European Innovation Partnership on Raw Materials

Application for a Raw Materials Commitment

**Sustainable and efficient beneficiation of polymetallic, complex and low grade ores mined in difficult, small or deep mineral deposits including tailings and wastes**

**Acronym:**
PolymetOre

**Links to the Strategic Implementation Plan:**
- **I. Technology Pillar**
  - **I.B Priority Area: Technologies for primary and secondary raw materials’ production**
    - **Action area n° I.2: Exploration**
      - 1) New exploration technologies
      - 2) Geo-models
    - **Action area n° I.3: Innovative extraction of raw materials**
      - 1) Automated mining
      - 2) Mining of small deposits
      - 3) Alternative mining
    - **Action area n° I.4: Processing and refining of raw materials**
      - 1) Innovative and flexible processing
      - 2) Metallurgical systems

**Objectives of the commitment:**
To develop sustainable and efficient technological solutions to benefit polymetallic, complex, and low grade ores containing Cu, Zn, Pb, Ni, Au, Ag, PGE, CRM such as In, Sb, Co, and other minor elements from diverse mines located in Spain, Portugal, Poland and Serbia
To develop required innovative technologies covering the whole value chain from exploration to metals production including re-processing of tailings and wastes
To develop innovative technologies to exploit difficult, small or deep deposits in the mentioned countries
To produce added value products including refined metals (commodities) through the advanced concept “mine to metal” aiming to optimise mining business
To apply for a Pilot Action focused to implement a pilot demonstration facility in the Iberian Pyrite Belt able to process polymetallic and complex ores and dirty or low grade concentrates
**Description of the activities:**

Mines operated in Spain, Portugal, Poland and Serbia by the mining partners present important limitations:
- Many deposits are difficult, small or deep, presenting high extraction and operating costs
- Drilling techniques and associated analytical procedures are very expensive
- Polymetallic sulphide ores contain interstitial and microcrystalline minerals requiring very fine liberation size (10-15 microns); as a result, comminution is high energy intensive and extremely costly
- It is very difficult to separate each metallic mineral to achieve qualified commercial concentrates and to ensure high recovery rates; a substantial proportion of metals is lost, in particularly lead and silver
- In many cases, produced concentrates have low grade and contain high level of impurities such As, Sb, Bi, Hg, etc, incurring in penalties
- The Polish copper shale ores are troublesome in terms of flotation upgradeability due to carbonate-organic matrix, impairing effective species liberation and froth flotation
- Mines viability is close related to metals prices and market conditions and situation may be critical when metals quotation decreases to a certain point

PolymetOre is an industry-driven project led by a committed group of mining companies and its main goal is overcoming above deficiencies. That aim, the established consortium is strongly organised and well-structured to ensure a successful project development; special attention is paid to present a future Pilot Action within European Innovation Partnership on Raw Materials (EIP-RM).

The consortium proposes to cover the next phases having the support of the Horizon 2020 programme and the EIP-RM initiative:

**PHASE 1. 2014-17. Preliminary developments.** Setting up the technological basis of the project, covering next activities:
- New exploration technologies, innovative drilling techniques; rare/minor metals control in new mining projects
- New mining technologies; cost and energy efficient ores extraction methods; mining automation and control; mining wastes handling optimisation
- Mining wastes and tailings: dry stockpile techniques including paste technology improvements; by-products recovery, recycling, reuse
- New flotation technologies to improve selectivity and concentrates quality; energy efficient comminution; more selective reagents; process automation and control
- Innovative leaching technologies applied to polymetallic, dirty and low grade concentrates paying special attention to chalcopyrite extraction and including pressure, atmospheric, catalysed, and biotreatment technologies; enhanced purification, solvent extraction, and metals winning technologies
- Mine waters and process effluents and residues, e.g. biotreatment to remove sulphates, improved membranes applications; valorisation and recovery of valuable components

**PHASE 2. 2017-20. Implementation of a Pilot Action on polymetallic sulphides at the Iberian Pyrite Belt.** Design and build a pilot plant demonstration facility including:
- Flotation of selective and bulk concentrates
- Hybrid process combining production of commercial qualified concentrates together with dirty or low grade concentrates sent to hydromet processing
- Hydrometallurgical process able to treat polymetallic, dirty or low grade concentrates producing refined metals (commodities) and added value by-products

**PHASE 3. 2020. Project feasibility studies:**
- Based on results of the demonstration facility testing, required feasibility studies will be undertaken for selected industrial case studies. A detailed dissemination and commercialization plan will be developed and implemented
Description of the expected impacts:

Assuming positive results of PolymetOre project, the following impacts are expected:
- Opening the opportunity to exploit substantial volume of polymetallic, complex and low grade ores which are currently uneconomic due to lack of viable ways; the key to succeed is applying the developed innovative exploration, mining and processing technologies, ensuring economic feasibility and return of investment
- To develop and apply a sustainable mining business model based on: (i) Better efficiency of exploitation of polymetallic, complex and low grade ores, increasing the deposits reserves and extracting more out of ores; (ii) Increase Cu and Zn recovery rates above 15%, and Pb and Ag recovery rates above 20%; (iii) Extraction of additional valuable products such as CRM’s: Sb, Co, In, etc; (iv) Valorisation of wastes, e.g. pyrite residues aiming to recover contained iron; (v) Mitigate negative environmental impact and increase process eco-efficiency in regards to water, energy and consumable reduction as well as generated wastes; (vi) More automated operations
- To improve mining business economy through: (i) Lower operating cost, being the target 10% reduction; (ii) More income thanks to higher metals recovery rates, higher concentrates quality (less penalties), and new extracted products or by-products, being the target 20% increase; (iii) Re-processing of tailings and mining wastes to recover contained valuables
- Creation of new jobs in next areas: (i) New mining projects to exploit mines that are now unviable; (ii) New process/plants sections devoted to recover new products or by-products; (iii) New hydrometallurgical plants installed on site in the mine aiming to produce copper and zinc electrolytic metals, lead and silver added value products
- Opportunities in equipment/service supply

Expected innovation outcomes:
New processes
New technologies
Other

Comments:

The innovation outcomes in regards to the mine business covered sought by the PolymetOre project are:
- New exploration technologies and more efficient drilling techniques and also new geo-models as required
- New mining technologies and more automated and cost-effective extraction methods
- More efficient, automated and less costly flotation techniques focused on selective and bulk concentrate production
- Hybrid process combining production of commercial qualified concentrates together with low grade concentrates sent to hydro plant
- Innovative hydrometallurgical technologies able to extract sustainably and efficiently Cu, Zn, Pb, precious metals, some CRM’s and other minor metals, producing refined metals and by-products
- Newly developed chemical, membranes-based, and biological processes dealing efficiently with wastes, mine waters and process effluents and also tailings

Name of the coordinating organisation:
COBRE LAS CRUCES S.A.
Country:
Spain
Entity profile:
Private sector - large company
Role within the commitment:
Cobre las Cruces as coordinator will assume responsibilities to manage the consortium and to develop the proposed activities as required in any future grant-agreement. Some specific commitments by the coordinator includes: (i) Arrange proposal and budget preparation based on partners contributions; (ii) Establish a work plan focused on a future Pilot Action implementation; (iii) Monitoring the commitments and obligations of the partnership

Other partners:

**Name of partner:**
EMED-Tartessus

**Country:**
Spain

**Entity profile:**
Private sector - SME

**Role within the commitment:**
- Final User of the technologies, procedures and techniques developed within PolymetOre proposal scope
- Investigate on polymetallic, complex and low grade ores beneficiation
- Develop Geometallurgical characterization procedures and models
- Investigate on new mining technologies for difficult, small or deep deposits
- Develop metallurgical and water treatment testwork, Innovative drilling programs, Minerallogical characterization works

**Name of partner:**
RIO NARCEA RECURSOS, S.A.

**Country:**
Spain

**Entity profile:**
Private sector - large company

**Role within the commitment:**
- Potential end-user of innovative developed technologies
- Collaboration with staff and installations in the investigation Project in specific areas of interest

**Name of partner:**
AYESA

**Country:**
Spain

**Entity profile:**
Private sector - large company

**Role within the commitment:**
- Development of any basic and detailed engineering related to the pilot plant or other facilities required in the project.

**Name of partner:**
SOMINCOR - Sociedade Mineira de Neves Corvo S.A.

**Country:**
Portugal

**Entity profile:**
Private sector - large company
Role within the
commitment:
- End-user of developed innovative technologies - Mining, industrial partner. Main objectives to improve concentrate quality, or produce a secondary "special quality" concentrate for novel metallurgical treatment - Will carry out lab. and pilot scale flotation testing to optimize plant efficiency - Can provide flotation pilot plant for testing of ores from partner mines - Will provide flotation concentrates for metallurgical testing

Name of partner:
TECNICAS REUNIDAS S.A.
Country:
Spain
Entity profile:
Private sector - large company
Role within the
commitment:
TR will provide its extensive know-how in hydrometallurgical processes and technologies and in methodologies to scale-up and validate innovative technologies. - Leaching technologies. Apply to diverse concentrates, e.g. chalcopyrite concentrates, polymetallic bulk concentrates. - Metals winning and refining from PLS, e.g. zinc SX and EW technologies - Metals winning and refining from leaching residue, e.g. lead and silver recovery in chloride media

Name of partner:
AGQ Mining and Bioenergy SL
Country:
Spain
Entity profile:
Private sector - SME
Role within the
commitment:
As a Technological Center we support research and development of metallurgical and environmental projects. We are specialized on chemical analysis of ores, rocks, and mineral wastes. Also we are offering services related with bench and pilot scale for metallurgical research and modulation. With our facilities of pilot plant we are able to carry out test on metallurgical and wastes recovery.

Name of partner:
OUTOTEC
Country:
Spain
Entity profile:
Private sector - large company
Role within the
commitment:
Mineral processing. Innovations in minerals comminution and flotation technologies, etc. Leaching technologies. Apply to diverse concentrates, e.g. chalcopyrite concentrates, polymetallic bulk concentrates, etc. Metals winning and refining, e.g. copper SX and EW technologies.
Name of partner: BASF  
Country: Germany  
Entity profile: Private sector - large company  
Role within the commitment:  
BASF's role is in the development, testing and application of novel solvent extractants to improve the hydrometallurgical extraction of copper from polymetallic ores. In particular such reagents will be optimized for use within high temperature concentrate leach processes, which will offer the mining industry a more sustainable alternative to the environmentally challenged smelting process.

Name of partner: UNIVERSIDAD POLITÉCNICA DE MADRID  
Country: Spain  
Entity profile: Academia  
Role within the commitment:  
Design, testing and assessment of new rock fragmentation techniques. Development and setting up of monitoring and fragmentation measuring techniques at a macro- and micro-scale. Downstream (processing plant) effects of fragment size distribution of the run-of-mine to increase cost-effectiveness of small or low-grade ores mining and processing. Environmental and societal impact of mining in nearby populated areas to improve operations feasibility.

Name of partner: Montanuniversitaet Leoben  
Country: Austria  
Entity profile: Academia  
Role within the commitment:  
Full partner working on the R&D parts of the mining, mineral processing and metallurgy related project parts; accompanying and supervising field tests; participation in prototype testing.

Name of partner: Instytut Metali Niezelaznych (Institute of Non-Ferrous Metals)  
Country: Poland  
Entity profile: Governmental/public body  
Role within the commitment:  
Running activities related to laboratory and pilot scale studies into ore treatment and
Name of partner: ALS Group
Country: Ireland
Entity profile: Private sector - SME
Role within the commitment: "We can carried out any analyses to related with: Sampling, Sample preparation, Mine Control Labs, assay consultants. Geochemical analyses, AMD/ARD (Acid Mine Drainage/Acid Rock Drainage) Environmental analyses Fire assays Impurities control in metals, concentrates and commercial ores. Isotopes analyses sampling and assays of concentrates at mines, port, etc before selling them) Metallurgical studies and Mineralogical through our ALS network."

Name of partner: MINING & METALLURGY INSTITUTE BOR
Country: Serbia
Entity profile: Governmental/public body
Role within the commitment: Scientific, researching and developing in the fields: geology, mining, metallurgy, technology (leaching, bioleaching, solvent extraction electro wining, electrolyze), chemistry, civilengeneering, mechanical and eletrotechnical engineering, and related fields.

Name of partner: Laboratório Nacional de Energia e Geologia (LNEG)
Country: Portugal
Entity profile: Governmental/public body
Role within the commitment: Partner within larger consortium responsible for data geneneration/gathering from Portugal. R&D in the fields of geological evaluation and hydrometallurgical processing of Portuguese sulfide minerals of the Iberian belt. The following tasks are foreseen: -Study of the Neves Corvo stratigraphic sequences -Detail study of the Neves Corvo gravity anomaly -Geological structures reinterpretation and modeling

Name of partner: RTB BOR GROUP
Country: Serbia
Entity profile: Private sector - large company
Role within the
commitment:
- Enduser of developed innovative technologies - Mining company, able to supply ores and concentrate samples for further research in PolymetOre proposal - Helping with existing geology, mining and metallurgy data - Take part in research. Involving in applying a new technologies.

Name of partner:
MAXAM EUROPE S.A.
Country:
Spain
Entity profile:
Private sector - large company
Role within the commitment:
To develop, implement and demonstrate the technical and economical feasibility of a 360º bulk explosives underground loading unit and the development of a pumpable bulk explosive allowing the elimination of sublevels in an underground mine. To develop and implement the best drilling and blasting processes, explosives and initiating systems allowing the minimization of the dilution effect in metal open pit mining, improving the ore bodies recovery.

Name of partner:
Ingeniería de Suelos y Explotación de Recursos, S.A. (INSERSA)
Country:
Spain
Entity profile:
Private sector - large company
Role within the commitment:
Test drilling for mining industry providing adapted and suitable solutions. Open to develop innovative drilling techniques.

Name of partner:
Mineral Industry Research Organisation - MIRO
Country:
United Kingdom
Entity profile:
Private sector - SME
Role within the commitment:
Contribution to project management (administrative and technical); contributing to dissemination and exploitation, promotion and PR issues; contributing with personal expertise in minerals processing and metallurgy; contributing to all assessment activities, sustainability and green processing aspects; contributing to risk assessment.

Name of partner:
Sandvik Mining
Country:
Sweden
Entity profile:
Private sector - large company

**Role within the commitment:**
- To contribute in developing mining technologies and methods for polymetallic, complex and low-grade ores exploitation and beneficiation
- To pay special attention to innovative mining technologies applied to difficult, small and deep minerals deposits

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**Name of partner:**
Luleå University of Technology

**Country:**
Sweden

**Entity profile:**
Academia

**Role within the commitment:**
- Contribution to develop innovative and efficient solutions to facilitate minerals species liberation and separation through selective flotation
- To improve production of high quality concentrates, favouring the removal of minor components and impurities subjected to penalties
- Innovation in technologies and processes leading to optimise energy consumption in minerals processing, in particular comminution and flotation, etc

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**Name of partner:**
BUREAU DE RESECHES GÉOLOGIQUES ET MINIÈRES - BRGM

**Country:**
France

**Entity profile:**
Governmental/public body

**Role within the commitment:**
- Innovations in geology and exploration technologies
- Innovative treatment solution for mining wastes and tailings
- Integration of new technology for energy efficient comminution step
- Innovative leaching technologies applied to polymetallic concentrates (with a special focus on chalcopyrite) including bioleaching technologies (tank leaching; new bioreactor concept)
- Innovative mine waters and process effluents treatment: valorisation and recovery of valuable components

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**Name of partner:**
MINTEK

**Country:**
South Africa

**Entity profile:**
Governmental/public body

**Role within the commitment:**
- Adapted biological cultures
- Best practice regarding inoculation methods, amenability testing of agitated leaching, metallurgical and geomechanical tests towards heap leaching
- Bioleaching process for polymetallics and refractory minerals in agitated and heap leaching systems
- Laboratory- and pilot plant scale testwork to determine design parameters for the above
- Desktop order-of-magnitude economic studies
Name of partner: GA Drilling
Country: Slovakia
Entity profile: Private sector - SME
Role within the commitment:
· Innovation in mining boreholes – development and demonstration of drilling technology based on high energy-electrical plasma which is especially suitable for hard rocks
· Innovation in online chemical analysis on drilling process – the plasma drilling technology can be customized for real-time exploration – extraction of geochemical information concurrent to the drilling process – very beneficial for reducing cost- and time-consuming lab analysis

Name of partner: Datum Monitoring
Country: United Kingdom
Entity profile: Private sector - SME
Role within the commitment:
Instrumentation development, supply and service for monitoring

Name of partner: INSTITUTO GEOLOGICO Y MINERO DE ESPAÑA (Spanish Geological Survey)
Country: Spain
Entity profile: Governmental/public body
Role within the commitment:
· Mineral Processing and Hydrometallurgical research. ·Develop new high resolution maps through building up Geomodels

Name of partner: Imperial College London
Country: United Kingdom
Entity profile: Academia
Role within the commitment:
· Contribution to develop innovative and efficient solutions to facilitate minerals species liberation and separation through selective flotation ·To improve production of high quality concentrates, favouring the removal of minor components and impurities subjected to penalties ·Innovation in technologies and processes leading to optimise energy consumption in minerals processing, in particular comminution and flotation, etc
**Name of partner:**  
KGHM POLSKA MIEDZ S.A.  
**Country:**  
Poland  
**Entity profile:**  
Private sector - large company  
**Role within the commitment:**  
-Mining company. End-user of the technologies, procedures and techniques developed in this project -Investigate on complex ores exploitation and beneficiation -Innovations in flotation and leaching technologies -Investigate on new mining technologies for difficult or deep deposits

**Name of partner:**  
MinPol KG - Agency for International Minerals Policy  
**Country:**  
Austria  
**Entity profile:**  
Private sector - SME  
**Role within the commitment:**  
-Contribution to all aspects of mineral policies in the field of mining, minerals economy, mining and environmental engineering, geology and IT, leading the WP on commercialisation, dissemination, promotion, technology transfer, education, skills and training activities -Leading dissemination and commercialisation activities

**Name of partner:**  
TNO  
**Country:**  
Netherlands  
**Entity profile:**  
NGOs  
**Role within the commitment:**  
Expert on the treatment of aqueous waste streams. Within the department of Water Treatment of TNO innovative water treatment technologies are developed in cooperation with end users and technology suppliers. Also consultancy in the area of Industrial Water Management and water treatment is carried out. Technology development focuses on the eco efficient reuse of water and simultaneously the recovery of valuable materials.

**Name of partner:**  
Atlas Copco SAE  
**Country:**  
Spain  
**Entity profile:**  
Private sector - large company  
**Role within the commitment:**  
Drilling equipment developer
Name of partner: Paques BV
Country: Netherlands
Entity profile: Private sector - SME
Role within the commitment:
-Innovative solutions for mining and process effluents and wastes through biological treatment -
To develop specific biotechnologies to remove sulphates and other contaminants

Name of partner: Cytec Industries B.V.
Country: United Kingdom
Entity profile: Private sector - large company
Role within the commitment:
CYTEC is the leading company for development of new, innovative mining chemicals. CYTEC would aim to partner with one or more mining company in the consortium to look at specific ore challenges. We would look to help improve processing efficiency, in both flotation and solvent extraction areas.

Existing EU contribution: No

Period to implement the commitment:
Saturday, 8 February, 2014 to Thursday, 31 December, 2020