Minerals Policy Guidance for Europe

Innovative Exploration and Extraction

Deliverable 3.2

Innovation evaluation criteria and best case practices in exploration and extraction–

Version 1, October 2016

This project receives funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 689527

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Manuscript completed in October, 2016.

ACKNOWLEDGEMENT & DISCLAIMER

This publication is part of a project that has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 689527.

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Table of Contents

1. Background and objectives

MIN-GUIDE: a brief introduction

The Horizon 2020-funded MIN-GUIDE project aims to support the secure and sustainable supply of minerals in Europe through the development of a major new online repository outlining guidance and the latest in good practice for minerals policy decision makers. The project's key objectives are (1) to provide guidance for EU and EU Member States minerals policy, (2) to facilitate minerals policy decision making through knowledge co-production for transferability of best practice minerals policy, and (3) to foster community and network building for the co-management of an innovation-catalysing minerals policy framework. MIN-GUIDE will profile relevant policy in Europe, identifying innovation-friendly good practice through quantitative indicators, qualitative analysis of country-specific framework conditions, and the compilation of minerals statistics and reporting systems. These insights will form the basis for the project's key output, an online Minerals Policy Guide (referred to in this document as 'the Policy Guide').

The project is split across 8 work packages (WPs) (see Table 1 unterhalb). The content-rich work packages are WPs 2-6: WP2 will produce a comprehensive and well-structured knowledge repository of EU level and EU Member States' mineral policies and governance frameworks; WPs 3-5 will identify, benchmark, and elaborate good practice on policy innovation capacity according to the different activities along the whole mining value chain (permitting, exploration, extraction, cross-border exploitation, processing, waste management, recycling, remediation and mine closure); and WP6 will review the mineral data base and recommend standardisation and systematic reporting requirements for EU Member States.

Common approach	WP1	Minerals policy guide development and conceptual basis
Core content	WP2	Stock-taking of EU and EU MS mineral policy and legislation
	WP3	Innovative exploration and extraction
	WP4	Innovative processing
	WP5	Innovative waste management and mine closure
	WP6	Raw materials knowledge and information base
Cross-cutting management and engagement	WP7	Stakeholder management, communication and dissemination
	WP8	Project management

Table 1: The MIN-GUIDE work packages

What is expected of this work package?

It is the aim of WP3 "Innovative exploration and extraction" to investigate how innovative exploration and extraction methods are taken up in different EU Member States and on EU level, and how this is supported or inhibited by national and European policy.

The work of WP3 will be split into 4 tasks:

- Identification of EU MS mineral policies and legislation relevant to innovation in minerals exploration and extraction (based on findings provided by WP2)
- **Identification of catalysing and inhibiting elements for the implementation of innovative mineral exploration and extractive methods (non-technological as well as technological elements) and, following this, an identification of best practice cases *(elaborated in this report)*.**
- Assessment of needs and gaps analysis for aligning future policy developments/directions with inclusion of all relevant stakeholders.
- Exploration of the feasibility of innovative mining legislation and legal framework for exploitation of sub-surface and deep sea resources.

The process

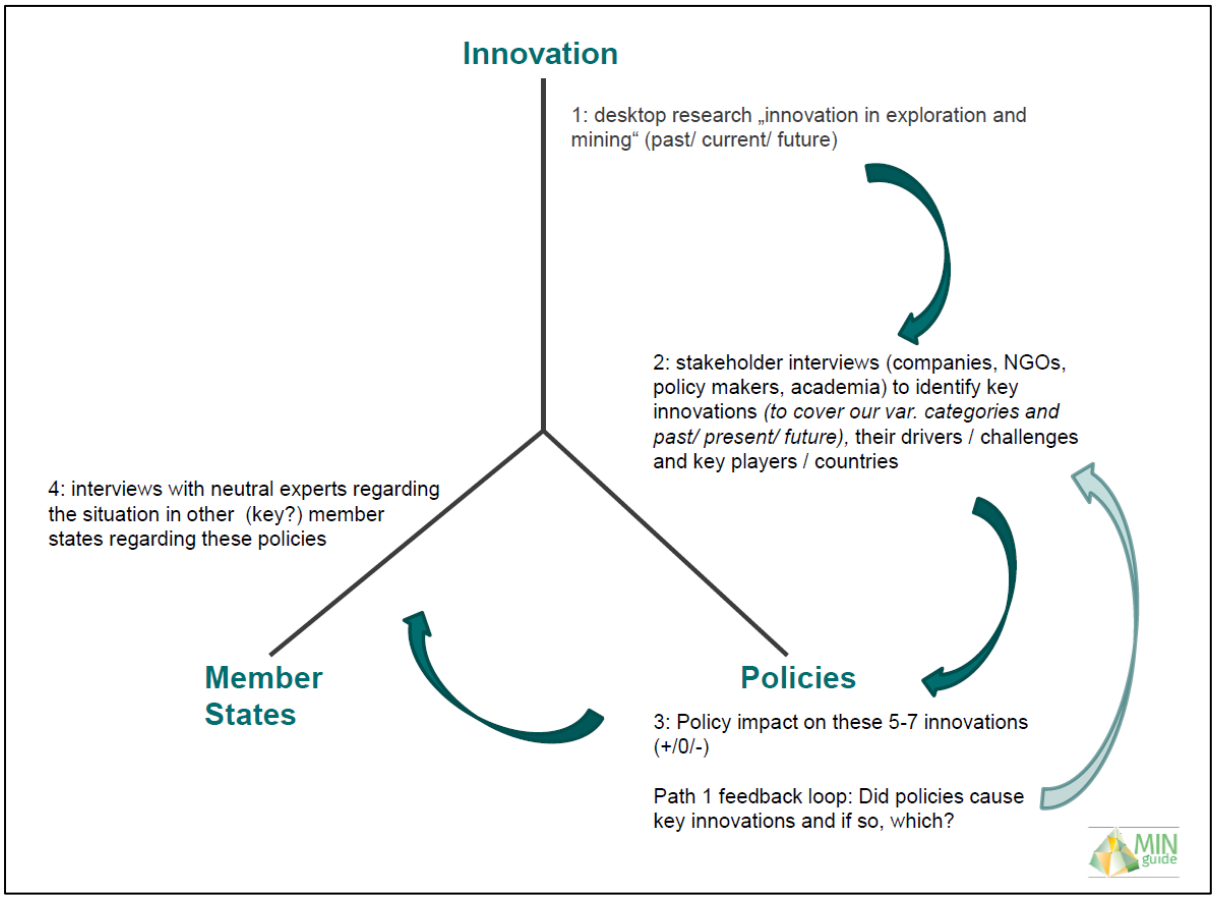
At the beginning of WP3, a challenge driven approach - related to real-world problems of exploration and mining – was chosen as the approach to follow:

> Identify key innovation challenges and / or outcomes and investigate if and how they are influenced by policies.

This approach was chosen since it delivered more tangible and practical results for industry stakeholders as well as policymakers.

Based on this, we followed a four step process (see graph 1 below):

1. Desktop research
2. Stakeholder interviews and questionnaire
3. Analysis of policy impact on innovations *(scope of next report)*
4. Second round of interviews for the case studies chosen and the situation in other EU countries *(scope of next report)*



Graph 1: WP 3 four step approach

This deliverable

With the procedure as described above, we changed the order of the deliverables in WP3; hence this MIN-GUIDE deliverable (D3.2) represents the first report of WP3.

The remainder of this report:

1. Provides the key findings of the desktop research, interviews and questionnaires with regards to innovation in exploration and mining
2. Identifies a list of key innovations and their drivers
3. Describes innovation cases which will be described in more detail and for which we will look at the policy framework in key EU member states later on in D3.1.

2. Findings from desktop research, interviews and questionnaires

Desktop research: Review of existing innovation related reports

A review of existing innovation related literature was undertaken at the start of WP 3 to identify the key drivers or challenges, as well as areas of current focus for innovation in exploration and extraction, mainly on the European context. The tables below show the results of this review.

Report	Innovation challenge / driver
Minerals 4 EU, Foresight Study- Thematic Report V: Developments on the raw material markets http://minerals4eu.brgm-rec.fr/search/site/m4eu-foresight#	Prices (mentioned as "the most important driver for exploration by far") Geological potential / data Political stability Suitable mineral policy Tenure of rights Repatriation of profits Management control Equity control Tax regime Public and government perception towards exploration and mining
Fraser Institute, Survey of mining companies 2015	Geological attractiveness (60%) *Policy perception index (40%), consisting of:* Uncertainty concerning administration, interpretation and enforcement of existing regulations Uncertainty concerning environmental regulations Regulatory duplications and inconsistencies Legal system Tax regime Uncertainty concerning disputed land claims Uncertainty concerning protected areas Quality of infrastructure Socioeconomic agreements/ community development conditions Trade barriers Political stability Labour regulations, employment agreements and labour militancy, work disruptions Geological database Security Availability of labour / skills

Table 2: Innovation challenges and drivers for exploration

Source	Innovation challenge / driver
Minerals 4 EU, Foresight Study- Thematic Report V: Developments on the raw material markets	Costs Remote locations Lower grades and more complicated orebodies Technology Increase productivity and reduce costs Reduce energy and water use Reduce environmental impact and footprint (reduce waste by developing by-products) Improve safety and health Increase socio-economic development opportunities Reduce macho-culture Conservative culture towards innovation, low R&D spending Permitting Long term policies – planning certainty
Minerals 4 EU, Foresight Study- Thematic Report II: Legislative and governmental challenges with regard to European mineral raw material deposits	Accessibility of mineral deposits Ownership Permitting Fees and taxes Right of access to land Nature (environment) protection requirements Spatial planning
MIFU/ SMART MINE OF THE FUTURE, CONCEPTUAL STUDY 2009-2010 (Underground mining only)	Strive for zero accidents through the development of technology and promotion of innovations in organisation and safety culture Contribute to sustainable mining by cutting energy consumption, CO2 emissions and ore losses by more than 30% compared to the current baseline and striving to prevent harmful emissions from the operations Stay competitive by means of vigorous efforts in research, development and innovation whereby the mining industry is moving in stages from full mechanisation to a fully controlled process industry
Rio Tinto´s Mine of the Future (http://www.riotinto.com/documents/Mine_of_The_Future_Brochure.pdf)	Geology Legislation Economics The need to keep employees safe
MinLex, 2nd Interim Report regarding Innovation, page 2	Innovation and development of extraction technologies generate new issues for resource permitting. New technologies, such as enhanced leaching, or in situ solution extraction method generate questions whether permitting of the extraction with these technologies would always be rejected due to uncertainties of long-term environmental effects. BAT (Best Available Techniques) guidelines and standards shall be elaborated and implemented in this line.

Table 3: Innovation challenges and drivers for extraction

For exploration, many of the drivers and challenges described in table 2 above, directly or indirectly influence or require innovation. For example, the Minerals 4 EU report considers **commodity prices** as the most important driver or challenge for expenditure on exploration itself. This is indirectly important for innovation because if overall exploration expenditure is low, so is expenditure (and the need) for innovation.

Geological potential and data, with its theoretical and technical aspects, is considered the most relevant direct driver for innovation. Data availability may be an important exploration driver and innovative ways of data access are essential. Also suitable mining policy is an important driver with scope for innovation.

For extraction, **costs and productivity, orebody geology** (incl. remote, lower grade or more complicated orebodies), **legislation** (i.e. environmental) and the **health and safety of employees** are considered key drivers and challenges for innovation.

Responding to the above mentioned challenges or drivers, the reviewed sources identify a number of innovation areas which are shown in Table 4 (exploration) and Table 5 (mining) below.

Better geological data, mapping and modelling to increase geological attractiveness and **new exploration technologies** such as new drilling techniques, integrated drilling and analytical technologies, down-hole and cross-hole sensing, 3D geophysical (seismic, gravimetric, magnetic, electrical and electromagnetic) are considered key innovation areas for exploration. All of these can be considered **process innovations** in response to the challenge/driver "geological potential and data", as described above.

For extraction, **process innovation** is also considered key. The top areas are **autonomous and automated, continuous**, including mechanical cutting or in-situ leaching**, safer and greener mining,** also applied in more **remote operations (deeper underground, deep sea).** All of these relate to the challenges/ drivers described above.

Source	Innovation needs
Minerals 4 EU, Foresight Study- Thematic Report V: Developments on the raw material markets	Increase geological attractiveness Better geological data / mapping Role of state / companies Incentives R&D for better technologies Increase exploration (expenditure) Explore in remote locations Explore inhospitable locations (extreme weather, arctic, deserts, high altitude, deep sea) Handle high country risk Manage increased depth of deposits Manage lower concentrations Manage more complicated chemistry Manage dependence on juniors Manage transparency and higher information demands from society Overcome that less land is available for exploration Overcome that there are less trained geologists Manage new technologies Develop new models for ore genesis Government policy incentives (tax deductions) Reduce business risks (stability)
Strategic Implementation Plan of the EIP Raw Materials	New exploration technologies: Developing new or improved highly efficient and cost-effective exploration technologies, such as new drilling techniques, integrated drilling and analytical technologies, down-hole and cross-hole sensing, 3D geophysical (seismic, gravimetric, magnetic, electrical and electromagnetic) and other relevant tools. Geo-models: Developing new geo-models of mineral deposits or belts formation interpreting in a useful form the data and information obtained from integrated geological, geophysical, geochemical and other methods. Models would increase knowledge on mineral deposit / belt types, including in the controls conditioning the deposition of rare metals as by-products in carrier “main” ore minerals, and also decrease the exploration costs (such as the number of needed expensive deep drills).

Table 4: Innovation areas for exploration

Source	Innovation needs
Minerals 4 EU, Foresight Study- Thematic Report V: Developments on the raw material markets	Scale up equipment Automatization of processes Continuous processes New technology Mechanical cutting to replace drilling, blasting and loading In-situ leaching Deep sea, deeper underground, space Increase R&D Better data at EU level (Technology tracking, R&D spending in the industry, etc)
MIFU/ SMART MINE OF THE FUTURE, CONCEPTUAL STUDY 2009-2010 *(Underground mining only)*	Technology (Technology will also be a strong driver for change in the future, from development within the sector, but mostly from the transfer of technology from other sectors such as IT, biotechnology and advanced materials) Safer mining Safety management No human exposure in the active mining area Ground control Resource characterisation Safer equipment/plants Leaner mining (assessed mining`s readiness for Toyota Production System and found that it isn`t ready yet; 2 requisites are listed below:) Improving the reliability of the mining equipment Creating a continuous mining process Greener mining Energy efficiency and CO2-reduction Increased ore recovery Reduction of emissions Reduced impacts of the waste generated - waste into products Resource characterisation The attractive workplace Safety Physical work environment Psycho-social work environment Social responsibility
Rio Tinto´s Mine of the Future (http://www.riotinto.com/documents/Mine_of_The_Future_Brochure.pdf)	Fully integrated, automated mining Improve employee safety Increase productivity Lower energy consumption Reduce environmental impact

Strategic Implementation Plan of the EIP Raw Materials	Automated mining: Developing cost-effective highly automated mining operations to reach deeper seated deposits and to avoid exposure of workers underground with in-situ minerals winning, pre-processing and backfill to reduce the amount of waste rock to be transported to the surface. Mining of small deposits: Developing cost-effective and environmentally sound concepts and solutions for exploitation of small or low-grade mineral deposits with pre-processing and refining capacities in their vicinity, using the assets of a larger mine or flexible and mobile mining technologies. Alternative mining: Developing safe and environmentally sound alternative techniques to extract the ores, such as “in-situ” leaching, solution mining or applying biotechnologies substantially reducing generation of mining waste and large tailings. Deep-sea mining: Developing new concepts and working cost-effective and environmentally-responsible deep-sea mining technological solutions a cost-efficient and pilot for minerals production, with a test-site at which technologies and methods for deep-sea mining can be tested and evaluated under real-world conditions.

Table 5: Innovation areas for extraction

Results from interviews and questionnaire

Following the initial desktop research, between July and September 2016 we interviewed twelve experts with various backgrounds (industry, academia, consultancy, government, NGOs) about their views on

- what they consider the most important innovations in exploration and extraction in the past 20 years, currently underway or on the horizon in the next ten years
- their drivers or barriers
- their impact, and
- their link to policy

In addition to these interviews and in order to get a larger number of inputs we designed a questionnaire (see annex), also based on the points described above used in the interviews.

In early August 2016, we emailed the questionnaire to about 200 stakeholders from our MIN-GUIDE stakeholder database, did a follow up in early September, emailed it to an additional 20 stakeholders (mainly from industry) and included the questionnaire in the MIN-GUIDE newsletter Nr.2, giving all recipients of the newsletter a chance to contribute.

By 17th October 2016 (the cut-off date for the first version of this report) we received 30 responses, which we considered together with the interviews as described above.

The following tables show the geographical and stakeholder group distributions of the questionnaire respondents.

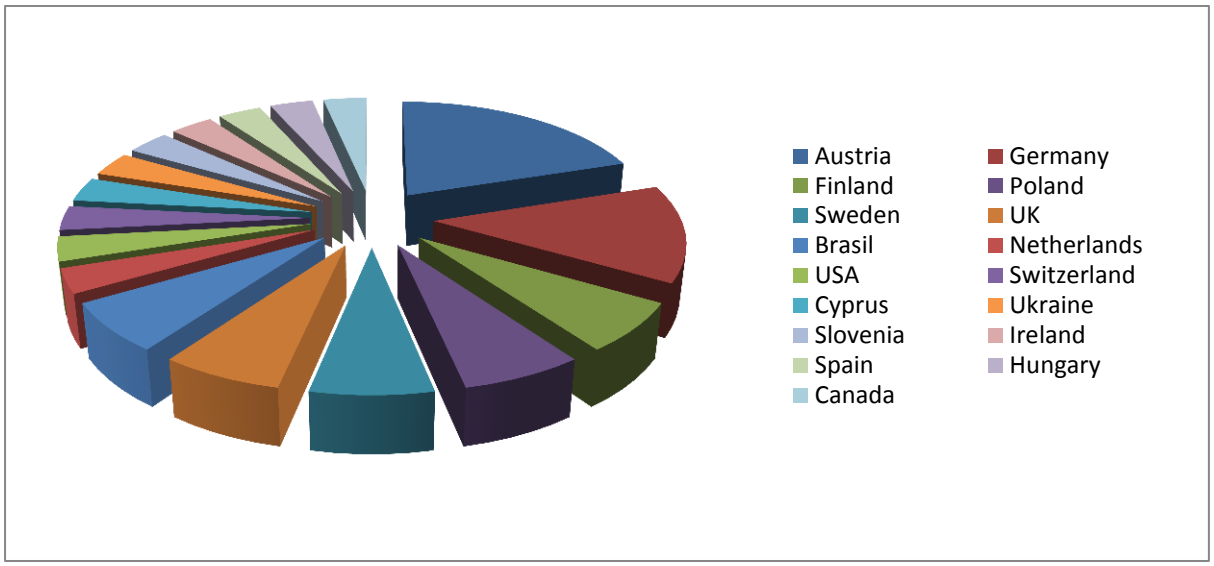


Table 6: Responses by geography (n=30)

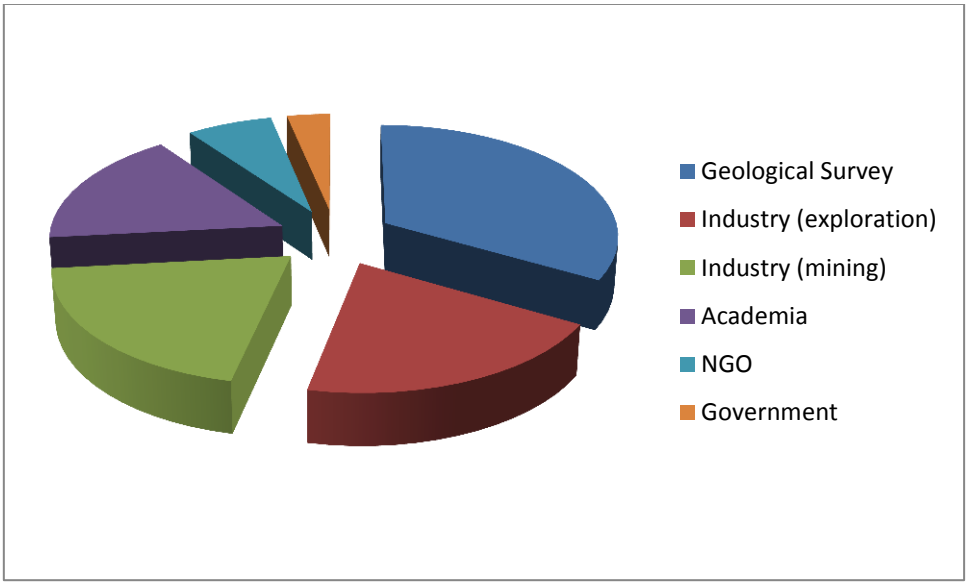


Table 7: Responses by stakeholder group (n=30)

In addition we got three responses that were not considered for further analysis since they did not deliver any usable or supportive results.

For exploration, the following innovations were mentioned by the experts as either having taken place in the last 10 years, currently being implemented or will be taking place in the next 5-10 years. They are listed below in descending order, with the most often mentioned innovations listed first.

Exploration innovations
New geo-models, i.e. 3D modelling using multiple geological, geophysical and geochemical datasets
Airborne geophysical methods
Use of commercially available drones and other small aircraft in surveying tenure or high precision mapping
In-situ analysis using portable XRF analysers
In-situ analysis using multispectral core logging
Trace-element lithogeochemical & mineral systems mapping
Use of MMI (mobile metal ion) theory in geochemical exploration
Advanced field work, including better sample processing and analysis techniques, data analysis and processes for environment-friendlier exploration
Advanced geological and geophysical data processing and interpretation, e.g. SOM (self-organising maps) method, prospectivity analysis
Advanced surficial geochemical and biogeochemical methods based on weak and selective leaching
Mobile GIS/GNSS applications and improved field mapping workflows, plus availability of cloud-based server storage
Deep drilling technologies, including accurate down-hole surveying and directional drilling, downhole geophysical and structural analysis (but NOT yet including downhole chemical analyses)
Deep penetrating geophysical technologies, in particular magneto-tellurics and electromagnetics (including SQUID development)
New drilling technologies
Improved online access to existing exploration and geological data
All geological data published
Faster technology to scan larger areas
Overarching mining code
Development of innovative near-mine and deep exploration technologies
Multi-layered information and integrated geological, geochemical and geophysical services and products
Integration of ancillary data to 3D models (e.g., remote sensing, geochemical, geophysical, and spectral data, etc.) adds an essential, holistic, multidisciplinary approach that further enhances the process.
New geo-models of mineral deposits interpreting in a useful form the data obtained from integrated geological, geophysical, geochemical and other methods to facilitate finding of new mineral deposits on the continent and at and below the sea-bed. Better understand ore genesis and direct exploration at deeper(down to 150-4000 meters), unexploited levels of the bedrock

Table 8: Exploration innovations

Overall however, experts in the interviews mentioned that there haven`t been any breakthrough innovations in exploration in the last 20 years, with the above listed innovations mainly building incrementally on previous innovations. Some also mentioned that “the most important thing in exploration is still the skills of the geologist”. This reveals the need to adapt and update present University curricula so that a new generation of professionals is prepared to face the challenges posed by mining in the 21st century.

For extraction, the innovations shown in table 9 below were brought up. The first two, **autonomous equipment** and **process control &data management** stand out, as they were mentioned more than twice as often as the innovations next down the list.

Extraction innovations
Autonomous equipment/operations including use of robotics, smart sensors and 3D printing
Process control & (big) data management („real time information and mass flows“)
Continuous processes and automation
Resource characterisation
New models for financing of mining
Lower environmental footprint (ie biodiversity, ore recovery, energy and CO2, water, waste)
New /Alternative mining methods (in-situ leaching, mechanical cutting to replace DLB, etc)
Digitally enabled worker including remote operation centres, virtual and augmented reality, virtual collaboration
Transparency and traceability including open platform databases, block chain usage
Surveying methodology and mine design
Scale up of production equipment
Resource characterisation for better structural control
Integrated platforms, enterprise ecosystems incl. IT/OT convergence, asset cybersecurity
Next generation analytics and decision making including Artificial Intelligence, simulation modelling
Land use planning governance (site level vs. Cumulative impact at regional level) - data will allow models/analysis as part of regional development plans
New business models and customer relations (collaborative business models, customer responsibility)
Dealing with extreme environments (deep sea mining, extreme depths, arctic…)
Various safety innovations including cultural change
Better skills base
Better infrastructure, i.e. electricity and “mine to market”
Electronic detonators in blasting
Renewable sources of energy
Electrification of haul trucks
Flexible (i.e. train-less) haulage

Table 9: Extraction innovations

What is also worth mentioning for extraction is that there is a difference in the input from the two NGO representatives. Whilst the other stakeholders' focus is to a large extent on (mining) process related innovations, they only brought up future innovation needs ("will happen in the next 5-10 years") around transparency, land use planning governance and better environmental management.

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3. Key Innovations in exploration and extraction and their drivers

The vast majority of the exploration innovations mentioned above are **process innovations** as per MIN-GUIDE´s definition of innovation. Only one, the "overarching mining code", can be considered a **system innovation** and it could be argued that some of the process innovations also include elements of organisational and systemic changes.

Similarly, the vast majority of the extraction innovations mentioned are **process innovations**, with some of them including some organisational elements. "Land use planning governance" and "new business models" can be considered **system innovations** and "better skills base" an **organisational innovation.**

Comparing the innovation areas considered key in the desktop research (better geological data, mapping and modelling and new exploration technologies for exploration and autonomous and automated, continuous, safer and greener mining, also applied in more remote operations for mining) with the actual innovations mentioned in the interviews and questionnaires one can see that there is a perfect overlap, with "new models for financing of mining", "transparency and traceability" and "land use governance" being mentioned additionally.

The above mentioned innovations from tables 8 and 9 are listed as key examples and will all be considered for transfer to the MIN-GUIDE online Minerals Policy Guide over the next couple of months.

Innovation drivers

In the interviews and questionnaires we also asked for the underlying drivers behind the actual innovations mentioned. Table 10 and 11 below describe them in descending order.

Exploration drivers
Geological potential and data, incl. more complex, deep underground (blind), deep sea orebodies
Public and government perception towards exploration and mining
Costs (faster, more efficient)
Improved technology from other application
Quality of infrastructure
Suitable mineral policy - management control
Environmental / Nature protection requirements
New, easier application of a method
Spatial planning
Suitable mineral policy - tenure of rights
Suitable mineral policy - tax regime

Table 10: Drivers for innovation in exploration

For exploration, **geological potential and data** was mentioned for most of the innovations and more than three times as often as the following drivers thus representing the key driver. This is consistent with the results of the desktop research as shown in section 2 of this report.

Extraction drivers
Productivity improvements
Improve safety and health
Cost reductions
Reduce environmental impact and footprint
Easier, faster permitting
Long term policy - planning certainty
Remote locations
Suitable mineral policy - tenure of rights
Lower grades & more complicated orebodies
Data interpretation and integration
Labour/ skills availability
Labour regulations and union agreements
Quality of infrastructure
Political stability
Suitable mineral policy - equity control
Transparency (better monitoring)
Civil society demands
Sustainability
Business opportunity

Table 11: Drivers for innovation in extraction

Productivity improvements, health & safety improvements and **cost reductions** were the drivers mentioned most often as key for innovation in extraction. Once again, this is consistent with the results of the desktop research.

4. Innovation Cases

Based on the approach described in section one of this report and on the clear trend in the number of how often innovations were brought up by respondents in section two, we will further develop the top five innovations for both exploration and extraction into case studies, following the process described in section 3.3 of MIN-GUIDE's D1.1 report.

Innovation cases
New geo-models, i.e. 3D modelling using multiple geological, geophysical and geochemical datasets
Airborne geophysical methods
Use of commercially available drones and other small aircraft in surveying tenure or high precision mapping
In-situ analysis using portable XRF analysers
In-situ analysis using multispectral core logging
Autonomous equipment/operations including use of robotics, smart sensors and 3D printing
Process control & (big) data management („real time information and mass flows“)
Continuous processes and automation
Resource characterisation
New models for financing of mining

Table 12: Innovations chosen for case study development

These cases will be developed by March 2017, using also input from MIN-GUIDE's policy lab 2, and then included in the MIN-GUIDE online Minerals Policy Guide.

5. ANNEX: WP3 Questionnaire

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MIN guide

MIN-GUIDE is a Horizon 2020 project that aims to establish a **coherent and innovation friendly minerals policy framework in Europe** by developing a Minerals Policy Guide and engaging diverse stakeholders in the mineral sector and related areas. For further information please visit:

www.min-guide.eu

For the purposes of the MIN-GUIDE project, we propose an understanding of innovation based on the OECD Oslo Manual definition:

"An innovation is the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organisational method in business practices, workplace organisation or external relations." OECD and Eurostat (2005, p. 146)
In lay terms, **we interpret an innovation to be the novel application of something** (e.g., a **product, tool, software, process, technique, method or concept**).
This questionnaire looks at **exploration and mining**, with exploration including all processes that lead to the discovery of new mineral deposits and mining including all processes involved in the extraction of materials from the earth. It excludes all processing of these materials and the handling of waste materials, which this project will look at at a later stage.

Not included in the scope of MIN-GUIDE are energy minerals incl. coal and oil& gas.

Please select for which area you would like to fill in the questionnaire:
☐ Exploration ☐ Mining ☐ Both
Name:
Organisation:
Country:

Please let us know if you want to get regular updates from the MIN-GUIDE project
☐ Yes ☐ No

Exploration

E1 Please rank the top 5 innovations in exploration that either took place in the last 10 years, are currently being implemented or will, in your opinion, take place in the next 5-10 years.	
	List of innovations *(please choose from the drop down list (and add as needed), starting with the most important)*
Innovation 1	
Innovation 2	
Innovation 3	
Innovation 4	
Innovation 5	
If you chose "Other", please describe:	

E2 For the top 3 of these innovations, please name the institution (company, research organisation, government agency, etc), person and/or country, who you think played/plays a leading role in implementing this innovation first.			
	Institution	**Person**	**Country**
Innovation 1			
Innovation 2			
Innovation 3			

E3 Please choose up to 3 key drivers leading to this innovation.				
	Driver 1	Driver 2	Driver 3	**If you chose "Other", please describe:**
Innovation 1				
Innovation 2				
Innovation 3				

E4 Please describe the impact of these innovations, i.e. what is the difference to before and why you consider this to be a top 3 innovation.	
Innovation 1	
Innovation 2	
Innovation 3	

E5 Please list up to 5 key policies/legislations directly or indirectly influencing this innovation, their impact (+/0/-) and the aspects relevant to this innovation.			
Innovation 1	Name of policy:	Impact:	Aspects:
Innovation 2	Name of policy:	Impact:	Aspects:
Innovation 3	Name of policy:	Impact:	Aspects:

E6 Does this innovation also have a significant impact on other parts of the mining value chain? Please select and describe the impact.					
					Description of impact:
Innovation 1	☐ Mining	☐ Processing	☐ Waste management	☐ Manufacturing	
Innovation 2	☐ Mining	☐ Processing	☐ Waste management	☐ Manufacturing	
Innovation 3	☐ Mining	☐ Processing	☐ Waste management	☐ Manufacturing	

E7 Moving away from the above described examples, can you generally think of policies/legislations that drove/ are driving innovation in exploration?			
Name of policy:	Owner:	Impact:	Relevant aspects:

E8 Please rank the top 5 member states of the EU that you think should be most concerned about the above mentioned innovations and policies.	
Country 1:	
Country 2:	
Country 3:	
Country 4:	
Country 5:	

Mining

M1 Please rank the top 5 innovations in exploration that either took place in the last 10 years, are currently being implemented or will, in your opinion, take place in the next 5-10 years.	
	List of innovations *(please choose from the drop down list (and add as needed), starting with the most important)*
Innovation 1	
Innovation 2	
Innovation 3	
Innovation 4	
Innovation 5	
If you chose "Other", please describe:	

M2 For the top 3 of these innovations, please name the institution (company, research organisation, government agency, etc), person and/or country, who you think played/plays a leading role in implementing this innovation first.			
	Institution	**Person**	**Country**
Innovation 1			
Innovation 2			
Innovation 3			

M3 Please choose up to 3 key drivers leading to this innovation.				
	Driver 1	Driver 2	Driver 3	**If you chose "Other", please describe:**
Innovation 1				
Innovation 2				
Innovation 3				

M4 Please describe the impact of these innovations, i.e. what is the difference to before and why you consider this to be a top 3 innovation.	
Innovation 1	
Innovation 2	
Innovation 3	

M5 Please list up to 5 key policies/legislations directly or indirectly influencing this innovation, their impact (+/0/-) and the aspects relevant to this innovation.			
Innovation 1	**Name of policy:**	**Impact:**	**Aspects:**
Innovation 2	**Name of policy:**	**Impact:**	**Aspects:**
Innovation 3	**Name of policy:**	**Impact:**	**Aspects:**

M7 Moving away from the above described examples, can you generally think of policies/legislations that drove/ are driving innovation in exploration?			
Name of policy:	Owner:	Impact:	Relevant aspects:

M8 Please rank the top 5 member states of the EU that you think should be most concerned about the above mentioned innovations and policies.	
Country 1:	
Country 2:	
Country 3:	
Country 4:	
Country 5:	