical thresholds. Possible alternative, sustainable energy sources importantly include geothermal energy. The large scale and safe deployment of these requires new geological knowledge and expertise, as well as renewed technologies. Geological storage remains an option for reducing CO2 emissions from burning fossil fuels, which are likely to remain the primary global energy source at least for the next decade (see also above). Policies for adaptation to climate change require new tools for protective coastal management, landslide mitigation, as well as new approaches for soils and groundwater.

**Geodiversity and geoheritage:** Both geodiversity, a crucial factor conditioning biological, cultural and landscape diversity, and geoheritage, those geological elements with high scientific, educational or touristic value, must be preserved for future generations. We must protect the most vulnerable and representative elements of nature, whether biotic or abiotic, keeping in mind that while most species, habitats and ecosystems may be resilient and undergo recovery, most geological heritage is non-renewable and irreplaceable. European NGSs are leading the latest advances in geodiversity characterization and geoheritage inventory and assessment. Natural protected areas need to incorporate the geological record of climate change and the evolution of life, and European legislation is also steadily moving forward towards the integrated protection of natural diversity and natural heritage. EGS has the capacity to assess in these aspects, and the increasing demand from society needs to be answered.

**The international dimension:** Due to the dispersion at national level of regulatory and technical capabilities related to natural resources and risks assessment, there is no single coherent support for EU policy development on these global issues. There is a need for a shared EU view of the world based on permanent survey and assessment capabilities akin to the US, China and other emerging global economies, e.g. BRICs. Whilst the world population continues to increase, and many third world / developing countries enter a path of increased social and economic development towards
Western European and US standards, new inequities are inevitable. Globally we are far from the objective of eradication of poverty championed by successive world summits. NGSs are in a particularly difficult position in this respect as the exploitation of mineral and energy resources are frequently condemned as a “malediction” for the producing country, when they – the NGSs - should be recognised as key facilitators of development. This raises the issue of “good governance”, implying the need for training and capacity building in the countries concerned. A link between the EU development policy and raw materials strategies, based on geoscientific information including reliable mineral resources statistics, in order to ensure a sustainable supply is essential. The EU strategy on raw materials needs to be prioritized in respect to trade, domestic mining and recycling.

Virtual Earth: Information technology pervades both the scientific world and everyday society and provides immense potential for advancement in the geosciences. 2D, 3D and even 4D (dynamic) models can now be constructed in order to map, model, understand and manage the subsurface and to predict, fuel debate and inform on potential use. Modern technology allows visualisation of potential raw material deposits, groundwater bodies and potential pathways. Through the development of interoperable spatial data services and open data policies, they can be linked to other information concerning infrastructure developments, agriculture and other special uses.

Public resources under pressure: NGSs, as part of the public sector, are facing increasing budget cuts resulting in reduced staff levels and other cuts, whilst at the same time there is increased demand for their data and information. Research and innovation, as well as specialized training, offer new opportunities in sectors which, in the recent past, were not necessarily favoured by public policy priorities. Improved synergies with academic research as well as better coupling with demanding private and public sectors are essential.

3. Vision and Goals – Maximizing added value and minimizing impact of using the subsurface

In the “Proposal for a European Innovation Partnership on Raw Materials” (COM(2012) 82) the European Commission notes that:

“For many years the basic geological exploration and mapping in the EU has been carried out by national geological surveys that have to operate within the constraints of national frameworks and regulations. Today, the full benefits of an appropriate coordination or even integration of some of the activities of the EU’s different 27 geological surveys has not been achieved. Yet, innovative thinking based on increased networking and cooperation offers a huge potential to move forward. Setting European standards will facilitate the creation of a uniform EU geological knowledge base, and can also lead to a more cost-effective development and use of required modern technologies, such as satellite-based resource information and advanced 4D computer modelling systems.”

The Strategy laid down in this Vision Document responds directly to this call for enhanced collaboration between the individual NGSs. It aims to mobilise and coordinate the NGSs human resources, expertise scientific capacities, and research infrastructures to establish a common EU “geological knowledge base”. Although the current vision is formulated from a geological surveys’ perspective, existing linkages will be exploited and, where necessary, new linkages will be forged with industrial, academic and policy stakeholders and partners both within and outside Europe, to create critical mass.

The vision of the Geological Surveys of Europe united in EuroGeoSurveys will make a significant contribution to the EU 2020 Strategy objectives of Smart, Sustainable and Inclusive Growth. In particular the vision is relevant to the flagship initiatives of “Innovation Union”, “Resource Efficient Europe”, and “An industry policy for the globalization area”. It will contribute to the Raw Materials Initiative objective of securing reliable and unimpeded access to raw materials for Europe’s industries, and to the 20-20-20 by 2020 objectives of Europe’s Energy 2020 strategy.

The vision will contribute to the **INSPIRE directive** through harmonizing and sharing of pan-European geological data.

Specific impacts on key policy drivers at regional, European and global scale are given in Appendix A.

4. Realising the Vision: Strategy based on 3 Pillars

The vision of EuroGeoSurveys and the Geological Surveys of Europe towards establishing a European Geological Service is based on three main pillars (Figure 2):

- **Pillar I**: A joint research programme with significant impact at EU policy level
- **Pillar II**: Completing, harmonizing, sharing and providing pan-European geological data
- **Pillar III**: Sharing knowledge, expertise, capacities and infrastructure.

**VISION STATEMENT**

By 2020 the Geological Surveys of Europe united in EuroGeoSurveys, together with relevant partners, will have established a common European Geological Knowledge Base and will jointly provide a Geological Service for Europe. This Service will provide the European Union with access to objective and seamless data, knowledge and expertise on geology and wider geosciences. It will be developed through an integrated geological research and innovation agenda aimed at filling critical gaps. This Knowledge Base and Service will contribute to the following goals:

- Enable optimal use and management of – including optimising planning of activities in – the subsurface, maximising its added value for raw materials, soil and groundwater, storage, and ecosystem services, while minimising environmental impacts and footprints;
- Contribute to good environmental status of the subsurface, including (ground)water, soils, and the ocean floor;
- Optimise Society’s resilience to natural (geological) hazards, including those induced by land use and climate change, thus reducing the loss of human life and environmental, economic and material damage resulting from them.

**Pillar I**: A joint research programme with significant impact at EU policy level describes the development of a coordinated **common programme of geological research** for the next 7-10 years, with focus on tackling **Societal Challenges and Needs** that require knowledge of **Subsurface Properties and Conditions**. This research programme will:

- Support innovation, industrial development and competitive growth;
- Support European policy-making to improve quality of life and safety for European citizens;
- Maximize the sustainability of exploration, exploitation and management of the subsurface and its natural resources;
- Strengthen the capacity of the geoscientific community and using it to its fullest advantage, with a greater focus on pan-European issues.

**Pillar II**: Completing, harmonizing, sharing and providing pan-European geological data addresses the need for pan-European, interoperable geoscientific information. It will focus on building a common **European Geological Data Infrastructure (EGDI)**. This infrastructure will form the backbone for delivering multinational, distributed, derived spatial and temporal datasets, in line with INSPIRE and other international standards. As such, it will be the foundation for the common EU geological knowledge base. Key to this pillar is the long-term operationality of the infrastructure.

**Pillar III**: Sharing knowledge, capacities and infrastructure ad-
addresses **capacity building** through training and participation in multinational and multidisciplinary research; multinational exchange of researchers and of best practices; and sharing of laboratories, facilities and infrastructures. It addresses the very different starting points and capabilities which currently seriously hamper some Member States and regions to unlock their scientific and innovative potential; the need for sufficient professionals in the field; and the need for optimisation of the European Applied Geoscience Research area.

This pillar aims to build capacity across the Applied Geoscience ERA:

- in European countries were this capacity is currently underdeveloped;
- across the ERA in order to provide NGSs but also academia, industry and relevant policy institutions with sufficient workforce (particularly in the field of Raw Materials);
- to jointly preserve knowledge and know-how that is critical, but too limited in scope or too expensive to effectively maintain it on a national level.

Together, the three pillars form the basis for creating an enduring European Geological Service to be developed, maintained and delivered by the National Geological Survey Organizations of Europe. They will allow the Geological Surveys of Europe and related national organizations to take their existing collaboration to the next level, and work towards integration of national programmes in the field of applied geology.

**Relationships between different elements of the strategy**

The joint research programmes (Pillar I) will deliver data and information products that will be made accessible by the EGDI (Pillar II). At the same time, pan-European, harmonised geological data and information served through the EGDI may enable joint research in Pillar I. Similarly, joint research projects (Pillar I) will facilitate exchange of staff, training, and capacity building, and will make use of shared infrastructure and capacities (Pillar III). In addition, many Pillar III activities will directly relate to the development and maintenance of the EGDI (Pillar II). The *European Geological Service* will ultimately provide a common single access point for EU bodies and other stakeholders.
5. Implementation

5.1 Aligning national efforts: Building the Geological Service

ERA (Pillar I)

The central aim of the Vision described in this paper is the coordination and integration of activities and expertise of Europe’s NGSs. In a very similar setting to that of NGSs, the National Metrology Institutes of Europe and the European Commission have in 2007 launched the European Metrology Research Programme (EMRP) under Art. 185 TFEU. This initiative was recently very positively evaluated. According to the evaluators, the programme has significantly contributed to modernizing the scientific metrology base and enabling it to have much broader impacts; to pooling resources and capacities on a European level; and to opening the metrology system to the best science available in Europe. In March 2012 the EGS General Meeting agreed that Art. 185 TFEU is a most suited tool to achieve the required European integration of geological survey abilities outlined above.

In analogy to the EMRP, we propose and seek support for an ERA-NET project on Applied Geoscience as a necessary preparatory step towards developing an Article 185 initiative. The objectives of this ERA-NET project will be to:

- Bring together NGSs (as programme managers of geological survey research programmes) and their governing ministries (as programme owners) to:
  - Systematically exchange information and best practices;
  - Build the environment and processes, particularly amongst the programme “owners”, to facilitate joint activities (including the identification and overcoming of legal and other barriers);
- Develop a joint Strategic Research Agenda, building on a systematic and on-going foresight process and including clear and SMART goals and objectives;
- Develop the organisational structures needed to implement and execute joint activities (where EuraMet e.V., which runs the EMRP 185 programme, will serve as an example);
- Develop modalities within the joint activities that will allow and guarantee exchange of researchers and knowledge, training and capacity building, and shared use and development of infrastructures (Pillar III);
- Initiate jointly planned research projects in selected pilot areas on a shared-funding basis through a first joint call;
- Secure financial and political commitment for an Article 185 programme in applied geoscience, take a go/no-go decision for such a programme, and explore possible alternatives for implementation of this vision.

Many of the prerequisites for the successful development and implementation of the proposed ERA-NET and Article 185 programmes are already in place. The collaboration of the Europe’s NGSs through in EGS is well established dating back to 1971. EGS is now a non-profit international organization under private law in Belgium, and has a dedicated Secretariat in Brussels. It has well-established connections to European institutions and DGs (partly through its Expert Groups), to industry (in particular through the European Technology Platform on Sustainable Mineral Resources), as well as to international sister organisations throughout the globe.

The resources available to European NGSs represent a significant portion of total public spending on geological R&D in Europe. EGS members are currently in the process of identifying which other organizations by country should be taken on board the proposed initiative in order to generate critical mass, as well as mapping out what resources could be made available to an Article 185 initiative. In parallel, the outline of the Strategic Research Agenda is being developed, and discussions on prioritisation of topics, programme modalities and targets for knowledge exchange, capacity building and sharing of infrastructures are ongoing.

5.2 Establishing the European Geological Data Infrastructure (Pillar II)

Over the last 10 years, European NGSs have participated jointly (i.e. 2 or more surveys) in a large number of European and international projects aimed at spatial and temporal data collection, harmonisation and dissemination. These include projects on digital geological maps and thematic maps on non-energy minerals, geo-energy, geo-hazards, CCS, marine geology, groundwater quality and quantity, shallow subsur-
face quality and chemistry, etc. (see the EGS Position Paper for an overview). Many of these projects have developed data standards, web portals, data infrastructures, information services etc. However, much remains to be done in this field as there is:

- **incomplete geographical coverage** of interoperable data services, since most projects have involved only a limited number of surveys;
- **no continuity of EU project results** (maintenance and updating of portals and data services) as there is no mandate or funding for structural support;
- **no joint, enduring information infrastructure** to facilitate continuity and sustainability of EU project results.

In order to tackle these issues, a scoping study was recently started under FP7 with the aim of designing a pan-European Geological Data Infrastructure (EGDI-Scope). When realized the EGDI will provide the backbone for sustainably serving interoperable, pan-European geological data currently held by the Geological Surveys of Europe, along with data from past, ongoing and future European projects. The objectives of the scoping studies are to:

- Develop connections with and gather user requirements from EGDI end-users;
- Select and prioritize datasets producing maximum societal benefit;
- Work out the Technical design of the infrastructure;
- Develop models for governance and future, sustainable funding of the EGDI.

The EGDI-Scope project will finish mid-2014, and will have as its key deliverable an implementation plan for the EGDI. This vision paper calls for further commitment to the establishment of the EGDI as a solid foundation for Pillar II of the strategy. Funding for implementation of the EGDI will primarily be sought through the e-Infrastructures programme of Horizon 2020.

### 5.3 Unlocking Member States’ and regions’ scientific and innovative potential (Pillar III)

The primary aims of Pillar III are:

- to share best practices and exchange know-how;
- to make effective and efficient joint use of the capacities and infrastructures available at individual NGSs;
- to aid individual NGSs in developing expertise and building capacity they currently don’t have;
- to jointly preserve knowledge and know-how that is critical, but too limited in scope or too expensive to effectively maintain it on a national level.

The achieve these aims, action is needed to develop training programmes; to develop fora for systematic knowledge exchange; to work out agreements for the joint use of infrastructures; to identify expertises that are threatened to disappear; to develop modalities for the mutual exchange of staff; etc. Many of these activities can be incorporated as mandatory elements in joint research projects resulting from ERA-NET and Article 185 calls. However, experience from similar previous programmes (e.g. the EMRP 185) show that Pillar III aims are difficult to achieve within such a setting and require special effort.

In addition, actions in this pillar may make use of regional funds, special funds for capacity building (e.g. the Marie Skłodowska-Curie programme), and others.

### 5.4 Alignment with on-going initiatives

In the field of Non-Energy Raw Materials, NGSs are actively contributing to the development of the Raw Materials initiative and the European Innovation Platform on Raw Materials. This initiative specifically calls for the development of a European Geological Knowledge Base, and in particular for improved Minerals Intelligence. The recently approved MINERALS4EU project, involving 25 European Geological Surveys together with EuroGeoSurveys, the EC’s Joint Research Centre and several other partners, aims to develop a European Mineral Intelligence Network. This project builds on results from recent minerals related projects such as EuroGeoSource, ProMine, EURARE, SARMa/SNAP-SEE, etc. The proposal is explicitly aligned with the EGDI-Scope project.

In the field of Geo-Energy, NGSs are and have been actively involved in many projects related to Geothermal energy, CO2 storage (e.g. contribution to the development of the CCS directive), storage of nuclear waste, and hydrocarbon explora-
tion and production (including so-called unconventional). Through these activities, NGs are well positioned to keep contributing to future developments in the field of energy. This includes the “New climate & energy framework for the period up to 2030” and notably the “Environmental climate and energy assessment framework to enable safe and secure unconventional hydrocarbon extraction”.

In the field of **Natural and Man-made hazards**, initiatives of particular relevance are the Copernicus (formerly GMES), GEO and GEOSS programmes, as well as the EPOS Research Infrastructure project. Although all these initiatives have a wider focus than hazards, NGs involvement in the past has particularly been related to geohazard monitoring, including subsidence, landslides, mining related hazards, earthquakes, volcanoes, etc. Close connections with GMES, GEO and GEOSS have been developed in the past in particular through the EGS Earth Observation Expert Group. Connections with EPOS are being developed through the EGDI-Scope project.

In the field of **Marine Geology**, the NGs community has collaborated transnationally for decades, for two main reasons. First, seabed mapping is expensive and can be done more efficiently when vessel time is shared among partners. Secondly, marine environments are generally highly dynamic and processes do not stop at national borders. The EGS Marine Expert Group is very active in the context of the European Marine Observation and Data Network (EMODnet). A jointly produced seabed-sediment map for the Greater North Sea, the Celtic Seas and the Baltic Sea has already been used by the European seabed-habitat community, and will be extended to the rest of the European marine waters in the coming years. The partnership will also extend its harmonized data products concerning subsurface lithology and stratigraphy, coastal behaviour, geohazards and natural resources to all European seas, using OneGeology-Europe as a common platform.

In the field of **Geoheritage and geodiversity**, NGs are contributing to integrated natural heritage and natural diversity conservation, governance of protected areas and sustainable use of geoheritage, including the promotion of global initiatives through the International Union for the Conservation of Nature (resolutions 4.040 and 5.048).

In the field of **Spatial Data Harmonisation and Standardisation**, the NGs community has been one of the most active contributors to the development of INSPIRE. This relates specifically to the data domains of Geology (Annex II), Energy, Minerals and Natural Risk Zones (Annex III). Delivery of INSPIRE compliant data is a specific objective of many past data-related projects. Also, most NGs are actively involved in the implementation of INSPIRE at national level.

### 5.5 Working together with partners

**International cooperation**

The societal challenges which are addressed in the proposed Article 185 initiative (and which are in line with Horizon 2020 and EU2020) are not restricted to Europe alone. Security of supply of sustainable energy and earth resources, as well as climate change mitigation, are all global problems requiring global solutions. However, Europe is losing relevance globally, particularly with respect to Asian and African countries. Cooperation with Asian and African countries might not be based on their raw material potential only but should be based on common activities and programs including capacity building, mutual learning for a sustainable use and protection of soils, ground water and natural resources and the prevention and mitigation of geohazards. The future is for joint research and exchange.

The Geological Surveys of Europe have numerous bilateral agreements with sister organisations around the world and a long record of capacity building projects in the field of geology/geoscience. An Article 185 initiative on Applied Geoscience will strengthen the position of the Geological Surveys of Europe and EGS as the natural and equal European counterpart of such international organisation. International cooperation activities within the proposed initiative will address:

- Direct participation of international partners in research projects of the programme;
- Promoting the (bi-directional) international mobility of researchers and staff;
• Alignment of standardization efforts with relevant global initiatives, and promoting the acceptance and deployment of European solutions outside Europe;
• Providing geoscientific data, information and advice to EU bodies in support of negotiations with third countries;
• International development and capacity building activities, particularly in bordering countries and in Africa.

Specific activities in the latter areas, even if funded outside the framework of the Article 185 programme - e.g. through the Development Funds - should be closely linked to it, in order to maximise the impact of EU investments.

Collaboration with industry and academia

Most geological surveys have well-established connections with industry and academia, both at national and European level (as demonstrated in many past and on-going EU funded projects and the concerted actions through ETP partnerships). There are a number of industries that directly benefit from or even depend on geological knowledge and information – in particular the energy and mineral resources industry, and to a lesser extent the building industry. In addition, there is an ever greater dependence in many sectors on earth resources, including minerals and aggregates, but also energy and heat (e.g. for greenhouses). Geoscientists in turn rely more and more on ICT (Information and Communication Technologies), which are often developed in collaboration with specialist SME’s.

Many geological surveys are Research and Technology focused organizations, and as such function as intermediaries between academia on the one hand and industry and policy makers on the other hand. Well-established connections with both sides will be further enhanced through the Article 185 initiative, in line with the Innovation Union principles. In particular, EGS and its Member Organizations will seek active – including financial – support from industry to the article 185 programme, particularly with respect to the Energy and Mineral Resources components of the Research Agenda.

Communication, dissemination and awareness raising

The programme proposed here has a strong focus on providing applied knowledge to policy makers, authorities, NGOs, industry and the general public. Close cooperation with these parties will therefore be a necessity in all elements of the programme. In addition, communication activities will contribute to the visibility of geosciences in general and the European Geological Service and Data Infrastructure in particular. Promoting geoscience among the public and policy makers is also necessary to make rational choices in environmental, energetic and geohazard matters, and to obtain political and financial support for investment in geoscientific research.
The Geological Surveys of Europe

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