Mining-Environmental Planning and Circular Economy in the framework of Sustainable Mining

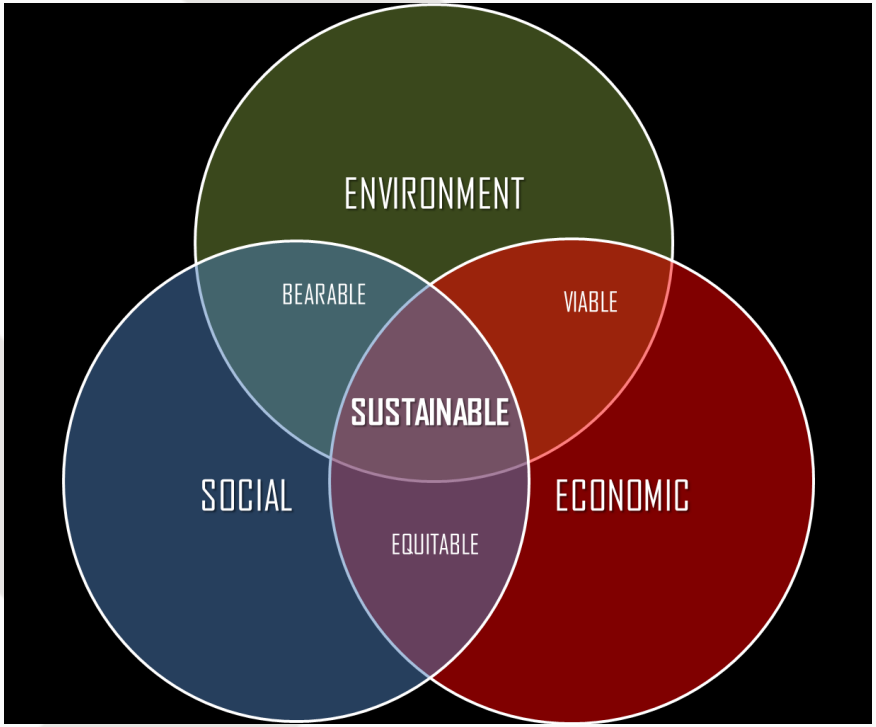
IGME - Geological Survey of Spain
Geochemistry and Sustainable Mining Unit

Virginia Rodríguez Gómez	v.rodriguez@igme.es
Lucas Vadillo Fernández	l.vadillo@igme.es
Julio César Arranz	jc.arranz@igme.es
Francisco Javier Fernández	fj.fernandez@igme.es

Peer Review Visit – REMIX Mining Conference
Valladolid, 20-22 March 2018

Instituto Geológico y Minero de España

Sustainable development is the organizing principle for meeting human development goals while at the same time sustaining the ability of natural systems to provide the natural resources and ecosystem services upon which the economy and society depend.



2030 Agenda for Sustainable Development
United Nations General Assembly

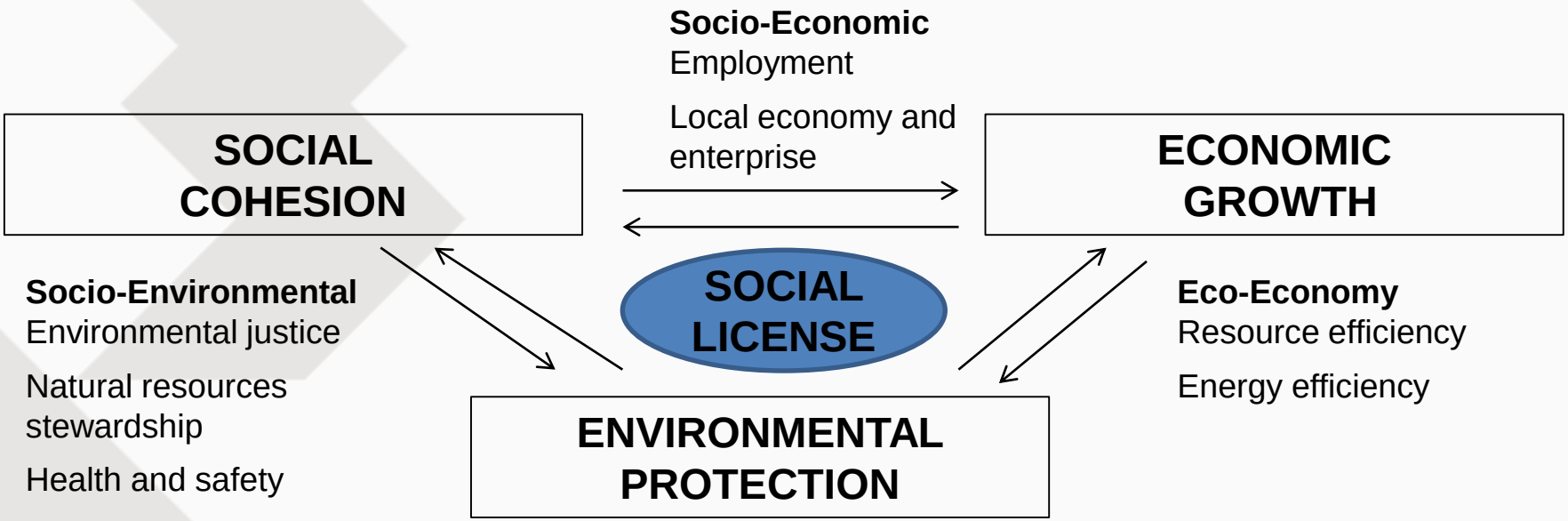
Sustainability and mining are two terms that do not fit together easily. Traditional mining has left an unquestionable footprint in the environment.

- Landscape degradation (pits, heaps, dams)
- Disappearance of the productive use of the land affected
- Water and air pollution
- Increased soil erosion in non rehabilitated areas

→ **SOCIALLY NEGATIVE IMAGE OF MINING**

However, **mining is necessary for development.** Metals, energy resources, industrial minerals, aggregates have been and will remain essential for the technological progress and the global economic growth.

Modern mining must be based on the application of Best Available Techniques and must comply with the three dimensions of the sustainable development:



Two aspects to achieve a compromise between mining and sustainability: Mining-Environmental Planning and Circular Economy

MINING AND ENVIRONMENTAL PLANNING

OBJECTIVE: To make compatible the optimization of the use of mining resources and the environmental (including social) protection. This approach would also allow to ensure access to areas with actual or potentially valuable resources for mineral exploration and exploitation activities (required in order to secure European access to necessary raw materials, including critical raw materials (CRM)).

The aim of this methodology is to integrate mining activities in the land-use planning, finding the more appropriate location for the extractive works, based on the existence of the mining resources and the land capability for mining activities.

The detailed objectives of the mining and environmental planning approach are:

- Division of the mining-resource territory into areas based on the suitability for exploitation purposes
- Development of Mining and Environmental Planning Maps (territorial zoning)
- Establishment of exploitation models
- Determination of criteria and restoration models

MINING AND ENVIRONMENTAL PLANNING MAP → Key figure of the methodology

SIMPLIFIED METHODOLOGY SCHEME

GEOLOGICAL AND MINING RESEARCH
Resources location

ENVIRONMENTAL AND SOCIOECONOMIC ANALYSIS
↓
Environmental inventory

ANALYSIS OF THE MINING ACTIVITY

→

DEFINITION OF ZONING CRITERIA

→

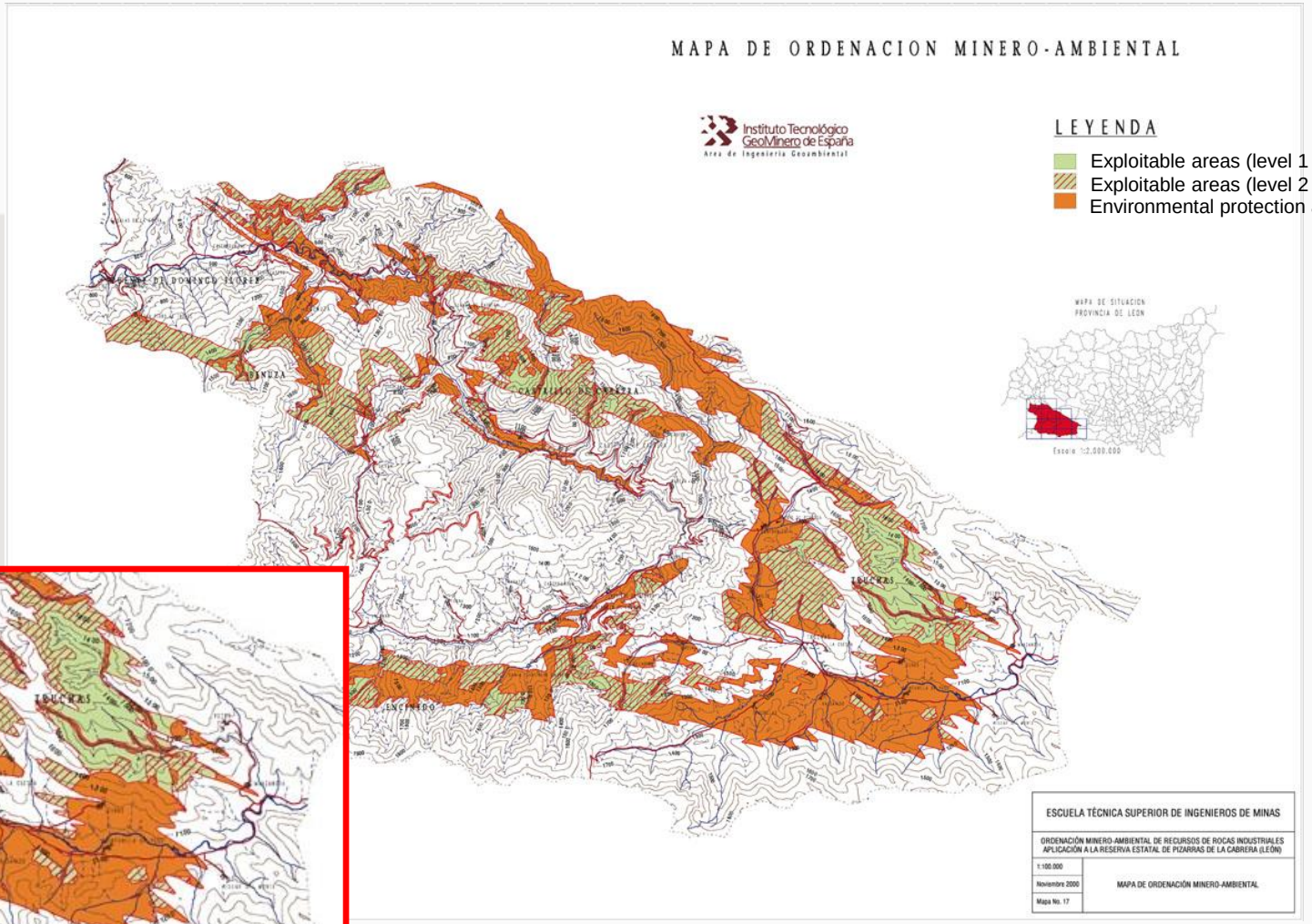
DEFINITION OF PLANNING CATEGORIES

MINING AND ENVIRONMENTAL PLANNING MAP

Territorial zoning proposal:

- Environmental protection zones
- Exploitable zones with different priority levels

MINING AND ENVIRONMENTAL PLANNING MAP



IGME has developed several projects related to the mining and environmental planning in Spain

MinLand

Mineral Resources in Sustainable Land-Use Planning

The main goal for the **MinLand** project is to ensure access to areas with actual or potentially valuable resources for mineral exploration and exploitation activities within the EU.

MINLAND will work towards establishing guidelines for a linked mineral and land-use policies for the equal assessment of mineral raw materials with other land uses. The aim is to secure access and unlocking known and unknown mineral deposits for exploration and exploitation for the present and the future.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No 776679

MinLand

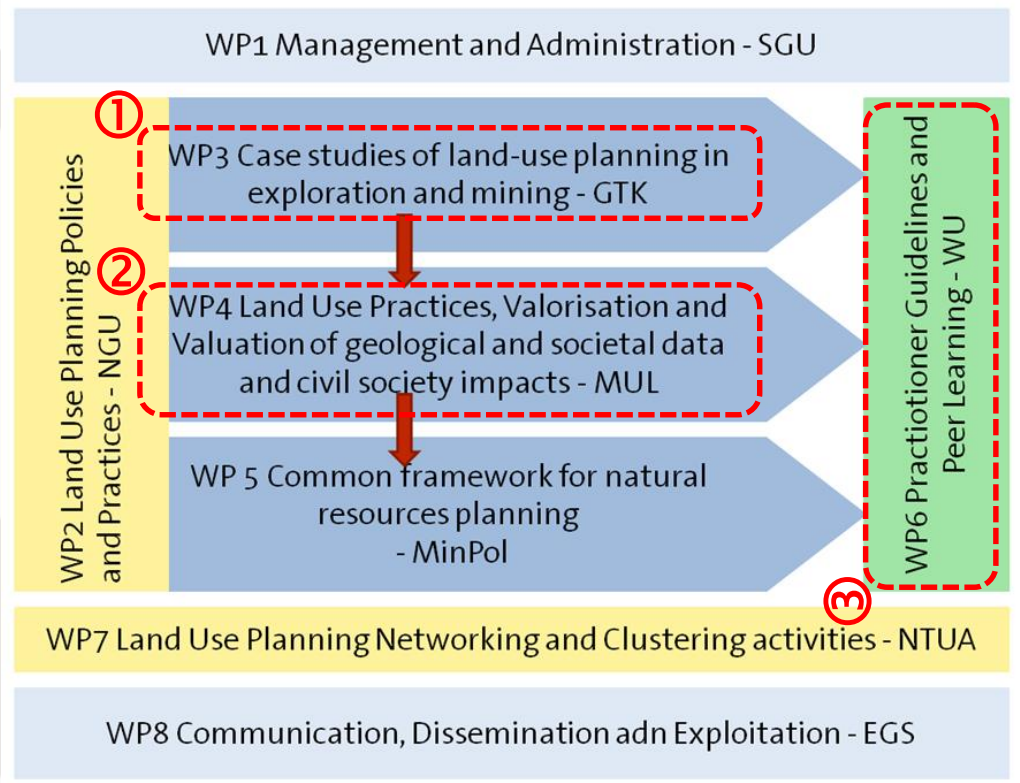
Mineral Resources in Sustainable Land-Use Planning

Participant	Participant organisation name	Country
1 (Coordinator)	Sveriges Geologiska Undersokelse (SGU)	Sweden
2	Norges Geologiske Undersokelse (NGU)	Norway
3	MONTANUNIVERSITAT LEOBEN (MUL)	Austria
4	National Technical University of Athens (NTUA)	Greece
5	WIRTSCHAFTSUNIVERSITAT WIEN (WU)	Austria
6	GEOLOGIAN TUTKIMUSKESKUS (GTK)	Finland
7	MINPOL GMBH (MINPOL)	Austria
8	Department of Communications, Climate Action and Environment (GSI)	Ireland
9	FEDERATION EUROPEENNE DES GEOLOGUES (EFG)	France
10	NEDERLANDSE ORGANISATIE VOOR TOEGEPAST NATUURWETENSCHAPPELIJK ONDERZOEK TNO (TNO)	Netherlands
11	POLSKA ACADEMIA NAUK INSTYTUT GOSPODARKI SUROWCAMI MINERALNYMI I ENERGIA (MEERI)	Poland
12	STICHTING WAGENINGEN RESEARCH (WRE)	Netherlands
13	DIRECAO-GERAL DE ENERGIA E GEOLOGIA (DGEG)	Portugal
14	INSTITUTO GEOLÓGICO Y MINERO DE ESPAÑA (IGME SP)	Spain
15	Länsstyrelsen Västerbotten (LV)	Sweden
16	BOLIDEN MINERAL AB (BOL)	Sweden
17	INDUSTRIAL MINERALS ASSOCIATION EUROPE (IMA)	Belgium
18	Laboratorio Nacional de Energia e Geologia I.P. (LNEG)	Portugal
19	EuroGeoSurveys (EGS)	Belgium
20	REGIONE EMILIA ROMAGNA (RER)	Italy
21	INSTITOUTO GEOLOGIKON KAI METALLEFTIKON EREVNON (IGME GR)	Greece
22	MacCabe Durney Barnes Ltd (MDB)	Ireland

22 institutions

14 countries

IGME is participating in different task of three work packages of MINLAND:



① WP3. CASE STUDIES OF LAND-USE PLANNING IN EXPLORATION AND MINING (M1-M9)

- Task 3.1: Framework for case studies
- Task 3.2: Execution of case studies
- Task 3.3: Evaluation of case studies

② WP4. LAND USE PRACTICES, VALORISATION AND VALUATION OF GEOLOGICAL AND SOCIETAL DATA AND CIVIL SOCIETY IMPACTS (M5-M13)

- Task 4.1: Mineral policies regarding land use requirements - valorisation and classification

③ WP6. PRACTITIONER GUIDELINES AND PEER LEARNING (M4-M23)

- Development of Good Practice Guidance documents

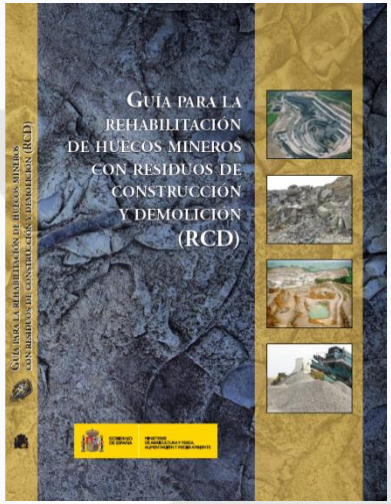
RIBERA DEL EBRO CASE

Regarding the work package 3, the project "Ribera del Ebro" ("Ebro River Bank") has been selected to be added to the case study list of MINLAND.

The importance of the case in the context of the project is due to the importance of Navarra as one of the European regions which one of the highest aggregates consumption. Thus, pressures on the environment due to aggregates exploitation are elevated.

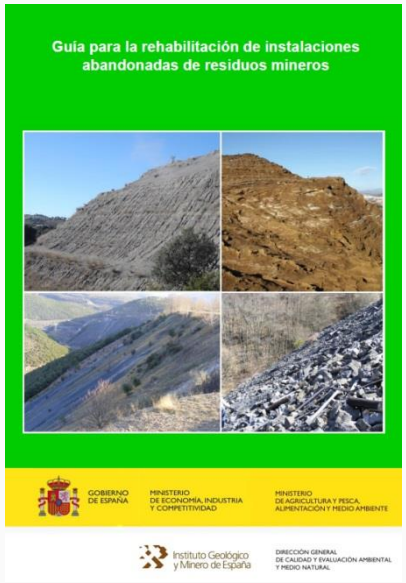
In addition, in Navarra, the agri-food sector is one of the most important engines of the economic development of the region, as well as the wine industry (Qualified Designation of Origin of wine of Rioja).

OTHER ACTIVITIES OF THE IGME LINKED TO SUSTAINABLE MINING



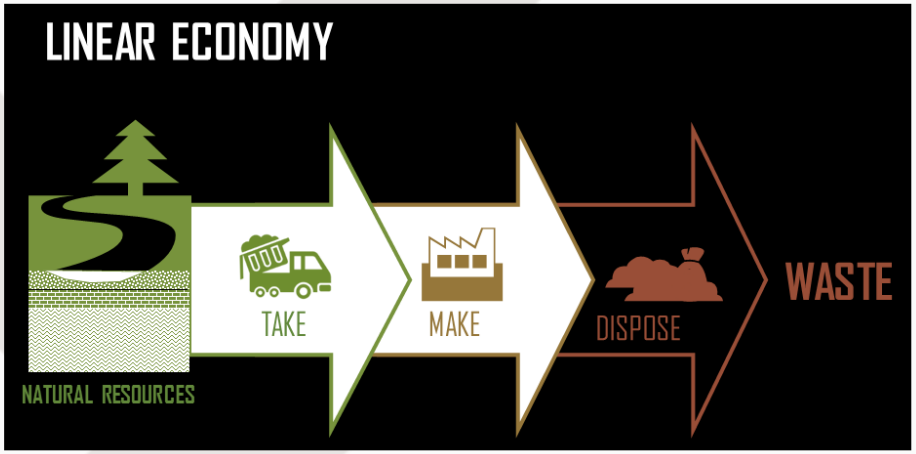
Guide for the rehabilitation of mining pits with construction and demolition waste

Guide for the rehabilitation of abandoned mining waste facilities (on a risk based approach)

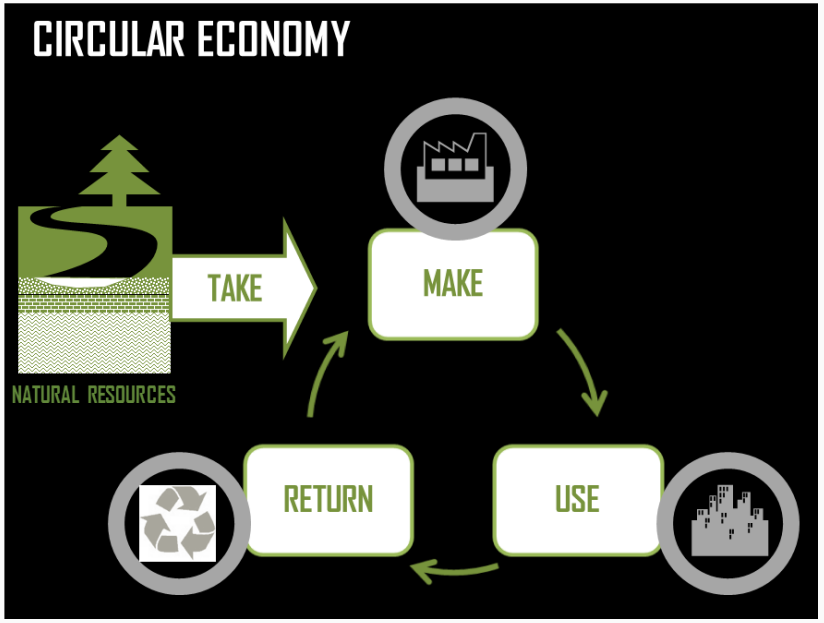


CIRCULAR ECONOMY – Closing the loop

Since the industrial revolution, our extractive industrial model have developed a 'take-make and dispose' pattern of growth — a linear model based on the assumption that resources are abundant, available, easy to source and cheap to dispose of. Moving towards a more circular economy is essential to deliver the resource efficiency agenda established under the Europe 2020 Strategy for smart, sustainable and inclusive growth. Circular economy systems keep the added value in products for as long as possible and eliminate waste. The circular economy is restorative and regenerative by design. Relying on system-wide innovation, it aims to redefine products and services to design waste out, while minimising negative impacts.



Vs.



CIRCULAR ECONOMY IN THE FRAMEWORK OF SUSTAINABLE MINING

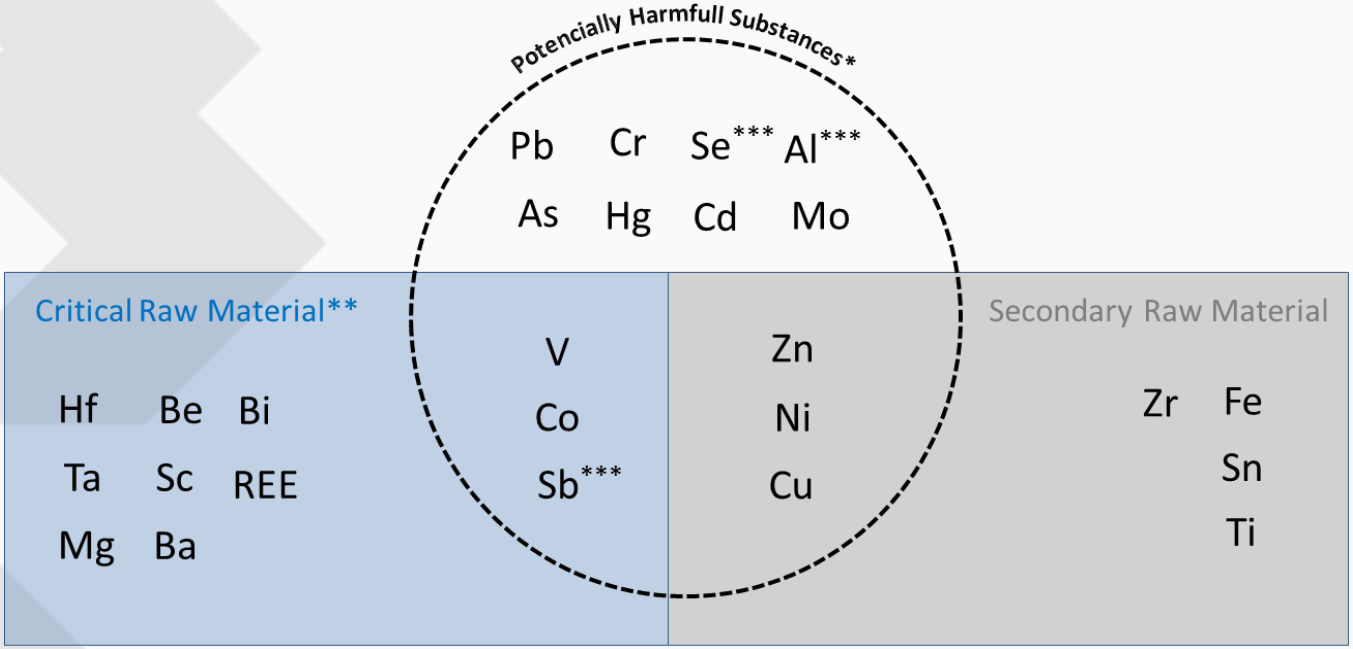
The implementation of the EU Strategy for Circular Economy necessarily goes through the **reprocessing of mining waste.**

Closed and abandoned mining waste facilities are a significant concern in Europe. For example, it is estimated that more than 14,000 closed and abandoned mining waste facilities exist in Spain.

Mining wastes often contain high concentrations of toxic elements, whose mobility and dispersion may pose an environmental hazard for soils, water, ecosystems and people.

Moreover, mining wastes can present interesting contents in Critical Raw Materials (CRM) and secondary raw materials. CRM have become essential for the industry sector, being necessary to produce a wide range of products and applications used in everyday life and modern technologies.

Reliable and unrestricted access to certain raw materials is a growing concern in the EU and around the world. They are highly important for the EU economy and the shortage of these materials poses a high risk. From the harmful substances that can be present in the mining wastes, V, Co and Sb, are also included in the 2017 list for critical raw materials for the EU. The recovery of other potentially harmful substances listed, although not being CRM, can be interesting as secondary raw materials (Cu, Zn, Ni). Other substances, also present in mining wastes but not listed as potentially harmful by the European Commission are catalogued as CRM or can be considered as secondary raw materials.



*2009/359/EC: Commission Decision of 30 April 2009 completing the definition of inert waste in implementation of Article 22(1)(f) of Directive 2006/21/EC of the European Parliament and the Council concerning the management of waste from extractive industries
**COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS on the 2017 list of Critical Raw Materials for the EU
***Added due to their probed toxicity

Regarding the compositional features of abandoned mining waste facilities inventoried in Spain, a high percentage of the test samples have shown contents of hazardous metals and metalloids above the limits set by the different territorial regulations of the Spanish regions. Although high concentrations of Cd, Cr and Sb have been found, the main environmental problems are clearly leaded by As and Pb in these facilities.

In addition, concentrations of Sb, Cd, Cr, V, Zn, Cu, and Ni (in some cases) are substantially above the geochemical background values considered.

Furthermore, tailings dam samples showed a small particle size (below 2 mm). Thereby, it is relatively easy for the pollutants to get into the aqueous phase, as well as to be mobilized by the wind. This condition is adverse in terms of environmental risk. However, the fine granulometry and the potential of some metals to mobilize could be key aspects when recovery actions want to be implemented.

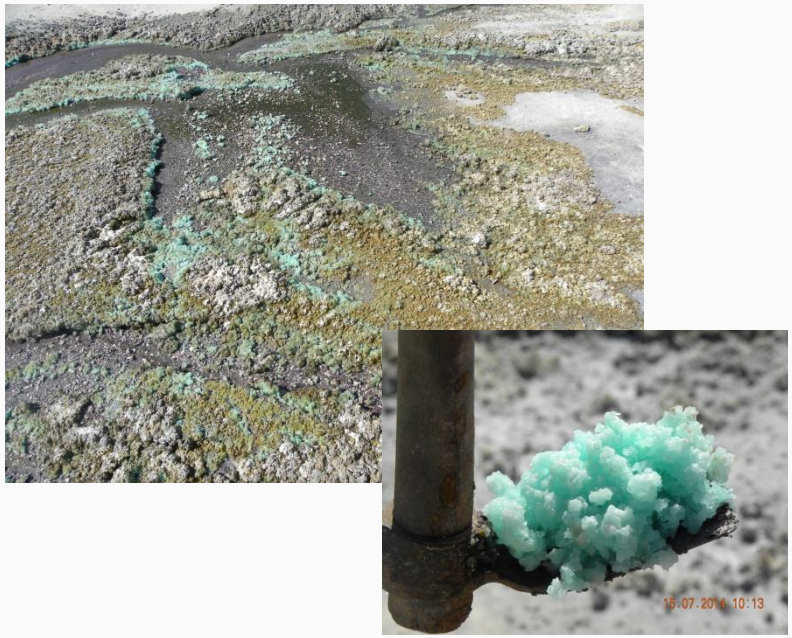
The removal of substances potentially harmful from the tailings dam is an important issue to solve in order to improve the environmental risk conditions of the facilities. In addition, the remaining materials may be a source of secondary raw materials (including CRM).

Thus, the reprocessing of mining waste provides a **triple benefit**:

- **Extraction of CRM and secondary raw materials from mining waste**
- **Removal of hazardous substances from the waste**
- **A new opportunity to manage properly the remaining waste**

The Geological Survey of Spain is currently developing two work lines linked to the reprocessing of mining wastes in the framework of Circular Economy:

- Recovery of metals from secondary sulphate salts formed in mining wastes (in cooperation with the Autonomous University of Madrid, UAM)



- Methods to extract CRM and secondary raw materials from mining wastes as well as removing hazardous substances and contaminants (in cooperation with the Higher Technical School of Mine Engineering of the Polytechnic University of Madrid, ETSI-Minas, UPM)

Mining-Environmental Planning and Circular Economy in the framework of Sustainable Mining

IGME - Geological Survey of Spain
Geochemistry and Sustainable Mining Unit

Virginia Rodríguez Gómez	v.rodriguez@igme.es
Lucas Vadillo Fernández	l.vadillo@igme.es
Julio César Arranz	jc.arranz@igme.es
Francisco Javier Fernández	fj.fernandez@igme.es

Peer Review Visit – REMIX Mining Conference
Valladolid, 20-22 March 2018

Instituto Geológico
y Minero de España