SKILLS CATALOGUE FOR THE RAW MATERIALS SECTOR

Deliverable 1.1, Version 5.0

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Authors:

Manuel Regueiro, Luis Jorda (IGME)

With contributions by:

Phillip Hartlieb (MUL), Robert Wenighofer (MUL), Robin Evans (UQ), Francisco Javier Elorza (UPM), Laurence Lamm (EIT Raw Materials). Christopher Keane (AGI), Giuseppe Di Capua (INGV), Denise Gorfinkiel (UNESCO). Ulrich Kral (TU Wien), Slavko Solar (EGS), Marco Konrat (LPRC), Isabel Fernández (EFG), Dhiti Tulyatid (CCOP), Adichat Surinkum (CCOP), Paula Adánez (IGME), Jon Ruiz (IGME)

Project coordination

Manuel Regueiro and Luis Jordá

Spanish Geological Survey. Instituto Geológico y Minero de España- IGME

Calle Rios Rosas 23, 28003, Madrid, Spain

Phone: +34 – 913495700

www.igme.es

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Intermin project partners

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SUMMARY

1. INTRODUCTION: INTERMIN

The H2020-Project INTERMIN has started in February 2018 and will last a total of 36 months. Its goal is to create a feasible, long-lasting international network of technical and vocational training centres for mineral raw materials' professionals. Specific objectives of the project are to develop common metrics and reference points for quality assurance and recognition of training and to create a comprehensive competency model for employment across the primary and secondary raw materials sector. INTERMIN activities will include:

a) To develop an international qualification framework for professional education and training programs on mineral raw materials' topics, based on present and future requirements by employers.

b) To foster joint international training programs by a merger of competences and scope of existing training programmes.

c) To optimise future interaction and collaboration in Europe and internationally.

The project activities require contact with people and institutions as well as the collection, analysis, treatment and storage of primary data (data collected by the Consortium involved in INTERMIN) and secondary data (data collected by others and published or publically available). INTERMIN also includes the development of a repository, which consists of a database of documents used and generated by the project.

2. WP1 INTERNATIONAL MAPPING (ATLASES) AND TASK 1: SCOPING

Work Package 1 will provide an overview of the current status of technical and vocational training offered for Raw Materials professionals including, but not limited to, geology, mining, processing, recycling, health, safety and environment, in Europe and in advanced mining countries. This package includes the development of a mapping methodology (e.g. desk and online research, surveys, interviews with programme leaders) and the definition of a skills list for the raw materials sector. This document is one of the products of the task 1.1 “Scoping” that define the functional requirements that are necessary to build up the database of the existing training programmes. This task includes the definition of a coherent system of skills (and the corresponding boundary) used by the raw materials sector. This catalogue (deliverable D1.1) will report on the skills identified as the key skills for raw materials education. This data will subsequently be used throughout the project as key for further interpretation and definitions.

3. SKILLS CATALOGUE

3.1 Introduction

The objective of this catalogue is to build a hierarchical logical structure, from the professional domain (where the skills are applied) to the training domain (where the skills are acquired). Thus we have scanned the mining sector globally and found all the potential jobs domains generally needed in mining operations disregarding the specific profession that practices them (usually several professionals develop the same functions). From the job descriptions profiles found we have described in detail the skills needed to perform such jobs.

This system can then be used to locate the subjects from the different training centers or programms that can provide such skills or learning outcomes.

This way, the intermin portal will be able to work both ways, from the job domains, or from the knowledge domain, and users will be able to define exactly their needs and training requirements.

The Intermin Skills Catalogue is focused on mining /extractive industries and secondary raw materials (recycling). The skills catalogue is based on the skills needed for the mining sector in a graduate – postgraduate level. The focus is not on technician skills (like drillers, foremen, etc) instead the learning outcomes analysed are those of the degree level.

3.2 Definitions

In order to undertand the logic structure of this catalogue, we must first define the different terms employed in the training and professional domains, so that we all understand the same when using a certain word.

MINING and EXTRACTIVE INDUSTRY

We understand mining in a global perspective, as the techniques associated to all minerals extraction from the ground and processes to obtain a useful substance. In this context intermin also includes ore dressing, metallurgy and recycling. The concept “mining” will include all kind of mineral and rock extraction (underground and open pit), dredging, metals, salts (from drilling and sea), quarries and pits for aggregates.

SKILLS

There is a clear need to understand the differences between skills and competences (ESCO[1] establishes “essential skills and competences”).

If we take the definition of skill from the Cambridge Dictionary[2], we finds that a skill is *"an ability to do an activity or job well, especially because you have practised it". Skill is thus, an ability normally acquired by practise.*

This definition is very relevant as links the knowledge acquired with the practical use of such knowledge.

The Collins dictionary[3] establishes two types of nouns:

[1] https://ec.europa.eu/esco/portal/home?resetLanguage=true&newLanguage=es
[2] https://dictionary.cambridge.org/
[3] https://www.collinsdictionary.com/

Countable nouns: *A skill is a type of work or activity which requires special training and knowledge.*

Uncountable noun*: A skill is the knowledge and ability that enables you to do something well.*

This is probably the reason why according to ESCO there is no distinction between skills and competences (see Skills - ESCO website[4]). The ESCO skills pillar distinguishes between the skills/competences concept and the knowledge concepts. This is done by indicating skill types.

COMPETENCIES

Competencies, in the most general terms, are "things" that an individual must demonstrate, to be effective in a job, role, function, task, or duty. These "things" include job-relevant behaviour (what a person says or does that results in good or poor performance), motivation (how a person feels about a job, organization, or geographic location), and technical knowledge/skills (what a person knows/demonstrates regarding facts, technologies, a profession, procedures, a job, an organization, etc.). Competencies are identified through the study of jobs and roles.

Competence is then the ability to do something successfully or efficiently.

KNOWLEDGE

In this context knowledge is the facts, information, and skills acquired through experience or education; the theoretical or practical understanding of a subject.

CAPACITIES

Also in this context the capacities of a subject for something, is his/her ability to do it.

SUBJECT

A branch of knowledge studied or taught in a school, college, university or professional training that provides a certain knowledge

COURSE

A prescribed number of instruction periods or classes in a particular field of study.

PROGRAM

[4] https://ec.europa.eu/esco/portal/skill

Significant long-term training activity which comprises of a series of courses, and usually has a flexible time and cost budget.

QUALIFICATION

A pass of an examination or an official completion of a course, especially one conferring status as a recognized practitioner of a profession or activity. An official record showing that a subject have finished a training course or have the necessary skills, etc. An ability, characteristic, or experience that makes a subject suitable for a particular job or activity:

LEARNING OUTCOMES

Learning outcomes are statements that describe the knowledge or skills students (or trainees) should acquire by the end of a particular assignment, class, course, or program, and help students understand why that knowledge and those skills will be useful to them. They focus on the context and potential applications of knowledge and skills, help students connect learning in various contexts, and help guide assessment and evaluation. Good learning outcomes emphasize the application and integration of knowledge. Instead of focusing on coverage of material, learning outcomes articulate how students will be able to employ the material, both in the context of the class and more broadly. Learning outcomes are thus statements of what a learner is expected to know, understand and/or be able to demonstrate after completion of a process of learning.

PROFESSION

A paid occupation, especially one that involves prolonged training and a formal qualification.

3.3 Scoping

It is important to consider here the scope of the list of skills which will be compiled. The professions whose skills will be defined, which definition or type of training and professional skills will be addressed, etc. We have to define the degree of detail in which the whole exercise will be performed.

For the mining skills catalogue we do not exclude the graduate skills. The Australian MEA framework which has been used as the basis of the skills catalogue is for undergraduate level education. However, the aim of the Intermin project is to build up a Network and catalogue of traning centres focused on post graduate university education. Later the project intends to

include the training performed by private companies and institutions (such as geological surveys) if such training is available to any potential student.

Regarding the University training we will first evaluate the 2 professions more closely related to non-energy mineral raw materials, which are mainly geologists and mining engineers.

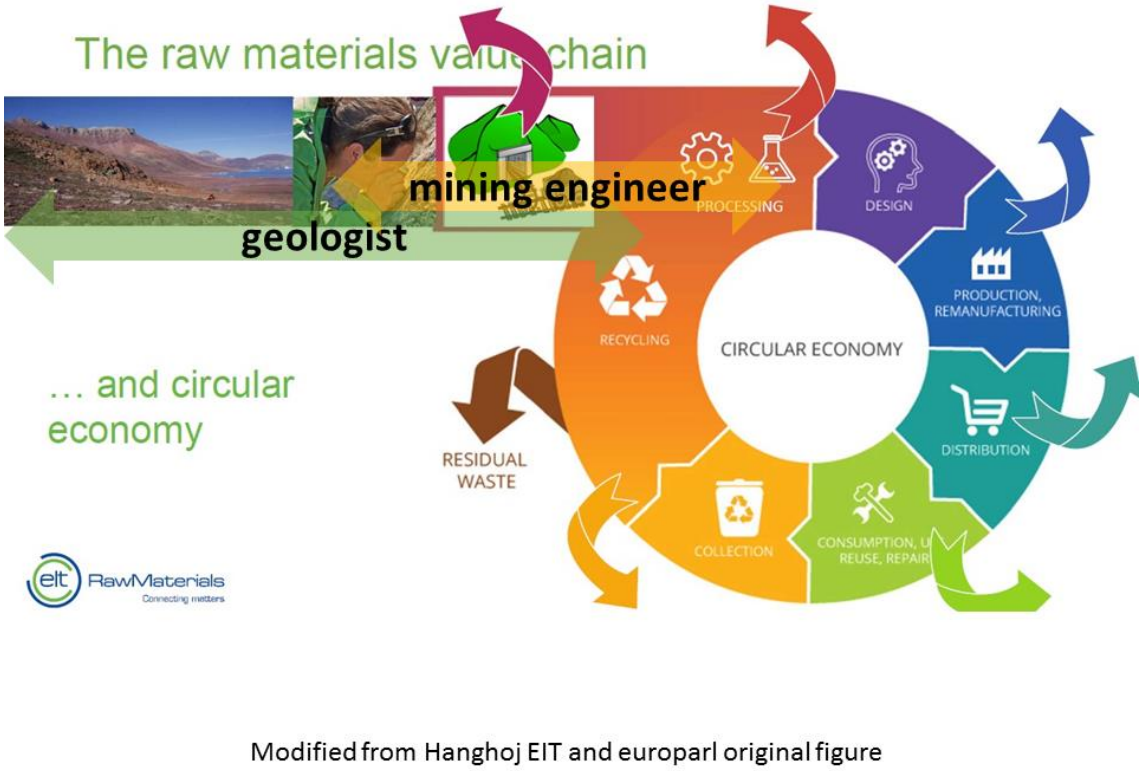

Figure 1: classical mining professions in the value chain

3.4 State of the Art: Brief historical approach to mining skills

Mining is as old as the human being. The primitive settlers in addition to hunting and collecting fruits had to provide themselves with various mineral elements essential for their daily life: as, for example,ornamental and decorative stones for their incipient artistic concerns. In the Neolithic period we already find minerals such as silex, salt, semiprecious stones (turquoise), malachite, iron oxydes, etc. And in the Chalcolithic copper, silver and gold. From the beginning, mining is going to be a very specialized activity, as was hunting and gathering. Different roles appear in the group of individuals, specializing some of them. Mining in the Roman Empire was more developed than that of the later middle ages. In Roman times there are clearly different jobs in the mine, completely specialized and technicians who design instruments of all kinds. Thus we find free people specialized in prospection, in excavation, in supports using wood, in treatment of ore and metallurgy, in the design and manufacture of drain devices, ladders, lathes, etc. Slaves would take care of painful jobs such as debris removal and machinery moving, but not of technical jobs. These were the first skills in mining. The first modern written treatise on mining (exhaustively), mineral processing and smelting, corresponds to the Middle Ages under the title “De Re Metallica”. It was written in 1556 by Georg Bauer known as Georgius Agricola. It was a compilation of the technique of the epoch, which passed orally and experimentally between technicians and supervisors, as happened in the guild of constructors. In the Middle Ages the most developed mining area in Europe was the area of Saxony, covering part of the current Germany, Czech Republic and Slovakia, whose technicians were requested in other areas of Europe such as Norway or Russia. Spanish colonial America from the sixteenth century was another area of extensive knowledge in mining and treatment that were also embodied in inventions and publications and were subsequently imported to Europe.

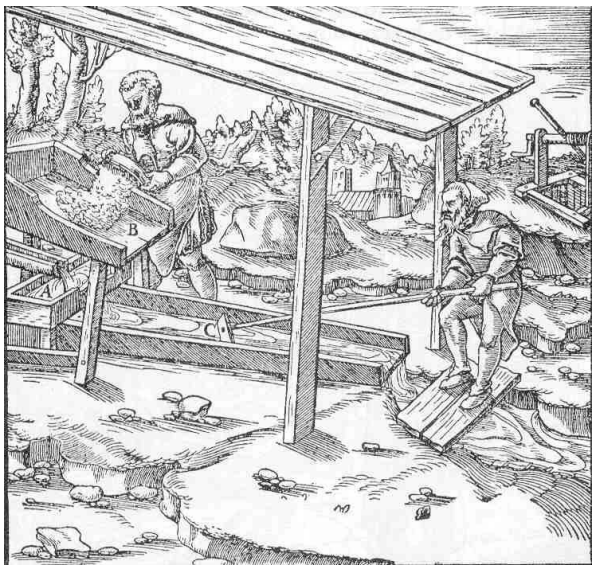

Figure 2: image of ore - ore dressing- in the book of Re metallica. In this book in each of the images we see people doing very diverse and specialized jobs (skilled).

However, it was not until the 18th century that a technical corpus and corresponding studies on mining appeared. The profession of mining engineer was officially born in the eighteenth century in Central Europe and in Spain somewhat later, linked to the American colonies. Both regions were the most developed in mining at the time. First of all to train state inspectors or body of state engineers (Humboldt was mining engineer) and supervisory technicians on foremen.

School of mines	Country	year
Mining and Metallurgical School Miskolc	Hungary	1735
Banska Stiavnica mining Academy	Slovakia	1762
Mining Academy Freiberg	Germany	1765
Saint Petesburg mining University	Russia	1773
Mining Academy Almadén	Spain	1777
Paris School of Mines	France	1783
Royal mining seminary	Mexico	1792

Table 1: First mining academies

As we will analyse further on, most of these classical mining schools, no longer primarily teach mining-related subjects, although some have retained the name. It is also interesting to point out that the creation of the mining academies indicates where was the main mining activity and developmengts in technology in those times. The most relevant mining academies and schools in America and Australia where created in the 19th C. (Melboure Australia in 1861, Mc Gill Canada 1870, Colorado School of Mines USA, 1874)

Ragarding the studies of geology, the science of the earth observation it goes back to the Greeks as a part of the Phylosophy studies. Theophrastus and Aristotle made relevant observations of the behaviour of rocks and sediments. During the Middle ages persian and muslims did relevant observations but we cannot still consider geology as a discipline itself. Geology still was a part of the natural science studies until the 18th C. in the 19th C. Geology as a science experimented a great boom both in the pure science approach with the new theories about the earth and origin of species and also in the applied field with the mineral prospection and the petroleoum industry at the end of the century. The oficial studies of geology as a science started in the 19th C (Geology and Mineralogy Chair Montpellier France 1809, Helsinki 1852, Chair of Geology Utrech 1879, Otago 1885, Kolcata India 1892). The British Geological survey was founded in 1835.

All technical and engineering studies historically quickly and efficiently incorporated the most recent technological advances, such as dynamite (Alfred Nobel 1866), the steam machine for drainage of mines and vertical movement in wells (late eighteenth century), electrification, compressed air, including techniques and improvements on the processes (mineralurgical, energetic, electrical). The skills remain very similar in the programs of studies, throughout the 19th century and the early 20th. The career of mining engineer is more oriented to the practical and technological aspects of the exploitation of the mine. Other jobs and studies such as chemistry and chemical engineering are going to be relevant in the processes associated with metallurgy and mineral ore dressing.

Geology progresses in a slow way until the great revolution that represented the drift of the continents (Wegener 1915) and the theories of plate tectonics (Hess 1962). Important advances in applied geology and geophysics came with the petroleum industry and then with mineral prospecting. However, curricula remain similar for a large part of the 20th century, without including new significant categories until well into the 1980s, when the programs were amplified mainly by the European mining crisis since the 1970s. In Europe the engineer

becomes a more generalist engineer, while in many other areas of the world the engineer is still a specialist. Although new professions are entering the world of mining in the technical part, with new environmental, ecological and mine closure regulations from the 1980s, these disciplines are rarely incorporated into the curriculum.

The legislative, regulatory and ecological standards and quality issues that are developed in the 90s are skills that technicians acquire outside the classical academic field, in graduate schools, professional associations and training centers, or more often in a self-taught mode once incorporated in the companies of the sector. It is important to know the type of training and where the technicians of the main mines and mining companies in the world acquire the required knowledge, the existence of specific agreements with universities and in-house programs and training of new programs and equipment. Historically, one of the sources of acquisition of some specific skills are related to agrements between Universities and enterprises in the forme of scholarships, which can vary in duration between three months and a year depending on the country and the University.

3.5 Skills shortages in Raw Material Industries in the 21st Century

Raw materials industries are facing skills shortages in many countries. This issue has been recognised as one of the major challenges facing the industry globally. Over the last decade it has been highlighted by industry executives, governments, workforce planners, industry consultants, and has been recognised as a threat to the development of the industry globally but particularlly in producing countries. This was emphasized by the Ernst & Young annual reviews of the mining and metal industry business risks. They ranked skills shortages as the overall number 1 risk facing the global mining industry. The lack of a skilled workforce is mainly driven by three factors: technological advances, cyclicity and demographics.

Mining requires a mixture of generic and specific skills. Modern mining operations are highly automated, and hands-on miners have largely been replaced by equipment operators. Today's mining industry relies on highly skilled workers with a diverse skill set. Mining companies look for graduates and technical specialists with not only mining knowledge but also the ability to use sophisticated technology and computing techniques, operating in challenging environments. These changes, driven by technology, are having a powerful effect on the structure and content of mining-related technical and vocational training.

The same is happening on the secondary raw materials or recycling sector. As industrial societies began to demand increasing quantities of raw materials to build up sophisticated equipments and devices, recycling of metals and minerals became much more complex. In the last 30 years recycling took a huge leap forward, from basic scrap collection into a mix of operations supported by reverse engineering and materials engineering, under the framework of circular economy.

Alongside policy development, the EU has been financing research projects[5] to evaluate the EU education and training offer in the raw materials sector. These projects provided a detailed overview of mining education and training in Europe, and have let to the conclusion that most geoscience education and training programmes in Europe are not focused towards mineral exploration or extractive industries, nor responding to the demand of recycling-related study programmes. According with data collected, despite the international dimension of geoscience, vocational and technical training on raw materials in Europe is traditionally carried out at national levels, in national languages, mostly in the mining regions. This indifference towards mining is confirmed by the decline in the numbers of both starting and graduating students of mining engineering in Europe [6.] In addition, the decline of undergraduate programs on primary and secondary raw materials in Europe (and in North America) corresponds to a shift to Asia, South and Central America[7.]

[5] See COBALT http://www.cobalt-fp7.eu/ and Euro-Ages http://www.euro-ages.eu/.

[6] Society of Mining Professors (SOMP) (2015): Survey on International Mining Engineering Programs.

[7] Mining, Minerals and Sustainable Development Project (2002). http://www.iied.org/mining-minerals-sustainable-development-mmsd

Top 10 risks	2016-2017	Over 9 years	2008 (peak of the super cycle)
01	Cash optimization	01	Skills shortage
02	Capital access	02	Industry consolidation
03	Productivity	03	Infrastructure access
04	Social license to operate	04	Social license to operate
05	Transparency	05	Climate change
06	Switch to growth	06	Rising costs
07	Access to energy	07	Pipeline shrinkage
08	Joint ventures	08	Resource nationalism
09	Cybersecurity	09	Access to energy
10	Innovation	10	Increased regulation

Figure 3 – Ernst & Young ranks skills shortages of the mining and metal industry as main Business Risk[8].

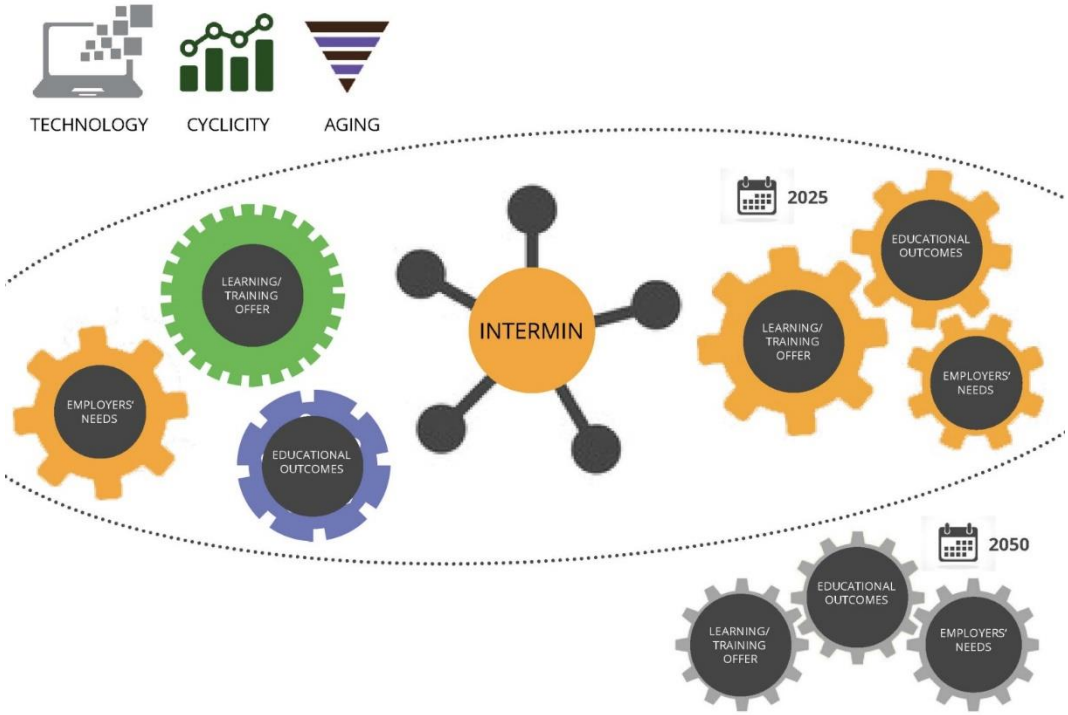

Figure 4: Representation of contextual environment and logical approach of INTERMIN.

It is also relevant to highlight some outcomes from the Raw Materials Scoreboard (European Commision Grow, 2016). The 2016 report includes a chapter on knowledge and skills:

- Talent shortage is recognizeed to be a significant problema in the raw materials sector

8 http://www.ey.com/Publication/vwLUAssets/EY-business-risks-in-mining-and-metals-2016-2017/%24FILE/EY-business-risks-in-mining-and-metals-2016-2017.pdf consulted on 27 February 2017.

- The mining industry (considering exploration, mining and processing) suffers from ageing work force and young graduates are often attracted to other sectors.
- There are indicators that the number of educational programmes relevant to raw materials is in decline.

3.6 The T-shaped profesionals

There is a new kind of skilled profesional in the Raw Materials sector named "T shaped" which is now been demanded in 21st century organizations. The concept in the Raw Materials sector is being introduced by TDoRe (see reference[9]) "*T-shaped professionals are characterized by their deep disciplinary knowledge in at least one substance area and capability to cross the boundaries between disciplines*"., although the concept of T-shape managers was first introduced by Hansen and von Oetinger (2001) in opossition to the I shape professionals (see http://tsummit.org/t) . T-shaped professionals are already in high demand for their ability to innovate, build relationships, advance research and strengthen their organizations.

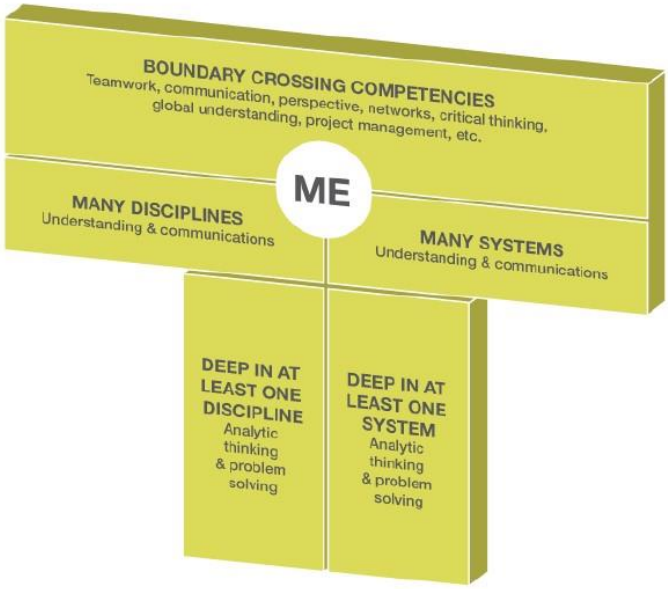

Figure 5:: Characteristics of a T-shaped profesional (source: http://tsummit.org/t)

9 https://www.vtt.fi/sites/TDore/PublishingImages/results/Required%20knowledge%20and%20skills%20of%20raw%20materials%20sector%20T-shaped%20innovation%20champions%20and%20barriers%20in%20their%20development.pdf

This kind of T-shaped champion must fulfil some requirements, such as being capable of new systemic inovations in áreas of waste reduction, recycling, material efficiency and residue utilization. But it provides also a deep understanding of the raw materials system and value chain, in particular a holistic understanding of the raw materials value chain. It is important to highlight that the importance of these requirements is shared by academia, research and industry but currently many graduates are educated to be productive in one field. This report indicates that employers are placing increasing importance on skills that go beyond a single discipline. There have been indentified some barriers to the developmemht of this kind of T-shaped champions:

- Researchers receive strong focus on technical excellence but very little in “soft” skills
- Lack of practical training and co-operation with companies
- Lack of improvement of employability skills in technical universities. Sometimes universities are creating non employable graduates
- Few policies that support collaboration between Universities, research centres and industry.

3.7 New skills and sustainability of the catalogue

As already indicated over the last 150 years, mining skills have not undergone major structural changes only in their contents. It is about training in technical skills and often scarcely in transversal or humanistic competences. Many classical mining schools reoriented their studies towards the management and civil engineering sector after the European mining crisis in the 70s.

Regarding new subjects and teaching changes, it is worth mentioning some important milestones at the end of the 20th century:

- Introduction of the environmental concepts. Environmental impact studies and specific regulations for the closure of mines from the 1980's. Initially there was a lot of reluctance and it was difficult to introduce these concepts in the industrial sectors, however the inclusion of environmental aspects in the business plan of a company and as a skill is already a consolidated reality
- Computing, new technologies and the internet. Since the 1990's it is an indispensable skill in technical studies and these are fully consolidated.
- Advances in robotics and automation. Emerging skill that is usually learned in the workplace.

- Social aspect in mining and industry, licensing and public awareness. Many mining projects in Europe (in particular) having passed all the technical, legal and environmental filters, are being blocked by social disconformity . It can be said, without a doubt, that the social license to operate (and everything related to NIMBY) is the Achilles heel of the extractive industry in Europe and many countries of the world, thus it has become a very relevant emerging skill.

The Intermin skill list will be validated during the Madrid workshop (to be held early 2019) and there will be an analysis about the sustainability and status of the skills list and how are these skills valid or not in a medium term

3.8 Starting point for the catalogue

It is important to make the skill catalogue as simple as possible so it can be practical as a search engine and a global database (for EU countries and relevant countries in mining). The simplicity of the catalogue will be a compromise between minimalism in the programming of menus and subsequent surveys, but at the same time in covering the disciplines that are named in very different ways in different places of the world.

The number of skills must be such that different countries and varied training can be identified in them (see table of skills in Apendix). We will consider, in a first approach, only one level of breakdown, but we have considered the idea of making sub-menus or sub-categories focused on the different subjects that are studied in the training plans and will have a place in a dropdown menu.

The table below includes a non-exhaustive list of the **graduated professions** involved in mining, but as roles in mining are very varied and can be exerted by any profession, the skills needed are thus shared among professions and better represented in the job definition which is included after. We will draft the skills catalogue using the job roles definition.

Professions	Job description
Geologist	Geological exploration
	Environmental impact studies
	Management
	Production control
	Quality
	Mining planning
	Mine safety
	Exploitation control
	Resource estimation
Mining engineer	Management
	Production control
	Mining planning
	Exploitation
Mining technical engineer	Exploitation
Geotechnical engineer	Geotechnical works in surface or underground mining
Geological engineer	Geotechnical works in surface or underground mining
Engineering Geologist	Distinct discipline that Geological engineer at least in North America
Biologist	Land reclamation
Industrial engineer	Mine design
Civil engineer	Mine design
Civil technical engineer	Mine design
Chemist	Processing
	R&D
Chemical engineer	Processing
Environmental sciences grade	Land reclamation, EIA
Forest engineer	Land reclamation
Architect	Mine buildings
Building engineer	Mine buildings
IT engineer	Programming
	Systems engineer
IT technical engineer	Programming
Land surveyor	Topographic surveys
Land technical surveyor	Topographic surveys
Medical doctor	Mine medicine
Psychologist	Mine medicine
Social Scientist	Community relations and Social performance (includes the term “Social licence to operate*” studies & works)
Manager	Management

** It is important to notice that the terminology "Social License to Operate" is under review by some expert in different fora, it can be considered too narrow and instrumental and for stablishing the wrong impression of what really is involved. The term "license" could be misleading as it suggest that some kind of signed document is involved, which is not the case.Iti s more a relationship that needs continuous attention to work through its ongoing highs and lows. A sort of sociological process that cannot be described through a legal term.*

The starting point will focus on the two professions most linked to the world of mining of non-energy raw materials minerals, that is the "classical" geologist and mining engineer (in some countries considered civil engineer of mines), as well as engineering geologist and geological engineer. The skills will be later completed with other related professions.

One of the most comprehensive documents regarding skills in the mining sector (extractive industries) is "**A graduate Capability Framework for the Mining Engineering Degree Programme. A guide for MEA Universities**" by prof Dowing from the Mining Education Australia, University of Queensland (2015). We have used this document as basis, and added other professions and jobs like those of geologists, the list of skills of ESCO of geologists and mining engineers, the latter presents some limitations (not explicitly in ESCO) which has been then completed with a desktop search of skills for "mining engineer".

We will complete these 2 “classical professions” with a list of 7 careers related to the mining sector[10]:

	Name of career	Faculty/ engineering	Mining value chain					
			exploration	Site set - up	mining	Processing	Market	Closure and remediation
1	Mining engineer	engineering	x	x	x	x	x	x
2	Industrial / mechanical engineer	engineering		x	x	x		
3	Chemical Engineer	engineering				x		x
4	Social performance specialist	Faculty	x	x			x	x
5	Geologist[11], Engineering Geologist and geological engineer	Faculty/ engineering	x	x	x	x		x
6	Communication	Faculty		x			x	
7	Environmental engineering	Faculty/ engineering		x	x	x		x

3.9 The intermin skills and questionnaire approach

The skills catalogue is intimately linked to the subsequent questionnaire. The skills catalogue will define two levels: skills and knowledge. Although these two terms can be quite confusing in the definitions provided since the only difference seems to be that skills are associated with

[10] https://www.thinglink.com/scene/562754907724054530?buttonSource=viewLimits
[11] Includes mineralogist – mineralogy specialists

practising and knowledge with experience. But how can one gain experience without practising? Skills are often assigned to the mining job area while knowledge to the learning outcomes. The exhaustive Intermin table os skills (see appendix) includes both and keeps the "academic domain" of subjects for the further questionnaire. These discrimination is maybe less encyclopedically supported but it is used as a working template for the survey which is the Intermin Table of Knowledge Skills and subjects.

The survey will pursue an approach to designing it in a tree-like structure which contains a choice of the main professions, the education programme is directed towards and followed by the mining job areas which the graduates of the profession cover. The mining job areas are segmented into sub-areas addressing the job area in more detail. Subsequently the survey supplies a broad selection of learning outcomes to tick which provide the basis of professional practice. The survey strictly accords to the INTERMIN TABLE OF KNOWLEDGE SKILLS AND SUBJECTS (see appendix) reducing individual denotations and classifications by the respondents as far as possible which reduces the effect of distorted assessment while converting the reply of the respondents into entries of a database.

In the questionnaire in the level of knowledge and learning outcomes tick boxes will be opened indicating if it covers that particular subject or not. Therefore it is important to reach a consensus on which are the subjects that will be included in each knowledge (see figure 2). The entries of the Skills/Knowledge and learning outcomes (see appendix: Intermin Table of Knowledge Skills) can be formulated as topics of the academic programme.

In the questionnaire, only specific knowledge and subjects will be included. The core subjects such as chemistry, technical drawing, programming, etc, will not be included and will be analyzed if it is necessary to include it them listed in a separate chapter.

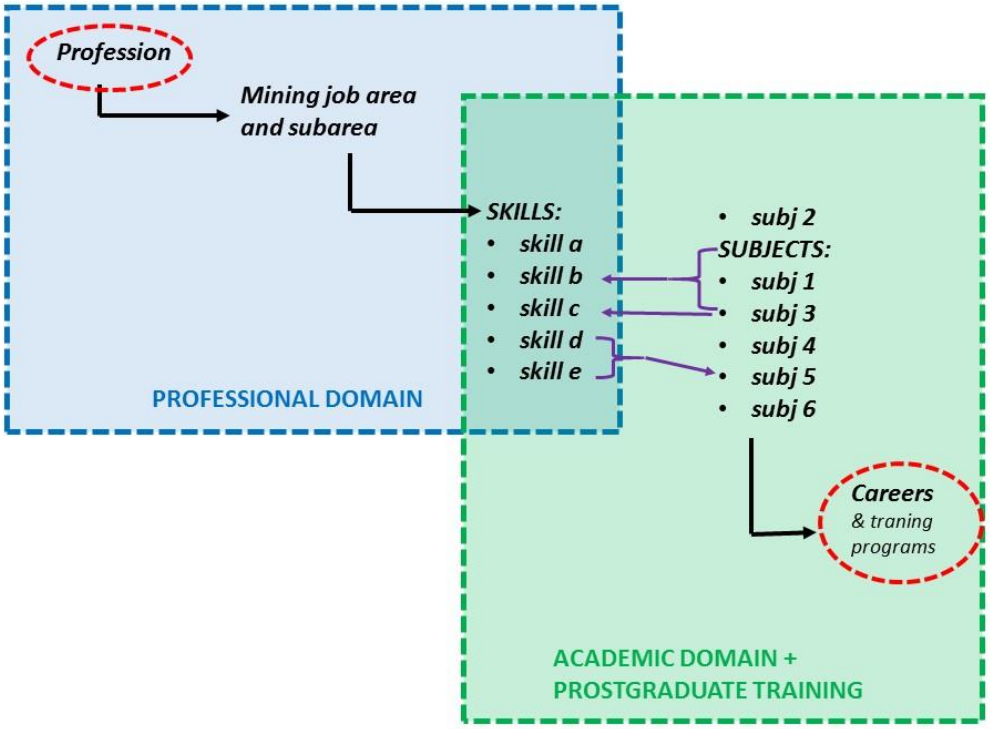

Figure 6: From Profession to Careers scheme, through skills and sunbjects

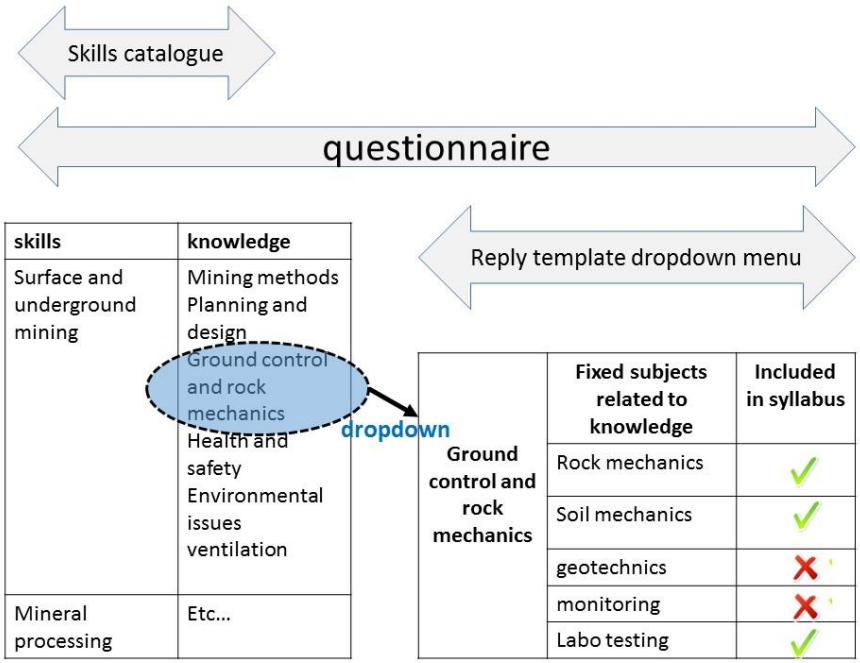

Figure 7 : skill catalogue and questionary scheme – example

The main problem faced is that the skills catalogue must be aligned with the further questionnaire. It should be comprehensive enough to have all the skills required but also easy

to fill in. The approach that we have chosen is to develop within this document a skills catalogue as comprehensive as we can, but keeping in mind that is can be shortened and some of the skills can be combined in order to build up a online questionnaire that can be filled in some 5-10 minutes by any training centre or University in the world.

Structure of the catalogue

As we have already mentioned the catalogue is not the questionnaire, and it is more comprehensive than it.

The skills catalogue has been translated into Spanish. Spanish language is spoken as an official or cooficial language in 20 countries in the world (18 in America, 1 in Europe and 1 in Africa). More importantly, some of the most relevant mining countries for base metals and precious metals are in Latin America: Mexico, Chile and Peru (Spanish speaking) and Brazil. It is important to translate the skills because the questionnaire will be sent to these countries. Other relevant world mining countries are english speaking; Australia, Canadá, South Africa and USA. We also highlight China and Russia.

The sources of the skills included into the catalogue/table come from:

- Mining Education Australia
- White book on Mining Engineering (ANECA)
- White book on Geologist (ANECA)
- Tunning project (Earth Sciences)

The catalogue is be structured in three main blocks:

1. Profession /typically related to a skill
2. Mining job area and subareas
3. Skills and knowledge outcomes (we integrate both in order to facilitate the selection/box)

[1] The status quotation is based on the vision of the experts involved in the document and the reviewers comments on that.

4. FINAL CONSIDERATIONS: NEXT STEPS

Within the Intermin consortium and our approach, we consider that the skills catalogue should be something dynamic and participative. This deliverable introduces the skills list that is included in Appendix. This list will be also translated into Spanish. The skills list will be used as a basis for the questionnaire, but it will not be used as it is now. In order to create a user friendly questionnaire this list will be probably shortened. From the skills /knowledge outcomes there will be a dropdown menu with the main subjects or topics that are taught in the different Universities, training centers, etc.

This skills list will be analysed and validated during the Intermin annual meeting that will be held in Madrid at the beginning of 2019 (Month 13 or the project intead of the originally scheduled M11 at the end of 2018). We have decided to shift this date due to logical end of year project and professional issues.

For this validation a questionnaire about the skills list will be launched before and during the conference, asking for some relevant information such as:

- Where to find this skills? In University, training centersor in in-house companies training.
- Which professions and careers relate most to the skill?
- Current status[12] off the skill
    - classical or consolidated skill
    - decreasing to deprecated
    - emerging skill or future needs identified
- Which skills are missing and why? In which area?
- Is any irrelevant?

[12] The status quotation is based on the vision of the experts involved in the document and the reviewers comments on that.

5. SOURCES OF INFORMATION AND REFERENCES

Relevant documents and links

- MEA Mining Education Australia, A graduate Capability Framework for the Mining Engineering Degree Programme (2015). A Guide for MEA Universities, versión 3, June 2015, University of Southern Queensland, 31 pages
- Raw Materials Scoreboard (2016) European Innovation partnership on Raw Materials, European Commission, 104 pages.
- European parliament. 2017. IPOL_STU(2017)595373_EN: Supporting the Market for Secndary Raw Materials in a Circular Economy, Workshop Proceedings (Brussels. 31 january 2017), 45pages
- Geoscience Knowledge and Experience Requirements for Professional Registration in Canada (2014) Geoscientists Canada, 28 pages
- Required knowledge and skills of raw materials sector T-shaped innovation champions and barriers in their development, EIT RawMaterials 2017 27 pages[13]

AMERICAN GEOLOGICAL INSTITUTE (AGI)

The American Geological Institute's Workforce program regularly monitors and measures the activities of university programs in the geosciences not only in the U.S., but globally. Part of this includes monitoring the specialties of faculty, the employment trends of new graduates, assessments of the skills they required for employment and those they believe would have been helpful. In addition, AGI works closely with various other organizations which have developed various perspectives on skill needs in the geosciences. Most recently, AGI was an partner with

[13] https://www.vtt.fi/sites/TDore/PublishingImages/results/Required%20knowledge%20and%20skills%20of%20raw%20materials%20sector%20T-shaped%20innovation%20champions%20and%20barriers%20in%20their%20development.pdf

the National Science Foundation-funded Summit on the Future of Geoscience Education, of which detailed the critical skills demanded by employers of new hires.

Additionally, AGI worked with GeoTech Center in its U.S. Department of Labor-funded effort to build out a full competencies pyramid for the geospatial industries. Substantial overlap exists in that pyramid with water resources and a number of key geoscience domains pertinent to the development of the INTERMIN catalogue.

Finally, the US National Academies of Science published Emerging Workforce Trends in the U.S. Energy and Mining Industries (2013), a comprehensive look up and down the labor pool for the resources industries. The American Geosciences Institute actively participated in supplying data, and information to that initiative.

Within the United States, the Associate of State Boards of Geology oversees the various state-level licensing requirements for geologists. Though standards vary from state to state, the licensing requirements in each state address specific demonstrable competencies and qualifications required to practice as a geologist within the state. Some of the state include oversight of professionals in the raw materials industries, and those skill bases need to be considered in the catalogue, especially as credential and license transferability is an ongoing initiative both within the United States and between the US and Europe.

ACCREDITATION BOARD FOR ENGINEERING AND TECHNOLOGY (ABET)

We have looked into the curriculum for mining and similarly named engineering programs of the USA **Accreditation Board for Engineering and Technology** [14]

1. Curriculum

The program must prepare graduates to apply mathematics through differential equations,

[14] http://www.abet.org/accreditation/accreditation-criteria/criteria-for-accrediting-engineering-programs-2018-2019/

calculus-based physics, general chemistry, and probability and statistics as applied to mining engineering problem applications; to have fundamental knowledge in the geological sciences including characterization of mineral deposits, physical geology, structural or engineering geology, and mineral and rock identification and properties; to be proficient in statics, dynamics, strength of materials, fluid mechanics, thermodynamics, and electrical circuits; to be proficient in engineering topics related to both surface and underground mining, including: mining methods, planning and design, ground control and rock mechanics, health and safety, environmental issues, and ventilation; to be proficient in additional engineering topics such as rock fragmentation, materials handling, mineral or coal processing, mine surveying, and valuation and resource/reserve estimation as appropriate to the program objectives. The laboratory experience must prepare graduates to be proficient in geologic concepts, rock mechanics, mine ventilation, and other topics appropriate to the program objectives.

EUROPEAN QUALIFICATION FRAMEWORK (EQF)

The European Qualifications Framework (EQF) acts as a translation device to make national qualifications more readable across Europe, promoting workers' and learners' mobility between countries and facilitating their lifelong learning. The EQF aims to relate different countries' national qualifications systems to a common European reference framework. Individuals and employers will be able to use the EQF to better understand and compare the qualifications levels of different countries and different education and training systems. Since 2012, all new qualifications issued in Europe carry a reference to an appropriate EQF level.

EUROPEAN SKILLS/COMPETENCES, QUALIFICATIONS AND OCCUPATIONS (ESCO)

ESCO is the multilingual classification of European Skills, Competences, Qualifications and Occupations. ESCO is part of the Europe 2020 strategy. The ESCO classification identifies and categorises skills, competences, qualifications and occupations relevant for the EU labour

market and education and training. It systematically shows the relationships between the different concepts[15].

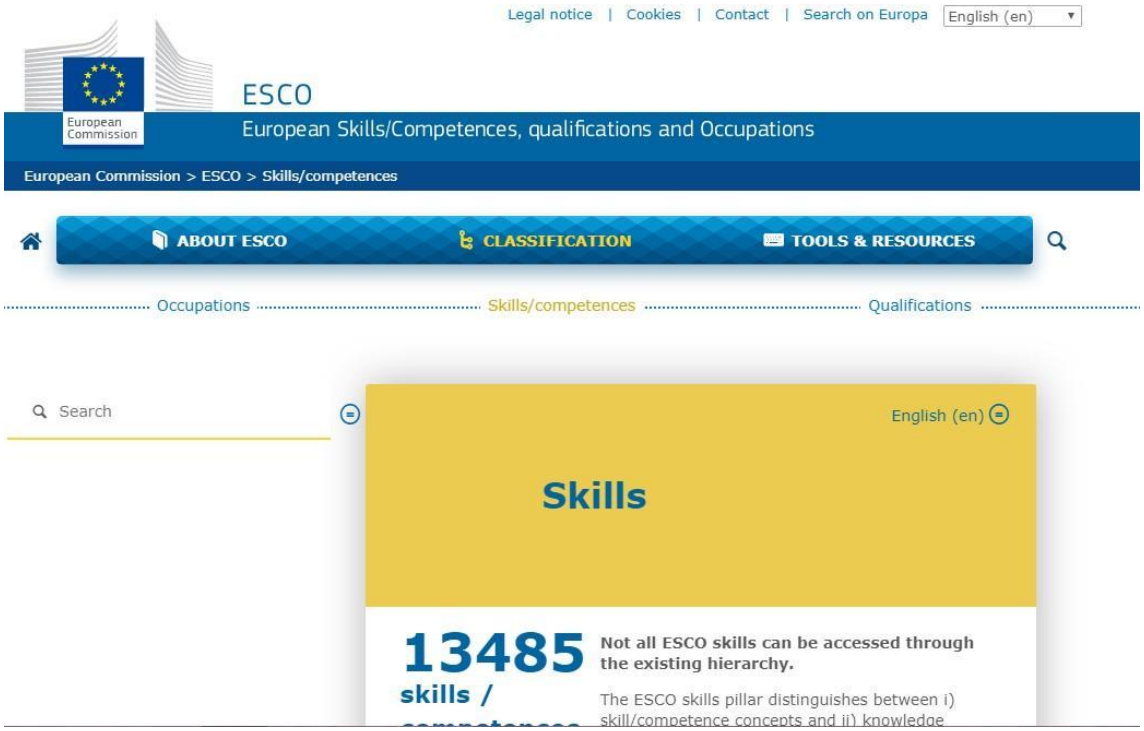

Figure 8: ESCO web page

The search in ESCO is quite easy but the information provided is in a very deep level of qualifications and skills. For instance, searching "mining engineer" (see[16]) it is very confusing

<u>ESCO Occupations search: geologist</u>

Description:

"Geologists research the materials that form the earth. Their observations depend on the purpose of the research. Depending on their specialisation, geologists study how the Earth has been shaped over time, its geological layers, and the quality of minerals for mining purposes, earthquakes and volcanic activity for private services, and similar phenomena."

Essential skills and competence:

- apply safety procedures in laboratory

[15] https://ec.europa.eu/esco/portal/home
[16] https://ec.europa.eu/ploteus/en/search/site/mining%20engineer?autocomplete_keywords=mining%20engineer

- apply scientific methods
- apply statistical analysis techniques
- calibrate laboratory equipment
- carry out geological explorations
- collect geological data
- conduct soil sample tests
- execute analytical mathematical calculations
- operate scientific measuring equipment
- perform laboratory tests
- perform scientific research
- record test data
- write scientific papers

Other searches: mining engineer

In the job search web PROSPECTS, we have found the "job profile of the mining engineer"[17] which includes the definition of the profession itself, responsibilities, salary, qualifications and the following skills:

You'll need to show that you're skilled in:

- working as part of a team, with the ability to manage and motivate people
- project management
- analytical problem-solving
- communication and presentation
- time management and planning, as well as the ability to prioritise your workload
- managing your finances and budgeting
- a good knowledge of IT and specialist software
- a willingness to travel and spend time away from home

[17] https://www.prospects.ac.uk/job-profiles/mining-engineer

- an outgoing and self-reliant nature
- Knowledge of health and safety issues related to mining.

Economic sector	Economic subsector	Occupation related to geoscience	Occupation related to geoscience not in the ESCO inventory
Construction	1. Construction site preparation 2. Engineering and design activities in construction	1. Surveyor 2. a) Geological engineer b) Surveyor	1. a) Geotechnician b) Geophysicist c) Structural geologist 2. a) Geotechnician b) Geophysicist
Energy, water and environment	1. Waste management - Remediation activities	1. Environmental technician	1. a) Environmental geologist b) Field geologist c) Sedimentologist
Engineering, scientific and technical activities	1. Engineering activities 2. Scientific, professional, and technical consultancy 3. Land surveying consulting 4. Scientific research - Physical science research 5. Testing activities	1. None 2. a) Laboratory assistant b) Gemologist 3. a) Geology technician b) Surveyor c) Cartographer d) Hydrographic surveyor 4. a) Paleontologist b) Geologist c) Hydrologist d) Oceanographer 5. a) Nondestructive testing specialist b) Exploration geologist c) Environmental technician d) Mine geologist	1. Engineering Geologist 2. a) Geochemist b) Geophysicist c) Geoscientific consultant 3. Hydrogeologist 4. a) Petrological specialist b) Geoscientific consultant c) Geomodels specialist d) Geophysicist e) Geochronologist f) Geo GIS specialist g) Dimensional stone special h) Geomathematician i) Geochemist J) Field geologists k) Geological mapping speci l) marine geologist 5. a) Petrological specialist b) Petrophysicist c) Geochronologists d) Water analysis specialist
Mining and heavy industry	1. Oil and gas extraction - Oil and gas project and planning 2. Mining and quarrying - Mine engineering 3. Mining and quarrying - Mine support activities 4. Mining and quarrying - Mine management 5. Mining and quarrying - Geology in mining	1. Petroleum engineer 2. a) Mine environmental engineer b) Mining geotechnical engineer c) Mineral processing engineer d) Mine development engineer 3. a) Geochemist b) Mineral processing operator c) Geotechnician d) Geological technician 4. a) Mine manager b) Mine production manager 5. a) Exploration geologist b) Environmental geologist c) Hydrogeologist d) Mine geologist	1. a) Rig/Site geologist b) Chief geologist c) Well site logger d) Directional driller e) Shale gas expert f) Fracking specialist g) Logging specialist 2. a) Environmental geologist b) Engineering geologist c) Chief geologist d) Geo model specialist e) Reserves/Resources estimation specialist f) GIS specialist g) Drilling specialist h) Logging specialist 3. a) Environmental geologist b) Engineering geologist c) Chief geologist d) Geo model specialist e) Reserves/Resources estimation specialist f) GIS specialist 4. a) Chief geologist b) Dimensional stone special 5. a) Chief geologist b) Geo model specialist c) Reserves/Resources estimation specialist d) GIS specialist e) Drilling specialist f) Logging specialist g) Geochemist h) Geophysicist i) Field geologist

Figure 9: ESCO occupations related to Geoscience (source EGS internal report)

6. APPENDIX: INTERMIN TABLE OF KNOWLEDGE SKILLS AND SUBJECTS. SKILLS LIST PROPOSAL

MINING JOB AREA	MINING JOB SUB - AREA	SKILLS /KNOWLEDGE OUTCOMES
1.- Business Management	**1.1. Mining in a global environment**	1.1.1. Analyses the market to predict future demand/supply trends. 1.1.2. Understands mine economics and the minerals market and their influence on mining systems 1.1.3. Understands economics and mining geology 1.1.4. Understands the impacts of commodity price fluctuations 1.1.5. Understands the trade-off between risk and value in mining decisions 1.1.6. Facilitates the implementation of environmental, engineering, mining and social best practices
	1.2. Legal and regulatory requirements	1.2.1. Understands and applies the 'license to operate' philosophy[i] 1.2.2. Understands and adheres to mining and related legislation and regulations 1.2.3. Understands and adheres to other relevant legislation and regulations[ii]
	1.3. Organisational structures	1.3.1. Understands the organisational, hierarchy and information flows for typical mining businesses and operations
	1.4. **Financial operations**	1.4.1. Understands the basics of investment banking and its relationship to the resources sector 1.4.2. Understands business development principles applicable to the mining industry 1.4.3. Interrogates and interprets financial statements 1.4.4. Creates comprehensive financial models 1.4.5. Uses financial models and Analyses financial data 1.4.6. Forecasts cash flows
	1.5. **Production costs**	1.5.1. Identifies the significant cost areas related to the operation 1.5.2. Delivers cost/benefit analyses 1.5.3. Generates CAPEX and OPEX from first principles 1.5.4. Performs trade-off studies by analysing production equipment economics 1.5.5. Identifies the impact their role has on the value chain of the business
	1.6. Production analysis and mine optimisation	1.6.1. Completes first-principles cost modelling 1.6.2. Understands and applies business analysis techniques (e.g. 6 sigma, Lean Processes) 1.6.3. Conducts simple financial analyses for optimisation projects 1.6.4. Participates in 'Big Data' analysis of mining data to identify the variables and uncertainties which matter to objectives 1.6.5. Supports the development of financial and production models (business analysis)[iii] 1.6.6. Undertakes accurate and reliable cost benefit analyses 1.6.7. Produces economic analyses by costing design inputs and calculating revenue sources 1.6.8. Conducts economic analyses of designs and proposals 1.6.9. Understands the basic KPI's used in mining (e.g. $ /oz etc.) 1.6.10. Monitors production performance against KPIs

	1.7. Risk management	1.7.1. Identifies and evaluates hazards and risks 1.7.2. Develops risk management strategies and plans 1.7.3. Implements risk management strategies and plans 1.7.4. Monitors and reviews the effectiveness of risk management strategies and plans
	1.8. Managing mining operations – Monitoring and compliance	1.8.1. Reviews planned operations 1.8.2. Manages operational risks 1.8.3. Oversees the implementation of plans 1.8.4. Reviews progress against plans 1.8.5. Reports outcomes to senior management and defines objectives 1.8.6. Synthesises and analyses data 1.8.7. Reconciles data against plans 1.8.8. Reports outcomes and recommendations to relevant stakeholders
	1.9. Management	1.9.1. Manages the business, managerial capacities 1.9.2. Improves the business 1.9.3. Manages change and risk, adapts to new situations 1.9.4. Manages projects, organisations and teams. Leadership 1.9.5. Prepare and manages budgets 1.9.6. Procures and manages assets 1.9.7. Allocates resources 1.9.8. Manages contracts, contractors and consultants
2- Geology Exploration Resources and reserves	**2.1. General Geology/Geography**	2.1.1. Geographic resource interpretation skills[iv] 2.1.2. Geographic resource construction skills[v] 2.1.3. Understands the basic principles of geology, deposit formation, geological controls and structures 2.1.4. Understand and apply fundamentals of stratigraphy, sedimentology, geomorphology and structural geology, relationship to subsurface geology 2.1.5. Identify basic rock-forming minerals and rocks in the field, in hand sample and in thin section, including economic minerals[vi] 2.1.6. Use standard GIS software (ArcGIS or similar) to display and interpret geographic and geologic data 2.1.7. Recognize different tectonic environments 2.1.8. Recognize different types of natural hazards and zonation 2.1.9. Get a sense of geologic (deep) time: speed and duration of processes, incompleteness of records, how are things dated, how old are eons/eras 2.1.10. Analytical chemistry with regards to various geological sampling techniques and how to apply these concepts to real world problem aired by others. 2.1.11. Know how to use public databases that contain information about earthquakes, stream flow, groundwater levels, volcanic activity, geodetic control, journal articles, mineralogy, land ownership, well records, mineral production data, etc.
	2.2. Applied Geology	2.2.1. Collect, store and analyse data using adequate field and laboratory techniques. Demonstrate basic field and laboratory safety techniques 2.2.2. Evaluate the problems of sampling, samples selection, precision and uncertainty during collection, registry and analysis of field and laboratory data. 2.2.3. Process, prepare and interpretation and presentation of data using quantitative and qualitative techniques, as well as the adequate software. 2.2.4. Reviews and interprets geological maps

		2.2.5. Elaboration and interpretation, topographic, geological and thematic and engineering maps
	2.3. Exploration and sampling	2.3.1. Understands and uses standard exploration and sampling processes 2.3.2. Interprets exploration data to provide geological information 2.3.3. Design, plans and manages sampling programmes (e.g. grade control, processing) 2.3.4. Designs, executes and interpretation of mineral resources, hydrocarbons or water exploration drilling campaigns
	2.4. Ore body modelling and resource and reserves estimation	2.4.1. Interprets geological sections and geological modelling of mining, energy and water resources 2.4.2. Conducts statistical analyses of geological data for models 2.4.3. Creates block models and estimates resources 2.4.4. Interrogates resource models to generate inputs for mine planning 2.4.5. Estimates yield/cut-off grade for resources 2.4.6. Demonstrates a knowledge of the JORC Code and other standards for resource classification requirements for reporting resources 2.4.7. Estimates reserves from a mining model (and interpretation) 2.4.8. Describes characteristics that impact product quality 2.4.9. Applies Net Smelter Returns or yield/cut-off grades in mine planning 2.4.10. Demonstrates an understanding of grade reconciliation, ore dilution and ore loss
	2.5. Mine feasibility studies	2.5.1. Prepares the required inputs for an economic evaluation of a mine (e.g. personnel, equipment etc.) 2.5.2. Provides input into feasibility studies 2.5.3. Develops production schedules 2.5.4. Prepares cost estimates for feasibility studies 2.5.5. Generates feasibility studies to the required level of accuracy 2.5.6. Conducts sensitivity analyses recognising the geological, technical, financial, social and political uncertainties in mining operations **2.5.7.** Prepares JORC and other standards Code compliant feasibility study reports
3. Mining geomechanics and technical mine design	**3.1. Modelling, analysis and design**	3.1.1. Reviews engineering geology and geotechnical data (including Identifies hazards and modes of failure 3.1.2. Designs testing programmes for geotechnical studies. Undertake geotechnical testing 3.1.3. Conducts rock mass and soil classifications 3.1.4. Understands rock and soil characteristics and identifies failure indications, fundamentals of rock mechanics 3.1.5. Conducts mine geotechnical mapping 3.1.6. Applies geomechanics principles to identify drillability, caveability and excavatability 3.1.7. Provides input on geotechnical issues that influence pit and dump design and abandonment planning 3.1.8. Incorporates geology and geomechanic information when selecting mining methods 3.1.9. Provides input on geotechnical issues that influence drill and blast designs 3.1.10. Understands support functions relative to ground behaviour mechanisms 3.1.11. Designs ground support and stope stability plans (e.g. underground, coal, hard rock) 3.1.12. Develops and interprets geological and geotechnical hazard plans 3.1.13. Evaluate surface and near-surface hydrology for hazard, design, and waste mitigation

	3.2. Implementing designs and plans	3.2.1. Procures and installs (or supervises the installation of) ground support 3.2.2. Works with safety personnel to provide geotechnical input into job safety assessments and incident reporting 3.2.3. Assesses risk and implements controls and associated monitoring
	3.3. Integrated mine design	3.3.1. Models systems and system interactions 3.3.2. Recommends methods, equipment and processes 3.3.3. Develops initial design 3.3.4. Completes detailed designs 3.3.5. Uses simulation and other techniques to optimise designs - scheduling[vii] 3.3.6. Reviews designs against requirements 3.3.7. Prepares and presents design documentation to relevant stakeholders 3.3.8. Monitors implementation of mine design
	3.4. **Mine rehabilitation and closure**	3.4.1. Establishes project and evaluate plans 3.4.2. Develops mine rehabilitation and closure plans 3.4.3. Manages rehabilitation 3.4.4. Manages monitoring and reporting processes
	3.5. Monitoring ground stability	3.5.1. Reviews planned operations 3.5.2. Manages operational risks 3.5.3. Oversees the implementation of plans 3.5.4. Knowledge of how to reviews progress against plans and take measures accordingly
	3.6. Drilling, blasting and rock cutting. Explosives	3.6.1. Design, operation and maintenance of explosive production plants 3.6.2. Designs blast patterns (e.g. spacing, burden, charge, fragmentation) 3.6.3. Controls fragmentation size by blasting 3.6.4. Estimates material requirements for mine development and stopes (e.g. consumables) 3.6.5. Understands and applies knowledge and experience of production drilling operations and equipment 3.6.6. Determines the most suitable drill and blast techniques to achieve desired outcomes 3.6.7. Designs drill patterns and charging/firing plans for open pit blasts 3.6.8. Designs drill patterns and charging/firing plans for underground blasts 3.6.9. Creates drill designs for mine stopes 3.6.10. Prepares drill and blast layouts for stopes 3.6.11. Designs production drill holes for the extraction of the stope 3.6.12. Understands and uses drill and blast software 3.6.13. Optimises drill and blast performance, including fragmentation. 3.6.14. Identifies hazards, assesses risk and implements suitable controls
4. Mining methods	**4.1. General mining methods**	4.1.1. General knowledge of mining methods and operations 4.1.2. Comprehends 3D mine plans 4.1.3. Understands the fundamentals of key mining processes (e.g. drill/blast, load/haul) 4.1.4. Demonstrates a technical understanding of operations (e.g. dragline walk-time, downtime for maintenance, interactions between equipment) 4.1.5. Understands the importance of cycle time and its impact on mine productivity 4.1.6. Understands how the planning, geology and mine operations teams work together

	4.2. Surface mining methods	4.2.1. Understands the design methods and standards used in pit, ramp and dump design 4.2.2. Estimates stripping ratio 4.2.3. Calculates basic pit/dump designs and overall pit wall angles for given design parameters 4.2.4. Designs truck and shovel excavations 4.2.5. Develops airborne dust management plans 4.2.6. Develops a method for selecting mine layouts (e.g. statistical method) 4.2.7. Optimises open pit design (e.g. Whittle) 4.2.8. Completes haulage simulations and prepares excavation/dump balances
	4.3. Underground mining methods	4.3.1. Selects a mine stope and method system for a generic ore body 4.3.2. Completes margin ranking exercises for mining blocks in defined plans 4.3.3. Designs underground rise patterns 4.3.4. Know wood timbering techniques (small scale mining and temporary openings) 4.3.5. Designs stope, roof and galleries support 4.3.6. Conducts underground testing of support elements
	4.4. Fill systems	4.4.1. Knowledge of how to designs mine backfilling systems, including delivery and quality requirements
	4.5. Reclamation	4.5.1. Demonstrates a detailed knowledge of the reclamation process 4.5.2. Designs tailings disposal facilities **4.5.3.** Management of residues and effluents: collect, store and reuse
5. Mining equipment and systems	**5.1. General Mining equipment and systems**	5.1.1. Uses key factors to select suitable mining machines (e.g. operational characteristics, costs, productivity, and performance) 5.1.2. Generates mine designs and schedules that are suitable for autonomous mining fleets 5.1.3. Uses maintenance tactics to plan maintenance schedules 5.1.4. Evaluates the performance of mining equipment and machines, including to inform scheduling 5.1.5. Monitors equipment delays (e.g. UoA%, A %, Utility %)
	5.2. Electrical systems	5.2.1. Design electrification projects in mines
	5.3. Loading systems	5.3.1. Understands the characteristics of loading equipment and operations 5.3.2. Designs dragline excavations and spoil piles

	5.4. Haulage systems	5.4.1. Designs roads and haul roads with correct cambers, drainage, traffic consideration etc. 5.4.2. Prepares haulage plans 5.4.3. Prepares trucking plans 5.4.4. Designs, exports and analyses haulage models 5.4.5. Optimises haul and dump operations and estimates equipment fleet productivity 5.4.6. Understands the operational requirements of the conveyor road and cable crew 5.4.7. Designs and develops schedule plans for continuous haulage systems (e.g. conveyor systems) 5.4.8. Designs efficient mine winder systems. Winch and shafts
	5.5. Mining software	5.5.1. Demonstrates proficiency in using at least one mining software package (e.g. VULCAN, DESWIK, XPAC) 5.5.2. Competently uses mine scheduling software 5.5.3. Knows the limitations of software packages when designing a stope or underground opening 5.5.4. Demonstrates deep understanding when managing data[viii] 5.5.5. GIS knowledge 5.5.6. Generates useful statistical data about open pit and underground designs 5.5.7. Demonstrates proficiency in using 2D CAD software 5.5.8. Demonstrates proficiency in using 3D CAD software
6. Mining services	**6.1. General services and planning**	6.1.1. Measurements, site planning, management and follow-up of engineering projects. 6.1.2. Earth movement control 6.1.3. Design of hydraulic and pneumatic systems applied to mining
	6.2. Dewatering	6.2.1. Designs dewatering systems for open pit and underground mines: inflow risks and aquifer interferences 6.2.2. Calculates water pumping capacity and pumping strategies 6.2.3. Monitors dewatering volumes for mine site water account
	6.3. Mine drainage and storage systems	6.3.1. Develops a surface water management plan, including diversions 6.3.2. Designs storm water management systems for open pit mines 6.3.3. Designs dam spillways and discharge strategies 6.3.4. Prepares erosion and sediment control systems during construction activities (e.g. haul roads)
	6.4. Water treatment	6.4.1. Calculates the water balance for a site, including tailings dams 6.4.2. Undertakes surveys and monitoring of water quality 6.4.3. Prepares cost-benefit analyses of passive and active water treatment options 6.4.4. Designs water treatment systems to achieve discharge requirements
	6.5. Ventilation	6.5.1. Understands and applies the key principles to mitigate air pollution and toxic gas concentrations in underground mining[ix] 6.5.2. Uses ventilation software to model ventilation systems 6.5.3. Designs efficient ventilation systems for underground mine designs 6.5.4. Carries out ventilation surveys

	6.6. Power supply systems	6.6.1. Assists with the design of power reticulation systems 6.6.2. Understands the hazards associated with power systems in abnormal and emergency situations
	6.7. Communications systems	6.7.1. Understands the application of communications in both normal and emergency situations 6.7.2. Designs communication systems for Autonomous Mining systems
	6.8. Monitoring systems	6.8.1. Identifies relevant monitoring requirements 6.8.2. Installs monitoring systems 6.8.3. Collects and analyses field data
	6.9. Surveying	6.9.1. Liaises with surveyors 6.9.2. Contributes to mine surveys 6.9.3. Undertakes basic mine surveys 6.9.4. Interprets survey data, plans, maps and photos, 6.9.5. Manages surveying operations
7. Mineral production and processing	**7.1. Feed systems and planning**	7.1.1. Understands mineral processing route and feed grade/quality controls 7.1.2. Understands ore and coal handling, preparation and loading processes
	7.2. Grade control	7.2.1. Applies the quality blending and sampling logic of a site (e.g. energy/size reduction) 7.2.2. Understands the implications of marginal stockpiles
	7.3. Comminution and sizing	7.3.1. Recognises the characteristics of different communition and sizing equipment and their limitations 7.3.2. Understands mine and mill interfaces
	7.4. Concentrator processes	Understands and applies knowledge of process steps, applications and limitations
	7.5. Further treatment and marketing	7.5.1. Understands and interprets details of sales contracts (e.g. custom smelter requirements) 7.5.2. Application of thermal, mechanical, chemical processes to optimize material properties 7.5.3. Materials quality control 7.5.4. Design, operation and maintenance of processing and treatment plants for minerals, industrial rocks, dimensional stone and waste material 7.5.5. Quality control tests 7.5.6. Design, operation and maintenance of metallurgical plants
	7.6. Mine planning	7.6.1. Analyses planning objectives 7.6.2. Reviews current status of operations 7.6.3. Identifies opportunities and constraints 7.6.4. Generate and evaluate plans 7.6.5. Prepares and presents documentation to implement plan
8. Generic, health and social tasks	**8.1. Environment**	8.1.1. Knowledge and management of environmental impact assessment studies 8.1.2. Implement quality management systems 8.1.3. Manage geological hazards in mining operations
	8.2. Workplace health and safety	8.2.1. Applies legislative and regulatory requirements 8.2.2. Develops and disseminates safe practice guidelines 8.2.3. Implements safe working practices and audits 8.2.4. Investigates accidents and incidents

	8.3. Communication	8.3.1. Communication in native language 8.3.2. Community relations 8.3.3. Knowledge of a foreign relevant-word wide spread language (English, Spanish, French, German, Chinese, etc.) 8.3.4. Transmit adequately the information in a written, verbal or graphic form for different types of audiences. 8.3.5. Using internet in a critical manner as communication tool and source of information 8.3.6. Communicate their science (geology, engineering, project) clearly and concisely both verbally. 8.3.7. Know and describes Social Geology and Geopolitics 8.3.8. Chairs meetings. Prepares documents and reports 8.3.9. Listens and communicates effectively 8.3.10. Consults and Negotiates 8.3.11. Promotes company, industry and profession 8.3.12. Ability to communicate Earth Science issues with the wider society 8.3.13. Recognize proprietary vs publicly releasable information and how to meet both corporate and public disclosure requirements
	8.4. Creative thinking, problem solving and research	8.4.1. Identifies, scopes and solves problems 8.4.2. Sources, analyses and synthesises data and information 8.4.3. Conducts research using appropriate methods 8.4.4. Uses conceptual, critical, strategic and systems thinking skills 8.4.5. Researches new products, technologies and processes
	8.5. Sustainability	8.5.1. Engages with stakeholders 8.5.2. Practices in an environmentally and legally responsible manner 8.5.3. Recognises corporate social responsibility 8.5.4. Recognises and protects cultural heritage 8.5.5. Know and apply principles of sustainable development
	8.6. Self-management	8.6.1. Undertakes autonomous professional development activities 8.6.2. Accepts responsibility 8.6.3. Manages time and activities 8.6.4. Practices ethically and professionally as member of a recognised professional organisation 8.6.5. Develops and maintains networks 8.6.6. Initiative and entrepreneurship spirit
	8.7. Working with people	8.7.1. Works effectively in interdisciplinary and international teams 8.7.2. Knowledge of training processes and programs 8.7.3. Recognises diversity and multiculturalism (Knowledge of other cultures and customs 8.7.4. Identify objectives and individual and collective responsibilities and act correctly in such roles 8.7.5. Recognise others points of view and opinions of other team members 8.7.6. Ethics. Transmit credibility and integrity 8.7.7. Coaching and leading teams
9. Social Performanc	**9.1 Acquiring and using social data and baseline information**	9.1.1 Ability to understand community's processes and local knowledge through data collection, research analysis, and interpretation skills 9.1.2 Using stakeholders Mapping methodologies 9.1.3 Capacity to understand and apply anthropological, ethnographic and archaeological Knowledge 9.1.4 Manage and apply concepts as a human right and gender equality

	9.2 Monitoring and evaluating social projects	9.2.1 Monitoring Social projects ensuring its achieving community and business's objectives 9.2.2 Manages social research's tools to measure outcomes during and at the end of the social project
	9.3 Engagement with Indigenous peoples	9.3.1 Assessing environmental impacts considering legal entitlements of land and water 9.3.2 Identify potential conflicts related to the use of land and water by the project 9.3.3 Understanding and applying principles of Free Prior Informed Consent (FPIC)
	9.4 Grievance management, Prevention & management of conflict	9.4.1 Implement and manage a grievance mechanism 9.4.2 Capacity to anticipate to possible conflicts 9.4.3 Manage methodologies to detect previous or arising conflicts 9.4.4 Apply conflicts resolutions techniques
	9.5 Cultural heritage management	9.5.1 Comprehend and apply Cultural Heritage Management (CHM) 9.5.2 Identify and mitigate impacts in CHM 9.5.3 Recognise stakeholders to work within CHM
	9.6 Community engagement	9.6.1 Understand and practice dialogue skills in engaging with communities 9.6.2 Implement appropriate engagement strategies
	9.7 Agreements & implementation	9.7.1 Multi-disciplinary stakeholder management to include different groups in the identification of previous agreements. 9.7.2 Ability to coordinate the work between different stakeholders to identify, understand and achieve futures agreements. 9.7.3 Ability to monitor and ensure compliance of the agreements
	9.8 Resettlement & influx management	9.8.1 Leadership skills to develop and coordinate relocation processes 9.8.2 Ability to assess and monitoring ongoing resettlement process 9.8.3 Analyses Risk and solutions before and during the process 9.8.4 Enlightening. Influencing and convincing policy makers and stakeholders
	9.9 Regional development	9.9.1 Knowledge of economic development framework to apply in a local context 9.9.2 Ability to undertake a impacts assessment to understand the effect of the project in the area and its infrastructure
	9.10 Local employment and workforce development	9.10.1 Works effectively with local employment organisation in order to register workforce's skills, availabilities and dynamics in the area. 9.10.2 Coordinate training and hiring processes 9.10.3 Understand supply chain dynamics
	9.11 Community enterprise development	9.11.1 Apply entrepreneurship skill to support current or future local business 9.11.2 Analyse how insert the project in the local business contexts 9.11.3 Work together to develop new initiative creating Shared Value
9. Recycling and secondary mineral raw materials. Circular Economy		9.1.1. Knowledge of quality assessment and certification. EU and international standards and labels 9.1.2. Capacity to design recycling plants 9.1.3. Knowledge on the supervision and or operating recycling plants 9.1.4. Ability to perform investigation and development in the field of new materials and new processes 9.1.5. Knowledge on reporting sustainability and process. Ecological systems 9.1.6. General knowledge on the renewable sources of energy 9.1.7. Knowledge on the regulatory barriers for secondary raw materials 9.1.8. General knowledge of the principles of circular economy, climate change and the recycling market

		9.1.9. Practical knowledge on waste management

[i] i.e. the interaction/influence of approvals, tenures, and leases, as well as community and environment issues, on mining
[ii] (e.g. national, state, and local government)
[iii] and understands how they impact on the value chain of the business
[iv] include: using maps, compass, photographs, diagrams, cartoons, images, statistics, keys, graphs, text, models, internet, speeches, surveys, films, TV, video clips and GIS to explain geological information
[v] include: presenting spatial data - may include, but is not limited to, drawing sketch and precise maps, using GIS layering and/or other multi-media to present specific geographic information, presenting statistical data - may include, but is not limited to, constructing graphs, tables, performing calculations based on data, presenting visual data - may include, but is not limited to, taking photographs or drawing pictures, cartoons, multi-media, complex presentation - may include multiple forms of data for example Visual, spatial and statistical combined. Knowledge of geographical
[vi] and have a grasp of what this means for ancient conditions (P, T, tectonic or igneous environment, precursor rock type)
[vii] scheduling comes together with optimization - that is, mining sequence is optimized under several parameters and constraints and linked through time periods: Aligns designs to geological model, defines production parameters, Knowledge of the sequences of production and activities
[viii] (e.g. large data sets, filing systems, naming conventions, limitations, statistics)
[ix] (e.g. dust, gas inrush/outburst, spontaneous combustion and fire explosion management)