



Establishing the European Geological  
Surveys Research Area to deliver a  
Geological Service for Europe

## Deliverable 1.4

### Forward Look Report

Authors and affiliation:  
**Yvonne Schavemaker**

[TNO]

E-mail of lead author:  
**Yvonne.schavemaker@tno.nl**

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## GENERAL INTRODUCTION

This Forward Look Report describes the activities that have been carried out under Task 1.5 Foresight Activities. It describes:

- **Updating GeoERA's Strategic Research Agenda** for a Geological Service for Europe
- **Synergies within and outside GeoERA** - What GeoERA does to optimize synergies:
  - o with research, innovation and policy actions;
  - o with initiatives outside GeoERA;
  - o between selected projects.
- **Foresight Activities**
  - o The explorative activities to create opportunities for future collaborative research, specifically in assessing the feasibility of establishing a Joint Co-funding programme in Applied Geoscience after GeoERA;
  - o Activities towards the development of the ultimate goal of delivering a Geological Service for Europe.

To support these activities, GeoERA set up a Foresight Team, consisting of the following members:

- Slavko Solar (EGS)
- Patrick Wall (EGS)
- Lisbeth Hildebrand (SGU - Sweden)
- Jan Host (NGU - Norway)
- Kris Piessens (GSB - Belgium)
- Malgorzata Przychodzka (PGI - Poland)
- Antje Wittenberg (BGR – Germany)
- Yvonne Schavemaker (TNO – The Netherlands)

At this moment GeoERA is still in the Joint Call Phase, so synergies and foresight activities will come more apparent in the future. This document will therefore be regularly updated.



## TABLE OF CONTENTS

1	UPDATING THE STRATEGIC RESEARCH AGENDA.....	4
2	GEOERA SYNERGIES WITHIN AN OUTSIDE GEOERA .....	4
2.1	Synergy with initiatives outside GeoERA.....	5
2.2	Synergy between projects .....	6
3	FORESIGHT ACTIVITIES .....	7
3.1	Learning .....	7
3.2	Proposition Paper of the GeoERA Foresight Team: " A Geological Service for Europe " .....	7
3.3	Foresight Meeting with GeoERA and EGS NDs.....	7
3.3.1	Purpose of a GS4E (see Annex A).....	8
3.3.2	Added value of a GS4E (see Annex A).....	8
3.3.3	Boundary conditions of a GS4E (from SWOT) .....	8
3.3.4	Foresight Questionnaire .....	9
3.4	Review of governance models and instruments .....	10
3.4.1	EC Models .....	10
3.4.2	Other Models .....	11
3.5	Important Trends and Developments .....	11
	ANNEX A: PROPOSITION PAPER OF THE GEOERA FORESIGHT TEAM .....	13
	A GEOLOGICAL SERVICE FOR EUROPE (GS4E) .....	13
	ESTABLISHING A GEOLOGICAL SERVICE FOR EUROPE (One-pager).....	16
	ANNEX B: SUMMARY OF THE GS4E QUESTIONNAIRE.....	17
	WHAT ARE THE SOCIETAL CHALLENGES THAT WILL DOMINATE THE DISCIPLINE OF YOUR EXPERT GROUP FOR THE NEXT DECADE?.....	17
	Challenges as defined under H2020 .....	17
	Challenges not identified in H2020 .....	19
	Additional comments .....	19
	WHAT OBJECTIVES RELATED TO YOUR EXPERT PANEL DO YOU SEE UNDER GS4E? .....	20
	First large objective .....	20
	Second large objective.....	21
	Third large objective .....	22
	WHAT ROLE DO YOU SEE FOR YOUR EXPERT GROUP IN GS4E? .....	23
	What role do you see for your expertise/experts? .....	23
	Background for the above choices .....	24



## 1 UPDATING THE STRATEGIC RESEARCH AGENDA

The need to stimulate economic growth and recovery, while ensuring common welfare and a healthy and safe environment to all its citizens within the European continent, increasingly puts pressure on the availability and exploitation of our subsurface natural resources, such as water, minerals and energy. This will remain the case in the coming decades. GeoERA aims to assist policy and decision-makers at multi-level governments, industry and other stakeholders, that face this challenge, with an enhanced knowledge base in applied geoscience in a harmonized way across Europe. Since this challenge will remain after GeoERA, the consortium is seeking for a more sustainable solution to provide this assistance in the future. GeoERA is a the starting point for a new collaborative structure supporting the implementation of a comprehensive Strategic Research Agenda in a long term, cohesive programme of scientific projects, aimed at developing optimized expertise and toolsets that can be employed both at regional/national and collaborative level. This will improve the ability of Geological Survey Organisations (GSOs) within Europe to support stakeholders in addressing grand challenges. Therefore, GeoERA can be seen as the first step to establish the European Geological Surveys Research Area to deliver a Geological Service for Europe (GS4E). GeoERA and thereafter the GS4E should align national research agenda's, to efficiently use research funds and to facilitate stakeholders with reliable data, information and profound expertise on the European subsurface and its natural resources.

Main aspects of a GeoERA strategic research agenda are formulated in GeoERA's proposal and therefore in the Grant Agreement. These aspects also align with the Strategy Document of EuroGeoSurveys<sup>1</sup>. Task 1.5 of Workpackage 1 will collate and update these aspects to determine follow-up activities and determine the mission, vision, challenges and research priorities for the coming decades, that should be leading to a strategic research agenda for the GS4E as long term cohesive programme. This is work in progress. In Chapter 3 of this document the activities to determine this have been undertaken in 2017 are described.

## 2 GEOERA SYNERGIES WITHIN AN OUTSIDE GEOERA

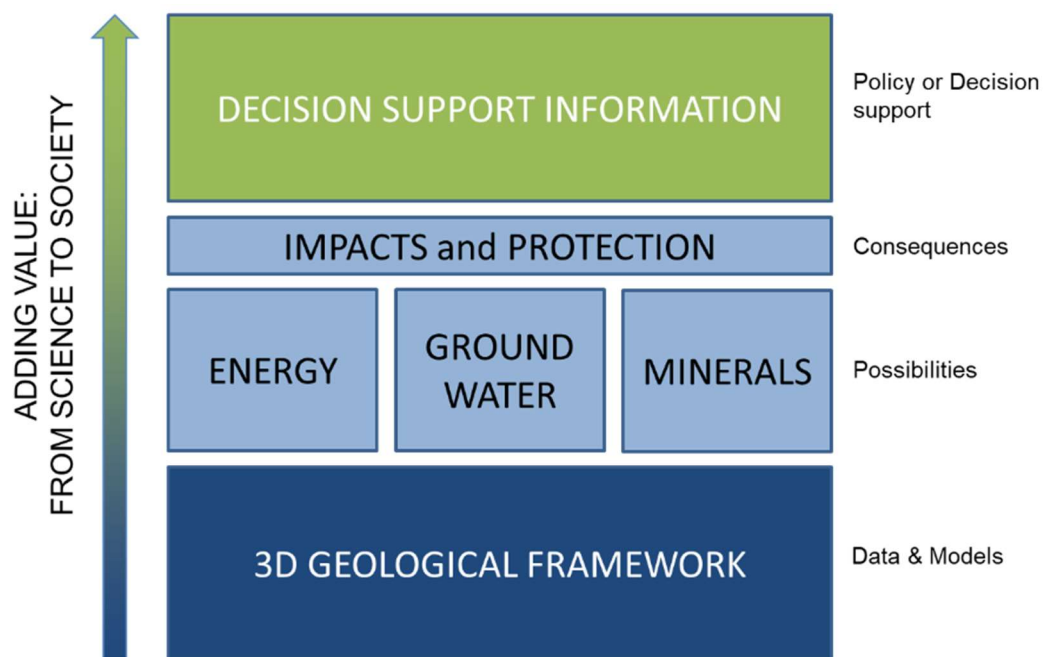
GeoERA looks into synergies within projects, between projects, and between GeoERA and the society, to increase its benefits for policy and decision making. To secure synergy of GeoERA projects with research, innovation and policy actions, all projects have been requested to focus on developing results valuable to the end-user, to apply science to society. This can be contributed on different levels (see Figure 1):

1. **Data and Models:** Value added science through the development of transnational to pan-European geological frameworks which identify the characteristics of the subsurface. This is the basic knowledge on which any specific research question will be based; it is the European Geological Knowledge Base.

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<sup>1</sup> <http://www.eurogeosurveys.org/wp-content/uploads/2014/08/EGS-Strategy-Document-2014-A4.pdf>

2. **Possibilities and Consequences of subsurface activities:** Value added science by focusing on activities in the subsurface (related to the topics: energy, groundwater and/or minerals), and their consequences and researching the impact on, the availability of, and/or the protection of subsurface resources for sustainable subsurface management.
3. **Policy or Decision support:** Value added science through transferring the knowledge from 1 and 2 towards workable information for the end-users for them to make policies and decisions based on a solid geological framework.



*Figure 1 Geological knowledge from science to society*

The projects will be assessed on their impact and value to the end-user after the results have been delivered in the projects.

## 2.1 Synergy with initiatives outside GeoERA

GeoERA looks carefully at initiatives that are relevant and which are developed outside GeoERA. The following organisations and/or initiatives have already close ties with GeoERA. Some of these organisations have a seat in the Stakeholder Council. In the first year of GeoERA, GeoERA's Stakeholder Council delivered fruitful input for the Call for Proposals. This has been recorded in Deliverable 3.3. In the coming years this list of synergies with organisations and/or initiatives outside GeoERA will be updated regularly.

- EGS, EuroGeoSurveys, is a network of European Geological Surveys where most, but not all, of the GeoERA partners are member. This network is a strongly supportive network to the ambitions of GeoERA and therefore there is a close collaboration on co-organizing meetings, but also on developing Foresight



Activities and developing the Strategic Research Agenda. EGS and GeoERA have the same ambition of a Geological Service for Europe.

- EFG, the European Federation of Geologists, is an organisation, that contributes 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, by several dissemination networks, tools and events. EFG supports GeoERAs ambition and has a seat in GeoERA's Stakeholder Council.
- EPOS, the European Plate Observing System, is an organisation to facilitate integrated use of data, data products, and facilities ("research platform") from distributed research infrastructures for solid Earth science in Europe. GeoERA, and specifically its Information Platform, and EPOS have similar ambitions for Europe, but vary from scope and end-users. EPOS has a seat in GeoERA's Stakeholder Council, which provides learning and collaboration opportunities.
- JPI Water, is a Joint Programming Initiative on "Water challenges for a changing world", aiming at achieving sustainable water systems for a sustainable economy in Europe and abroad. Part of the sustainable water systems are knowledge on groundwater systems. These systems are explicitly addressed in GeoERA. Having JPI Water in GeoERA Stakeholder Council it provides opportunities for synergies with another Joint Programme.
- JRC, the European Commission's Joint Research Centre, is an important stakeholder for GeoERA. They were invited to GeoERA's first stage Call for Project Ideas to let GeoERA know its current and future needs within sustainable subsurface management. JRC is welcome at all public GeoERA events.
- NRC, the Natural Research Council Canada, is involved to explore synergies across the Atlantic and share knowledge and expertise on common challenges. NRC has a seat in GeoERA's Stakeholder Council.
- UNECE, The United Nations Economic Commission for Europe, is closely involved with the assessment of the mineral, energy and groundwater resource base in Europe and in the outside world and develop harmonized methods to do this. This closely relates to GeoERA's ambitions on harmonization of data and information. UNECE has a seat in GeoERA's Stakeholder Council.

Besides these, organisations are also welcomed to join GeoERA projects as Non-Funded Partner or as Associate to contribute to the GeoERA project results.

## **2.2 Synergy between projects**

GeoERA appointed specific Theme Coordinators who have the task to coordinate transnational Projects within their Themes (i.e. Groundwater, Energy or Raw Materials), e.g. by:

- facilitating regular meetings between Project Leads
- facilitating Theme seminars where Projects can present their progress and discuss possible synergies and best practices
- Seek and exploit synergies with other themes, e.g. by:
  - o regular meetings between Theme Coordinators;



- facilitating direct exchanges between particular projects across Themes;
- facilitating exchange of Projects' progress and results between Themes, in particular during the GeoERA meetings.

In the first year of GeoERA, the Theme Coordinators have stimulated the GeoERA partners to draw up Project Ideas and Project Proposals to within and between GeoERA Projects. Also, it has been set obligatory for all projects under GeoERA to have an Interface Workpackage in which close collaboration is ensured with the cross thematic GeoERA Information Platform for a proper management and dissemination of the Project Results. In the coming years when the projects are being carried out the results of this effort will be more specified.

### **3 FORESIGHT ACTIVITIES**

#### **3.1 Learning**

The GeoERA Secretariat and/or the Foresight Team of GeoERA is visiting several workshops, courses and conferences to support GeoERAs future opportunities. This is a list of a attended events:

- ERA-LEARN Foresight Course, 20-21 February 2017, Vienna, Austria.
- PLATFORM Master Class "ERA-NET Cofund Actions - tools and methods for efficient call management" and Workshop "Monitoring, Evaluation and Impact Assessment of P2P Networks and Projects", 7-8-9 June 2017, Copenhagen, Denmark.
- PLATFORM Joint Programming Seminar, 19 April 2017, Wageningen, The Netherlands.
- Annual Joint Programming Conference, 7-8 November 2017, Brussels, Belgium.

#### **3.2 Proposition Paper of the GeoERA Foresight Team: " A Geological Service for Europe "**

Based on the GeoERA rationale, and the Strategy document of EuroGeoSurveys, the Foresight Team delivered a proposition paper on the ambition of the European Geological Surveys of GeoERA: A Geological Service for Europe (GS4E). This proposition paper is aimed at supporting the further development of GeoERA into a GS4E, the added value, the strenght of collaboration on national and European level, by building on a strong bases which is already established among European GSOs. The paper and a one-pager is attached in Annex A.

#### **3.3 Foresight Meeting with GeoERA and EGS NDs**

On the 28<sup>th</sup> of June 2017, a GeoERA Foresight Meeting was held together with GeoERA partners and EGS National Delegates (NDs), i.e. representatives of all geological surveys from different countries that are member of GeoERA and/or EGS. Together with this group, a SWOT exercise was performed to determine the strengths and weaknesses of a GS4E organization (and of our current position) and to determine and discuss the opportunities and threats of a GS4E that we will face in the future. The SWOT was focused on organizational aspects.





To complement these organisational aspects with geological research objectives for the future, a questionnaire was sent out in advance to the GeoERA Theme Coordinators (Energy, Raw Materials, Groundwater and Information) and EGS Expert Group Chairs (Energy, Minerals, Groundwater, Information, Marine environment and Earth Observation). The EGS Expert Groups represent groups of experts from different European countries, that work on a specific theme. The responses to this questionnaire delivered a first impression on what activities are expected to shape the focus of the GS4E. To achieve the GS4E it will require a clear vision on its purpose, achievements an added value and support from both the EC and the Member States. This will require a suitable model or instrument. There are several existing models that could be useful in establishing a GS4E. Therefore the FT researched several models and instruments to facilitate a GS4E. Results of these exercises are published for GeoERA members at the public Intranet and a summary can be found below. Besides the existing models, the FT is exploring combinations or alternatives of these. In paragraph 3.3.1, 2 and 3 the main conclusions are shared from the Proposition paper and the Foresight Meeting

### **3.3.1 Purpose of a GS4E (see Annex A)**

The participants in the Foresight Meeting recognized the purpose of the GS4E as described in the proposition paper, i.e. support policy and decision-makers in sustainable subsurface management to tackle societal challenges, with a harmonized European geological knowledge base of geological data and information and its associated expertise.

### **3.3.2 Added value of a GS4E (see Annex A)**

The participants in the Foresight Meeting recognized the added value of the GS4E for the EC and for individual Member States, as mentioned in the proposition paper:

- Improved understanding of Europe's subsurface to aid in policy and decision making.
- Improved regional, national and European assessments.
- Exchange of knowledge and building capacity across Europe.
- Delivery of high quality transnational scientific expertise based on a harmonized knowledge base.
- Broad internationally supported results of applied geosciences.

### **3.3.3 Boundary conditions of a GS4E (from SWOT)**

From the SWOT analyses, carried out during the Foresight Meeting, the following boundary conditions were mentioned for the development of the GS4E:

- It should be about data and information and expertise. GS4E cannot only be a database, it can only serve its purpose combined with expertise to make the proper translation from rough data to policy support.
- It should advocate society minded geoscience, focusing on the applied sciences.





- It should deliver high quality research and services that are demanded/requested by policy/decision makers, to obtain the necessary recognition and visibility.
- It should be based on GSOs national mandates, which ensure access to the best available, quality controlled, up to date data, information and expertise.
- It should be managed by the GSOs of Europe.
- No European entity should take authority over the national/regional entities.
- It should be open to (all) regional and national GSOs (focussed on EU-28, possibly larger).
- It should be able to set its own agenda independent from the research agenda of the European Commission.
- It should be supported on Member State and European level and recognize both interests.

STRENGTHS	WEAKNESSES
<ul style="list-style-type: none"><li>- Society minded</li><li>- Strong established network among GSOs</li><li>- Large capacity across Europe</li><li>- Single access point</li><li>- Inclusive</li></ul>	<ul style="list-style-type: none"><li>- Differences between GSOs</li><li>- Dominance national interest</li><li>- Fail to deliver value or quality</li><li>- Lack of Strategy</li><li>- Overambitious</li></ul>
OPPORTUNITIES	THREATS
<ul style="list-style-type: none"><li>- Capacity building</li><li>- Financial support from the EC and/or MSs</li><li>- Visibility at EC and MS level</li><li>- Closer relationship with EC</li><li>- Increased independence from EC agenda</li></ul>	<ul style="list-style-type: none"><li>- External Competition</li><li>- Incompatibility MS interests vs EC</li><li>- Lack of EC/MS support</li><li>- Administrative burden</li><li>- Data without expertise</li><li>- Autonomy shift from GSOs to GS4E</li></ul>

### 3.3.4 Foresight Questionnaire

The Theme Coordinators of GeoERA and Expert Group Chairs from EuroGeoSurveys represent a large group of experts at geological surveys that have a good idea of what they would acquire and require from a GS4E. They are seen among GeoERA Members, as competent bodies of experts to facilitate the aim of GeoERA, the objectives and results towards the stakeholder community. Therefore, we requested them to answer three questions regarding the future of a Geological Service for Europe:

- What are the societal challenges that will dominate the discipline for the next decade?
- What objectives related to your group of experts do you see under GS4E?
- What role do you see for your group of experts in GS4E?

There were two periods in which the representatives could fill in this questionnaire, in June 2017 and in November 2017. Questionnaire input came from GeoERA's TC (Energy, Groundwater and Minerals) and EuroGeoSurvey's MREG (Minerals group), EOEG (Earth



Observation group), GEG (Geochemistry group), MGEG (Marine Geology group) and GEEG (Geo-Energy group). The Theme Coordinator of the Information Platform and the EGS Spatial Information group were not been able to fill in the questionnaire in the given timespan. This input is considered a good representation of the opinion of experts working at geological surveys in Europe. The literal, non-commented transcript of the questionnaire responses can be found in Annex B. In below paragraphs the main conclusions are described.

#### 3.3.4.1 *Societal challenges of GS4E*

The main societal challenge indicated by the representative of experts is the environment. Secondly, raw materials, resource efficiency and water research is indicated as important, followed by the climate action, public engagement, energy security, and resilience to disasters.

#### 3.3.4.2 *Objectives of a GS4E*

Main research objectives indicated by the representative of experts where collected and ranked here based on the number of votes of the participants, from more to less relevant:

- Provide unbiased overview of Europe's resources
- Reduce the risk and impacts of geohazards
- Environmental protection
- Connect to stakeholders and end-users
- Stimulate the industry
- Develop/apply/determine feasibility of new technologies

#### 3.3.4.3 *Preferred role of the experts in the GS4E*

The representative of experts see their role in a future GS4E based directly to the core objectives of such GS4E. Some representatives, see their role more in a facilitating way, providing their expertise when required or expect to be more active with the interface towards stakeholders.

### 3.4 **Review of governance models and instruments**

The Foresight Team thought it useful to research the opportunities for the application of different governance models and instruments for a GS4E. Besides the models of the European Commission also other structures have been looked at to acquire aspects and inspiration for a good fit to the ideas of a GS4E.

#### 3.4.1 **EC Models**

There are several EC instruments that could be applicable for GS4E supported by DG RTD. Many of these models are flexible and can be amended fit for purpose, i.e. fit to the boundary conditions that we set for the GS4E. From the EGS Strategy document, the GS4E was anticipated to be in the form of an Article 185. However, the presented



evaluation of current Joint Programming tools at the ERA-LEARN Annual Joint Programming Conference indicated that there is little enthusiasm for new Art. 185s. Article 185, the EJP and the ERA-NET, are three tools of DG RTD instruments, that have been discussed among the Foresight Team. At the Annual Joint Programming Conference at 7-8 November 2017, a single tool was announced for FP9 to simplify the Joint Programming landscape. For a follow-up for GeoERA, it is reasonable to think that one should look at FP9 as suitable and feasible programme for inclusion of a GS4E. Therefore, the preferred needs and boundary conditions of a GS4E will be carefully researched to match such a new Joint Programming tool, in the near future.

### **3.4.2 Other Models**

Since the future of a new Art. 185 proves to be more uncertain than when GeoERA was proposed, the Foresight Team decided to also look at other opportunities that could support the facilitation of a GS4E. There are (governance) models of other European institutes or international cooperation institutes that can serve as inspiration for a GS4E model, where transnational research and services are carried out, such as the European Environmental Agency, closer collaboration with JRC, the European Chemical Agency and European Organization for Nuclear Research. Some models are more applicable than others for the development of a GS4E based on the above set boundary conditions set by the GSOs. The Foresight Team is exploring aspects of these various models for the purpose of a GS4E in the coming year.

## **3.5 Important Trends and Developments**

The aspects of a strategic research agenda reflected in the GeoERA Grant Agreement, has been developed by the analyses of trends and developments on global and European level that are relevant for sustainable subsurface management. The Foresight Team will closely look at the current Megatrends, the Horizon 2020 Societal Challenge, the Sustainable Development Goals of the UN and anticipate on future trends, developments and challenges to identify how GeoERA and a GS4E could support these goals through its contribution to sustainable subsurface management.

From the megatrends important aspects to keep in mind are population growth, urbanization, climate change, resource scarcity and economic growth and geopolitics, which underline the importance of sustainable subsurface management. GeoERA and the GS4E, as a strong partnership between GSOs (SDG#17), can deliver an important contribution through the delivery of data, information and expertise, to:

- Assess our water resources (SDG#6),
- Assess and develop affordable and clean energy (SDG#7)
- Support economic growth, through working with industry partners (SDG#8),
- Support innovation in subsurface management (SDG#9),
- Assess risks of subsurface use that can jeopardize safe and resilient human cities and settlements (SDG#11)

- Minimize and mitigate climate change impacts and research sustainable alternatives (SDG#13)



Figure 2. The UN Sustainable Development Goals

The H2020 Societal challenges within GeoERA are reflected as follows:

- *Economic growth*; The economic significance of subsurface resources (energy, non-energy raw materials) and their exploitation and use is enormous. These sectors are worth several billions of Euros and provide millions of jobs within Europe.
- *Secure, clean and efficient energy*; Europe's need for reliable, clean and efficient energy asks for a sound, seamless overview of natural resources in Europe and methodologies to exploit these in a sustainable way and ensure access to the required resources.
- *Climate action, environment, resource efficiency and materials*; To mitigate the effects of climate change it is important to understand the relationship between climate and natural hazards. Minimizing carbon emissions to the atmosphere, requires alternatives, such as geothermal energy, storage of carbon dioxide in the subsurface, and the availability of "green-technology products".
- *Food security, sustainable agriculture and forestry, marine and inland water research, and the bio-economy*; To guarantee a sufficient supply of food and water Europe needs to know the location, quantity and quality of its soil and groundwater resources and develop sustainable methodologies for its use. Mapping of the sea floor is vital to the management of the marine environment and essential to its biological and mineral resources.
- *Health, demographic change and wellbeing*; The need to provide EU's citizens with a healthy, clean and safe living environment asks for a clear, unambiguous understanding of the resilience and vulnerability of Europe's subsurface. To protect EU's citizens against natural and induced hazards it is important to know under which geological conditions areas and people are subject to risks.



## **ANNEX A: PROPOSITION PAPER OF THE GEOERA FORESIGHT TEAM**

### **A GEOLOGICAL SERVICE FOR EUROPE (GS4E)**

Societies rely on a secure, responsible and affordable supply of water, energy and mineral resources to meet their basic needs, in order to live life in a safe and healthy environment<sup>2</sup>. The natural resources from the subsurface, i.e. groundwater, geo-energy and raw materials, represent essential elements in this provision. It is obvious that the growing population all over the world leads to a higher demand for these natural resources and puts the subsurface increasingly under pressure. Although the extraction of subsurface resources stimulates economic growth and contributes to jobs and welfare, it has become apparent that it can have negative consequences to the environment, e.g. subsidence or induced seismicity, or contribute to climate change by the emission of greenhouse gasses. Yet, the subsurface can also play an important role in minimizing these consequences, by providing alternative technologies such as geothermal energy and Carbon Capture and Storage (CCS). Balancing this subsurface water-energy-mineral nexus is challenging and related to three prominent questions:

- What crucial subsurface resources and services (e.g. storage, environmental management, climate control) can be provided and how are these spread across Europe in terms of capacity and accessibility? How can we characterize its potential?
- How can we develop and maintain subsurface resources and storage spaces in a safe and responsible manner, with minimum impact on the environment?
- How can we ensure optimal use and management of the subsurface which matches current needs and challenges of societies, such as affordable and secure supply of water, energy and mineral resources, while keeping areas safe from geohazards?

Geological data, information, knowledge and expertise underpin the responses to these questions. All countries within the European Union recognised this early on and established Geological Survey Organisations (GSOs). They represent the national custodians of geological data, information and knowledge and are the only organisations that have a long tradition in working on natural resources. Applying this data requires established expertise, which at the same time needs to evolve dynamically to keep track with the ever changing social, economic and environmental context. GSOs have the national mandate to:

- Gather, store, use and quality control subsurface data and information;
- Apply geoscientific research and services based on this data and information;
- Advise their government on policy- and decision making based on these data and information.

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<sup>2</sup> As emphasized in EEA Megatrends SOER2015 and the UN Sustainable Development Goals to 2030; 3, 6, 7, 8, 9, 14, 15 and 17.



This emphasizes the uniqueness and exclusiveness of GSOs, since no other company, consultant, university or (European) research organization has direct access to such vast amounts of valuable, quality controlled data, information and expertise on the subsurface.

The natural role of the GSOs, in advising their governments directly on pressing societal challenges, makes the GSOs a group of strongly society-minded geoscientists. Since geological challenges do not stop at borders, there is a constant drive for GSOs to collaborate with their colleagues in other countries, gaining:

- A better understanding of their subsurface by harmonized and shared data and information;
- Regional geological context for national assessments;
- Access to new expertise and best-practices by exchange of knowledge and building capacity;
- International recognition on specific topics;
- Broad internationally supported scientific evidence to support policy making and the development of trust in scientific results<sup>2</sup>.

The above arguments are as equally relevant on a country-to-country, pan-European and global scale. The European Parliament<sup>3</sup>, the European Commission (EC)<sup>4</sup> and several EU initiatives in policy areas such as the Raw Materials Initiative<sup>5,6</sup>, the Groundwater Directive<sup>7</sup> and the CCS Directive<sup>8</sup>, need access to the data and expertise of the GSOs. Broadening the effort of collaboration of GSOs towards a pan-European scale can deliver a strong and sustainable pan-European geological knowledge base regarding Europe's subsurface resources and its related societal challenges.

In response to growing requests, intensified collaboration recently led to the launch of the ERA-NET Co-Fund Action: "Establishing the European Geological Surveys Research Area to deliver a Geological Service for Europe" (GeoERA). GeoERA is a 30M EUR programme supported by 48 GSOs from 33 countries in Europe. It contributes to the sustainable use of the subsurface by delivering data, information and expertise to policy and decision makers through a single access point, based on the European Geological Data Infrastructure (EGDI). GeoERA and EGDI are both initiatives of EuroGeoSurveys (EGS), an international non-profit organization representing the national GSOs from 36 European countries. GeoERA lays down the first foundation for a sustained collaboration

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<sup>3</sup> European Parliament resolution of 13 September 2011 on an effective raw materials strategy for Europe (2011/2056(INI))

<sup>4</sup> Letter from Máire Geoghegan-Quinn, and 6 other Commissioners, to Secretary General of EGS, 17-12-2013

<sup>5</sup> European innovation partnership on raw materials (COM)2012)82):

<sup>6</sup> European competitiveness report 2011 (SEC(2011)1188)

<sup>7</sup> Blueprint to safeguard European water resources SWD(2012)381/2

<sup>8</sup> Review of the CCS Directive COM(2015) 576 final ANNEX 2





and alignment of national research programmes on applied geosciences. The expansion, prosperity and success of this collaboration depends on the support of the Member States and the EC.

The GSOs of Europe represent a considerable workforce of experts and hold a significant public budget to carry out their task for their government. Equipped with additional support from the EC, the GSOs are capable of setting up a Geological Service for Europe, building on GeoERA, tailored to suit the dynamic needs of society, policy and decision makers. This Service will represent a robust and maintained access point to pan-European harmonized and interoperable data, expertise and knowledge, ensuring access to the best available quality data and information, managed by the GSOs themselves. The Geological Service for Europe will represent a strong geological knowledge and research base, founded on the long-standing expertise of GSOs, and will be able to provide answers regarding our subsurface to today's and future scientific and societal questions and challenges that we face in the dynamic world we live in.

To achieve this ambition, the EC is requested to support a Geological Service for Europe, through facilitating a follow-up action towards a more sustainable partnership. We are looking forward to receiving your feedback on the ambition set out in this paper and on an appropriate instrument to support it through e.g. a joint programme under H2020 or the 9<sup>th</sup> Framework Programme.





## ESTABLISHING A GEOLOGICAL SERVICE FOR EUROPE (One-pager)

The availability, accessibility, and recoverability of minerals, metals, water, energy and other subsurface resources are more than ever a crucial issue in nowadays society. The European Parliament, the European Commission (EC) and several EU initiatives in policy areas, e.g. the Raw Materials Initiative, the Groundwater Directive and the CCS Directive, need access to relevant subsurface data. Today, data are available only partially and most of the time not harmonised and thus incomparable between countries. A Geological Service for Europe (GS4E) would provide the European Commission, and associated stakeholders, with access to harmonized subsurface data, information and expertise, to support sustainable use of the subsurface in addressing Europe's challenges.

### *Why a Geological Service for Europe?*

Every Member State has a Geological Survey Organisation (GSOs), that has the national mandate to gather, store, maintain and disseminate subsurface data and information and have a long history in applying their knowledge to everyday challenges for social, economic and environmental purposes and advising their national governments. Currently, geological data, information and expertise is therefore mainly available at national levels, making it problematic to use it for required overviews and/or analyses to obtain important insights on cross-border and/or at a pan-European scale. A GS4E would foster the lining-up of national research agenda's towards EU priorities and store the generated data from common projects in a common sustainable data infrastructure to prevent the loss of data and knowledge as is too often the case now. It will contribute to an orchestrated knowledge based response to the Paris Agreement and to several UN Sustainable Development Goals in the different countries, and will guide Europe in sustainable subsurface management needed in a growing Europe.

### *Build further on current initiatives*

In response to growing requests, intensified collaboration recently led to the launch of the H2020 ERA-NET Co-Fund Action: "Establishing the European Geological Surveys Research Area to deliver a Geological Service for Europe" (GeoERA). GeoERA is a 30M EUR programme supported by 48 GSOs from 33 countries in Europe. It contributes to the sustainable use of the subsurface by delivering data, information and expertise to policy and decision makers through a single access point, based on the European Geological Data Infrastructure (EGDI). GeoERA and EGDI are both initiatives of EuroGeoSurveys (EGS), an international non-profit organization representing the national GSOs from 36 European countries.

### *Integration of GS4E in EU-FP9*

GeoERA will end in 2021. Consequently, involved GSOs are looking to the available tools to sustain the geological knowledge platform beyond GeoERA, and to upgrade the initiative towards a GS4E at pan-European scale. Making geological challenges an integral part of European and national research agenda's is required to tackle current and future challenges related to subsurface resources. It seems therefore the right timing to include the development of a GS4E in the European Commission's 9th Framework Programme and achieve continuation and development through a new co-funding instrument.



## ANNEX B: SUMMARY OF THE GS4E QUESTIONNAIRE

This report presents the literal, non-commented transcript of the questionnaire responses. The input of this report was used at the GeoERA foresight meeting of 28/07/2017. In the fall of 2017 additional response was received by the Groundwater and Marine Geology representatives. The results in this questionnaire are grouped according to groups of experts on a certain discipline.

Entries received from:

Name	Survey	Representative of	Discipline
<b>GEOERA THEME COORDINATORS</b>			
Serge van Gessel	TNO, The Netherlands	GeoERA GeoEnergy and EGS GeoEnergy Expert Group (GEEG)	Geo-Energy (GE)
Klaus Hinsby	GEUS, Denmark	GeoERA Groundwater and EGS Water Resources Expert Group (WREG)	Groundwater Resou
Gerry Stanley	Geological Survey Ireland	GeoERA Raw Materials	Mineral Resources (I
<b>EGS EXPERT GROUP CHAIRS</b>			
Daniel de Oliveira	Laboratório Nacional de Energia e Geologia, Portugal	EGS Mineral Resources Expert Group (MREG)	Mineral Resources (I
Gerardo Herrera	IGME, Spain	EGS Earth Observation and Geohazards	Earth Observation (E
Veronika Kopackova	Czech Geological Survey	EGS Earth Observation and Raw Materials (EOEG)	Earth Observation (E
Anna Ladenberger	Geological Survey of Sweden	EGS GeoChemistry Expert Group (GCEG)	Geochemistry (GC)
Sytze van Heteren	TNO, The Netherlands	EGS Marine Geology Expert Group (MGEG)	Marine Geology (MC

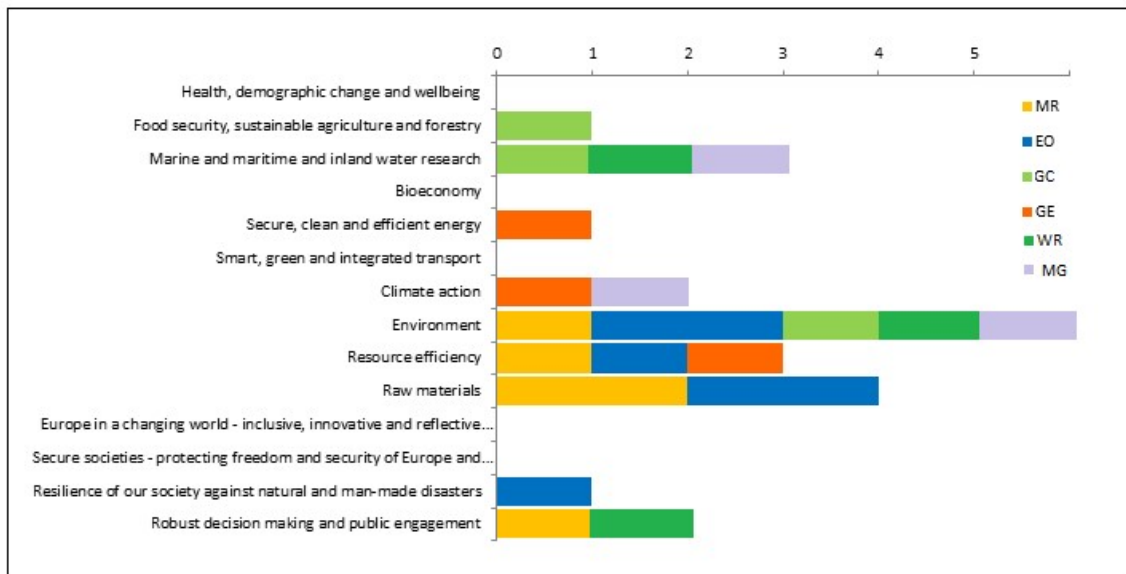
## WHAT ARE THE SOCIETAL CHALLENGES THAT WILL DOMINATE THE DISCIPLINE OF YOUR EXPERT GROUP FOR THE NEXT DECADE?

### *Challenges as defined under H2020*

The list below are the Societal Challenges as defined under H2020. These are normally grouped into seven challenges, but split up in the list below. A detailed description can be found on <https://ec.europa.eu/programmes/horizon2020/en/h2020-section/societal-challenges>.



H2020 - challenge	MR	EO	GC	GE	MG	WR
Health, demographic change and wellbeing						
Food security, sustainable agriculture and forestry			1			
Marine and maritime and inland water research			1		1	1
Bioeconomy						
Secure, clean and efficient energy				1		
Smart, green and integrated transport						
Climate action				1		1
Environment	1	2	1		1	1
Resource efficiency	1	1		1		
Raw materials	2	2				
Europe in a changing world - inclusive, innovative and reflective societies						
Secure societies - protecting freedom and security of Europe and its citizens						
Resilience of our society against natural and man-made disasters		1				
Robust decision making and public engagement	1				1	





### Challenges not identified in H2020

Expert group	Challenges not identified in H2020
Mineral Resources	Grass roots exploration technologies; Competing land uses
Earth Observation	creating GLOBAL products which are validated and up-to-date, applications which are scalable, robust and not site-specific
Geochemistry	The Categories are defined broad enough to encompass most of the challenges
GeoEnergy	Information, knowledge and ethics - reliability, accessibility and value-chain implementation
Groundwater Resources	The importance of groundwater quantity and quality issues in general and their relation to both human health, food production, good status objectives for groundwater dependent terrestrial and associated aquatic ecosystems and the built environment is generally not sufficiently acknowledged and understood. Authorities, politicians and even other environmental science disciplines often do not recognize and understand the importance of groundwater. We have to continuously strive to get groundwater issues higher on the agenda nationally and internationally e.g. in EU research programmes.
Marine Geology	None

### Additional comments

Expert group	Additional comments
Mineral Resources	Resource efficiency also
Geochemistry	Applied Geochemistry will be used for the location and delineation of new potential primary raw materials
GeoEnergy	The above selected challenges are primary targets for energy. They are however enablers for, or depending on "Robust decision making and public engagement". This one is overarching for almost any societal challenge, and all of our geo-expertise areas. Any research action in one of the main societal challenges will fail to meet its target objective when it does not end-up in a proper and accepted decision process, policy regulation or any other societal implementation platform. The additional challenge on "information and knowledge" is added because the acceptance and credibility of information is currently at stake. Global society is struggling with alternative facts and truth-finding. Different sources contradict each other and even the outcomes of respected scientists and institutions are questioned. This may become one of the biggest threads for global society because it severely disrupts major decision processes. The digital revolution is one of the instigators of this trend, yet it is also the key to the solution. For GSOs it is clear that we deliver reliable science, but how to make sure that is also perceived as such by society and that its accessibility and value-chain implementation are safeguarded. This strongly related to Geo-Ethics
Groundwater Resources	We are currently assessing European groundwater research in relation to the societal challenges of H2020 in the KINDRA project ( <a href="http://www.kindraproject.eu">www.kindraproject.eu</a> ). The work is finished spring next year. Groundwater research is relevant for most of the societal challenges, I've indicated the three most important, but health, sustainable agriculture and resilience to natural and man-made disasters are also very important challenges for the water resources expert group
Marine Geology	Development and optimized use of Copernicus services are important in marine geology, as are shared open data and optimized use of big data. Also, we need to reduce our dependence on external IT parties, by making sure that we control our



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own data and data-product dissemination as cooperating geological surveys (EGDI).

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## WHAT OBJECTIVES RELATED TO YOUR EXPERT PANEL DO YOU SEE UNDER GS4E?

Provide below the three main objectives that you would propose to be part of GS4E, starting from your expert view and the societal challenges indicated on the previous page. Formulate each objective as an answer to a challenge. Include some argumentation. Specific (detailed) objectives can be added as examples. Also locate the objective with reference to the science-policy-society interface.

The text limit for each objective is 1000 characters.

### *First large objective*

Expert group	First large objective
Mineral Resources	The CRM list that is produced by the EU is very limiting. Ideally a comprehensive database of all mineral resource occurrences (metallic, non-metallic and energy) should be made for the whole of the EU partner countries. It is only with this available information that the EU can really understand its shortcomings and pettiness in the field of mineral resources. Providing unbiased and accurate data on minerals resources in Europe thus supporting the European Raw Materials Knowledge Base (EU-RMKB).
Earth Observation	Reduce the impact of geohazards in European society following a three pillar strategy: (1) Periodic mapping of damaging geohazard events in Europe and harmonization of the existing databases, ensuring that they can be integrated to deliver, periodically, maps on the location and the impact of geohazard events in Europe. (2) Detection and monitoring of ground surface deformation areas using satellite Radar Interferometry. Integration of deformation measurements with the existing databases of hazards to identify and rank the most critical urban areas in Europe. (3) Site-scale monitoring and numerical modeling of critical areas in order to: (a) support decision making process in pre and post emergency situations, assessing the hazard and the risk of exposed urban structures and infrastructures; (b) recognize the best mitigation strategies and to evaluate the effectiveness of these strategies under different future scenarios, also including the effect of Climate Change. Active and abandoned mine lands are those lands, waters, and surrounding watersheds contaminated or having environmental scars from the extraction, beneficiation or processing of ores and minerals. This challenge can be addressed by the widespread use of modern techniques of earth observation, especially in a view of the availability of satellite Sentinel constellation, under the Copernicus. One of these techniques is a satellite radar interferometry, which allows for detection of movements of ground surface. The technique enabling the use of radar images to identify slow mass movements is now rapidly developing and widely. In addition, new generation of optical satellites can allow modelling physical-chemical properties (e.g., AMD, vegetation stress, polluted water bodies) of sensed surfaces, with Sentinel 2 and future EnMap data it will be possible to move from local to regional or global scale. Moreover, with Sentinel-2 data the dynamic changes will be possible to monitor.
Geochemistry	In order to ensure safe and sustainable agriculture and forestry, reliable and at the continental scale harmonised geological/geochemical information in the form of interoperable databases is crucial. Various sample materials are of interest: soil, water, bedrock and even biological media such as plants and animal tissues.



	<p>Geochemical conditions in analysed sampling media may have an important impact on quality of food produced, forest fertility, nutrients uptake in plants and animals, effects on productivity and health, etc. Provision of data needed for Forensics (among others tracing the origin of food, e.g. lamb meat, olive oil, apples, honey, wine) can become an important service in the future. Coupling of geosphere and biosphere is needed. Establishment of geochemical background values for Europe in various sample media can influence the formulation of new policies.</p>
<b>GeoEnergy</b>	<p>To establish a robust and versatile platform and standard practices by which GSOs can integrate outcomes of regional/national/European geological research including basic subsurface measurements, property models, resources assessments (fossil, geothermal, storage) and impact/hazard predictions. GS4E should elaborate on the GeoERA results, extending their implementation and functionality to all countries and geo-energy resources/capacities. The workflow is based on the principles of 1) establishing interoperable 1D/2D/3D/4D geo-information (raw data/geo-models/properties/dynamics) at multiple scales; 2) using that information for compatible/comparable assessment of resources, capacities and induced effects/impacts and 3) transforming these outcomes to serve decision processes and end-user needs. The workflow must be generic enough to be future proof and to be adaptable to new challenges and assessments of new innovative uses of the subsurface.</p>
<b>Groundwater Resources</b>	TBD
<b>Marine Geology</b>	<p>Ensure open, low-threshold access to our non-confidential data and data products through EGD. As collaborating geological surveys, we need to control our own destiny as service providers (expert knowledge as well as basic products such as maps). We should make it easy for third parties to create tools that use our data and data products (maps and models) for derived, applied products that address national, transnational and pan-European societal issues. Happy clients of these third parties, including governments, can do more to emphasize the importance of a well-functioning portal and underlying database than we can ourselves. We need others to say that what we do is important.</p>

### ***Second large objective***

<b>Expert group</b>	<b>Second large objective</b>
<b>Mineral Resources</b>	<p>From the above challenge, it follows that sustainability can only be analysed from a detached view of the mineral resources and who and what is supplying and consuming what. However, this can only be really done when market trends are also introduced into the mix as well as trends related with recycling rates and types of materials. The challenge is to aggregate all these factors and analyse as a whole. Providing expert information to the European Commission on matters related to Raw Materials. Specifically explaining how the primary Raw Materials sector operates in a market based economy; explaining the challenges facing both explorers and miners; providing input to Commission documents and publications on Raw Materials.</p>
<b>Earth Observation</b>	<p>Creating new application or services using state-of-the art EO data (e.g. Copernicus data or future HS satellite data) for geohazards monitoring and prevention, mining sites monitoring as well as primary and secondary exploitation of raw materials with new technologies, on site, fast and integrated, sustainable, cost effective, which can primarily be realized via advanced proximal sensing and remote sensing.</p>
<b>Geochemistry</b>	<p>Ensuring safe and long-lasting water resources requires independent geological/geochemical information about the status and quality of water.</p>



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	Harmonised and interoperable databases for the European shelf, the European Mediterranean and the Baltic Sea, based on low sampling density mapping can play an important role in protecting marine environment and at the same time exploring the possibility of industrial exploitation (raw materials, mineral resources) of marine resources. Harmonised databases for surface water and groundwater at various scales (low to high density sampling) will play a crucial role in developing policy for drinking water standards (e.g., threshold values), water-protection and sustainable exploitation.
<b>GeoEnergy</b>	To enable a proper implementation of GeoEnergy information and research in various decision processes, follow-up actions and society education. The key challenge is to ensure that our knowledge and information proceeds through the value-chain, thereby allowing it to deliver the expected impact. It is not only a matter of re-shaping information, but also understanding how it is perceived by the society and end-users. Do we understand the needs of end-users and the impact of our information in their processes? How to ensure that end-users understand the uncertainties of our information and that this is adequately incorporated in the decision processes? How do we communicate the spatial and geological complexities?
<b>Groundwater Resources</b>	None
<b>Marine Geology</b>	Link marine and terrestrial geology. We are being quite successful at harmonizing and merging our geological data and data products across borders, both on land and at sea, but have forgotten in this process that geological systems and processes don't stop at the waterline. Encouraging our marine and terrestrial experts to work together is a challenge at the national level because they are often funded by different ministries. Perhaps the EU can play a facilitating role.

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### *Third large objective*

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<b>Expert group</b>	<b>Third large objective</b>
<b>Mineral Resources</b>	The topmost crustal surface, down to 100m, is perhaps what we know best when dealing with mineral resources. There needs to be a continuous towards investigating the area of the crust below that imaginary line. New and innovative exploration technologies have to be used and new discoveries have to be made as well as developing optimised extraction methods to make lower grade / lower tonnage mineral occurrences profitable and economically attractive. The challenge is to make grassroots exploration a target for the next funding programme. Carry out specific research on Raw Materials issues within the competence of the GS4E. This could include, for example, assessment of the resources of specific commodities within Europe; evaluating novel research proposals; producing position papers on particular issues in the Raw Materials sector; and so on.
<b>Earth Observation Geochemistry</b>	None
	Digital databases with the geochemistry of various geological materials (e.g., water, soil, rock, mineralised rock) freely available to users are necessary to evaluate the quality of the environment before and after human activities (e.g., in risk assessment, post-mining activities, land planning, etc.). Several actions should be taken into account in order to satisfy the demands in environmental protection and monitoring, for example, mapping the connection between geochemistry and biodiversity, soil geochemical conditions in different climate zones, distribution of potentially hazardous elements across the continent, etc.
<b>GeoEnergy</b>	To explore, investigate and develop new innovative ways for using/creating geoscientific knowledge and information. GSO data and knowledge is important

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	feedstock for other research in the field of GeoEnergy, e.g. new resource types, frontier plays, exploration methodologies or ways to recover resources and use subsurface space. This also includes aspects under Climate, Environment, Groundwater, etc. At the same time the innovation on modelling and assessment may trigger new developments in associated research areas.
<b>Groundwater Resources</b>	None
<b>Marine Geology</b>	By focusing on a limited number of objectives (in a limited number of GeoERA projects with a limited number of work packages that match activities already planned /ongoing in national programs), we ensure the feasibility of the present phase in our strategy to create a well-functioning geological service. It is more important to showcase that we can make things work transnationally and cross-disciplinary than to cover a full spectrum of topics.

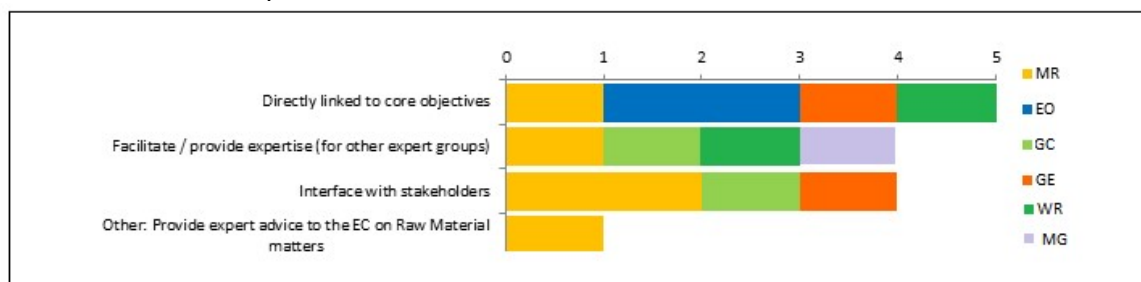
### WHAT ROLE DO YOU SEE FOR YOUR EXPERT GROUP IN GS4E?

The three/four themes in GeoERA are directly linked to EGS Expert Groups. This was not the goal, and can be organised differently.

#### *What role do you see for your expertise/experts?*

	MR	EO	GC	GE	MG	WR
Directly linked to core objectives	1	2		1		1
Facilitate / provide expertise (for other expert groups)	1		1		1	1
Interface with stakeholders	2		1	1		
Other:* Provide expert advice to the EC on Raw Material matters	1					

\* Provided as free input





### ***Background for the above choices***

<b>Expert group</b>	<b>Background for the above choices</b>
<b>Mineral Resources</b>	<p>MREG is a facilitator and a guide providing expert knowledge on RM. MREG is the EGS expert group on mineral raw materials and therefore we are directly linked to the Raw Materials Challenge. Each MREG Member is part of a wider network within their Country which deals with various views from different stakeholders. The EC, to date, has not received or understood, unbiased expert advice from Member States on matters related to Raw Materials.</p>
<b>Earth Observation Geochemistry</b>	<p>EOEG is the only expert group that can only contribute to the challenges and objectives referred before.</p> <p>Geochemistry Expert Group represents geochemists with various backgrounds and it is not a topical group. Therefore, our intended mission within the GeoEra initiative is to support topical groups (energy, groundwater, mineral resources, remote sensing) with our expertise in the field of applied geochemistry (sampling, methodology, interpretation).</p>
<b>GeoEnergy</b>	<p>Our core objectives are directly related to societal needs and impacts (resources for energy supply, capacities for lowering GHG emissions, waste management, preventing and mitigating hazards/impacts).</p> <p>As stated in at previous questions, our work and information is closely linked to the decision processes regarding subsurface exploration and exploitation (knowledge implementation). Experts in our group regularly interact with policy makers (geo-technical advice) and industry (exploration/exploitation).</p> <p>We are mostly a user/consumer of information and services from other groups (e.g. geochemistry, geobiology, earth observations, information systems), yet the outcomes of our work can also be of importance in return (e.g. cross-thematic issues with groundwater, subsurface composition and behavior, induced hazards)</p>
<b>Groundwater Resources</b>	<p>As mentioned previously groundwater is of importance for most of the societal challenges defined in the H2020 programme, and water research and management involves many different research institutions, consultants and authorities - WREG needs to be able to interact with representatives at all levels - from municipalities to the European Commission as well as provide knowledge and easily accessible and sound data for the European Geological Data Infrastructure and participate in research and knowledge provision together with the best universities and water research institutes</p>
<b>Marine Geology</b>	<p>The marine contribution to GeoERA is quite modest. We can facilitate by volunteering our successful EMODnet expertise, the result of decades of lobbying in Brussels, cross-disciplinary networking, and generation of trust among partner surveys. It is important to stress that successful lobbies are ones set up with known end users of our products, such a ecologists and engineers (MODEG is good example). The EU is more receptive to our please when they see that we're not just representing ourselves as geoscientists. Also, it takes time. More than a decade of investment (EU projects with a lot of in-kind effort) passed before we got to the present service contracts. Finally, service contracts are instrumental for small partners to build out a particular expertise, while allowing others to add existing nationally paid activities that create win-win situations.</p>