Innovations and the Role of Policy in Exploration and Extraction

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Key drivers and challenges for innovation

General Insights

- **Exploration**
  - Commodity prices
  - Geological potential and data
  - **Suitable mining policy**

- **Extraction**
  - Costs and productivity
  - Orebody geology (incl. remote, lower grade or more complicated orebodies)
  - **Legislation (i.e. environmental and health and safety)**

- **Policy plays a role in stimulating and enabling innovation**

Innovations exploration

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

Legende

- Mostly process innovations
- No breakthrough innovations in exploration in the last 20 years
- “Skills of the geologist”
- Field vs. data

Innovations extraction

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”

- Mostly process innovations
- First two considered key
- NGOs: more innovations **needed** concerning transparency, land use, environmental management

Role of policy for exploration & extraction innovations

- **Innovations are mainly driven by business opportunity**
- **Policy is only playing a secondary role, except for areas where innovation can help with meeting legislative requirements**
  - Health and safety (e.g. communication and warning systems in underground mines)
  - Environment (e.g. resource efficiency, energy & CO_2, water, waste management)
- RMI seen as positive since it made minerals a political priority again
- Horizon 2020 and EIT RM programmes seen as positive for e&e innovations

Relevant policies

- Raw materials policies, i.e. strategies
- Health, Safety and Environment related policies
- Research & Development related policy instruments (e.g. tax incentives, subsidies)
- Information based instruments / education (raw materials knowledge)

Innovation examples and support factors

Innovation	Policy factors	Non policy factors
Drone based magnetic surveying	National aviation policies can be a barrier, e.g. because of restricted areas or "line of sight" requirements	Costs: the intention is to reduce drilling needed but also it provides a cost effective way to do mineral exploration in new, unexplored areas
Autonomous equipment (e.g. trucks or drills) and operations	National research policies and grants, EU and national environmental policies, EU and national Health & Safety policies and national tax policies	Productivity improvements and cost reduction
(Big) data management	National research policies and grants, EU and national environmental policies, EU and national Health & Safety policies and national tax policies	Productivity improvements and cost reduction

Recommendations on future policy

Raw materials related EU and national policies and strategies, and other policy areas

- Develop a strategy for the management of solid non-energetic raw materials in every EU MS
- Provide accessibility and safe supply of raw materials
- Foster and simplify permitting procedures for exploration and extraction of raw materials
- Follow and shape policies in other areas

Societal issues such as health and safety or the environment and education

- Improve the social acceptance and the public perception of mining

RDI policies and tax incentives

- Research activity/financing
- Resource characterisation

Thank you for your attention

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