



**Sustainable decarbonised co-extraction of
vanadium and titanium minerals from Europe's
low-grade vanadium-bearing titanomagnetite
deposits (AVANTIS)**

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1. Introduction

This deliverable (D5.1 Clustering report 1) comprises a detailed description about the procedures followed towards identifying relevant projects for clustering with the AVANTIS project, as long as a detailed list of the related projects. This is the first iteration, since it will be followed by the Clustering report 2 and Clustering report 3, which will also include the activities related to Task 5.2 Contribution to clustering workshops which will be initiated on M5.

2. Methodology

The process towards identifying related projects for clustering activities as conducted by the research team of Technical University of Crete (TUC), was a two-step procedure and carried out, involving:

- i. Extensive search in EU databases (i.e. CORDIS) and Internet search for projects with scope and objectives related to AVANTIS.
- ii. Extraction of the essential information and compilation of the related tables.

Initially, extensive search was conducted via cordis (<https://cordis.europa.eu>). All projects that were part of the same call (HORIZON-CL4-2023-RESILIENCE-01-02 - Innovative technologies for sustainable and decarbonised extraction (RIA)) were selected by default, and then a detailed survey was performed for the projects that belonged in the same thematic area. Based on this search, 20 projects selected for further processing. The list of the projects along with the call in which they were submitted, is presented in Section 3.

3. AVANTIS' potential clustering projects list

The detailed list of all projects identified suitable for clustering are presented in Table 1.

Table 1: AVANTIS's clustering projects list¹

ID	Project's Name	Related Call	Type of Project
1	Unlocking the supply of rare earth elements in Europe through responsible, sustainable and decarbonized innovative technologies (REESOURCE)	HORIZON-CL4-2023-RESILIENCE-01-02 - Innovative technologies for sustainable and decarbonised extraction (RIA)	HORIZON RIA
2	Autonomous Exploration and Extraction of Deep Mineral Deposits (PERSEPHONE)	HORIZON-CL4-2023-RESILIENCE-01-02 - Innovative technologies for sustainable and decarbonised extraction (RIA)	HORIZON RIA
3	A Sustainable Ecosystem for the Innovative Resource Recovery and Complex Ore Extraction (XTRACT)	HORIZON-CL4-2023-RESILIENCE-01-02 - Innovative technologies for sustainable and decarbonised extraction (RIA)	HORIZON RIA
4	Decarbonized Titanium Recovery from Aluminium and Titanium Production Residues (EURO-TITAN)	HORIZON-CL4-2023-RESILIENCE-01-02 - Innovative technologies for sustainable and decarbonised extraction (RIA)	HORIZON RIA
5	Cost-effective processing and refining of lithium into lithium hydroxide from strategic European multi-mineral lithium hard-rock projects (LITHOS)	HORIZON-CL4-2023-RESILIENCE-01-03: Technologies for processing and refining of critical raw materials (IA)	HORIZON IA
6	Sustainable European Rare Earth Elements production value chain from primary Ores (SUPREEMO)	HORIZON-CL4-2023-RESILIENCE-01-03: Technologies for processing and refining of critical raw materials (IA)	HORIZON IA

¹ The links provided in Table 1, are the ones to the official description of each project to the CORDIS site.

7	Cost-effective, sustainable and responsible extraction routes for recovering distinct critical metals and industrial minerals as by-products from key European hard-rock lithium projects (EXCEED)	HORIZON-CL4-2022-RESILIENCE-01-07: Innovative solutions for efficient use and enhanced recovery of mineral and metal by-products from processing of raw materials (IA)	HORIZON IA
8	Demonstration of battery metals recovery from primary and secondary resources through a sustainable processing methodology (METALLICO)	HORIZON-CL4-2022-RESILIENCE-01-07: Innovative solutions for efficient use and enhanced recovery of mineral and metal by-products from processing of raw materials (IA)	HORIZON IA
9	Innovative digital sustainable aggregates systems (DIGIECOQUARRY)	SC5-10-2019-2020 - Raw materials innovation actions: exploration and Earth observation in support of sustainable mining	HORIZON IA
10	New Exploration Tools for European Pegmatite Green-Tech Resources (GREENPEG)	SC5-10-2019-2020 - Raw materials innovation actions: exploration and Earth observation in support of sustainable mining	HORIZON IA
11	Pilot Action for Securing a Sustainable European Next Generation of Efficient RE-free magnets (PASSENGER)	SC5-10-2019-2020 - Raw materials innovation actions: exploration and Earth observation in support of sustainable mining	HORIZON IA
12	A Holistic Digital Mine 4.0 Ecosystem (Mine.io)	HORIZON-CL4-2022-RESILIENCE-01-06 - Sustainable and innovative mine of the future (IA)	HORIZON IA
13	Digital and innovative mine of the future (DINAMINE)	HORIZON-CL4-2022-RESILIENCE-01-06 - Sustainable and innovative mine of the future (IA)	HORIZON IA
14	Intelligent digital toolbox towards more sustainable and safer extraction of mineral resources (NETHELIX)	HORIZON-CL4-2022-RESILIENCE-01-06 - Sustainable and innovative mine of the future (IA)	HORIZON IA
15	European Mining in the Green and Digital Era (MASTERMINE)	HORIZON-CL4-2022-RESILIENCE-01-06 - Sustainable and innovative mine of the future (IA)	HORIZON IA
16	Multi-scale, Multi-sensor Mapping and dynamic Monitoring for sustainable extraction and safe closure in Mining environments (m4mining)	HORIZON-CL4-2022-RESILIENCE-01-08 - Earth observation technologies for the mining life cycle in support of EU autonomy and transition to a climate-neutral economy (RIA)	HORIZON RIA
17	Secure and sustainable supply of raw materials for EU industry (S34I)	HORIZON-CL4-2022-RESILIENCE-01-08 - Earth observation technologies for the mining life cycle in support of EU autonomy and transition to a climate-neutral economy (RIA)	HORIZON RIA
18	Multi-source and multi-scale earth observation and novel machine learning methods for mineral exploration and mine site monitoring (MultiMiner)	HORIZON-CL4-2022-RESILIENCE-01-08 - Earth observation technologies for the mining life cycle in support of EU autonomy and transition to a climate-neutral economy (RIA)	HORIZON RIA
19	Sustainable exploration for orthomagmatic (critical) raw materials in the EU: Charting	HORIZON-CL4-2021-RESILIENCE-01-06 - Innovation for responsible EU sourcing of primary raw materials,	HORIZON RIA

	the road to the green energy transition (SEMACRET)	the foundation of the Green Deal (RIA)	
20	Agile Exploration and Geo-modelling for European Critical Raw materials (AGEMERA)	HORIZON-CL4-2021-RESILIENCE-01-06 - Innovation for responsible EU sourcing of primary raw materials, the foundation of the Green Deal (RIA)	HORIZON RIA

For each of the projects presented in Table 1, a table has been created which contains the following information: (i) Project's title, (ii) Acronym, (iii) Webpage, (iv) Related Call, (v) Contact's person name and email, (vi) Starting and Ending date, (vii) The project's description. A sample project's presentation is presented in Table 2. It is worth mentioning that Table 1, was compiled according to the relevance of the project to the objectives and goals of AVANTIS. The project which are more relevant to AVANTIS are higher to the list.

Table 2: Sample project's presentation table

PX	The project's title	Acronym	Project's webpage
The projects ID			
Call: The EU call under which the project is funded			
Contact person: The project's contact persons		Email: The email address of the contact person	
Start Date: The starting date of the project		End date: The ending date of the project	
Project Description: A short description of the scope and project's objectives.			

The detailed project list is presented in Section 4. The full list will be available in a searchable format at AVANTIS' official site. All the projects presented in Table 1, have been identified as potential partners for clustering activities and they were contacted using an invitation email, which clearly stated the scope and goals of the AVANTIS project. The related email is presented in Figure 1.

Figure 1: Sample invitation for clustering activities

Dear Sir/Madam,

I am contacting you on behalf of AVANTIS's project consortium (<https://avantis-horizon.eu/about-avantis/>), a project which started on 01 January 2024 and deals with Sustainable, decarbonised vanadium, titanium and iron extraction from Europe's low-grade vanadium-bearing titanomagnetite deposits. AVANTIS aims to develop a low-carbon, extraction approach for Europe's low-grade under/unexploited, vanadium-bearing titanomagnetite (Ti-V-Fe-(P) deposits (and mining wastes) in Finland, Sweden, Norway, Poland and Ukraine. This novel "responsible mining" approach will extract two key CRMs V and Ti as pre-concentrates, which can be further processed by the relevant downstream industries to high-purity materials, e.g., VRFB, Ti-V alloy. AVANTIS will also impact on the co-extraction of light rare earths and phosphorus from the rare-earth containing apatite concentrate.

The AVANTIS consortium, consists of 10 Beneficiaries from 6 European countries (Belgium, Finland, Poland, Norway, Spain, Greece) plus 3 Associated Partners from Finland and Australia.

I'm representing Technical University of Crete (TUC), which is the leader of Work Package 5 "Clustering with other EU projects" which aims to increase AVANTIS impact by interacting and joining efforts with other leading initiatives at European level. If you are interested in getting informed about our activities, participate in upcoming events and potentially participate in joint clustering initiatives, please let us know. In case that you may have questions, or you need additional clarifications, please don't hesitate to contact us. Looking forward to hearing from you at your earliest convenience

Best regards,

Dr. Anna Kritikaki

4. Detailed projects description

P1	Unlocking the supply of rare earth elements in Europe through responsible, sustainable and decarbonized innovative technologies	REESOURCE	N/A
Call: HORIZON-CL4-2023-RESILIENCE-01-02 - Innovative technologies for sustainable and decarbonised extraction (RIA)			
Contact person: N/A		Email: via cordis	
Start Date: 1/12/2023		End date: 31/5/2027	
<p>Project Description: Responsible, sustainable and low CO₂ footprint mineral extraction is vital for the preservation of our planet. Ensuring responsible supply of minerals, involves addressing the environmental, social, and economic impacts of minereral extraction and developing technologies and know-how to minimize them. Mining within these low-impact boundaries in a world that is putting an increasing pressure on the mineral supply requires developing environmentally friendly, safe, intelligent and resource efficient extraction technologies and methods. REESOURCE will set a sustainable and decarbonized value chain basis for the extraction of Rare Earth Elements (REEs) in Europe, supporting the ambition of the continent to become self-sufficient on REEs. This target will be achieved through a set of actions (scientific, technical, social and financial) that will serve to pave the road for the development of the European mining of the future. These include i) enhancing key technologies of raise mining to foster “invisible mining”, with minimal socioenvironmental impact and lower CO₂ emissions’ footprint compared to existing approaches; ii) developing novel formulations based on environmentally friendly chemicals for both, the mineral beneficiation process of REEs and the process water treatment, supporting the recirculation of this resource; iii) developing a novel stabilization technique for tailings, making them suitable for backfilling, stabilizing the mine and avoiding the need of tailing ponds; iv) valorize the tailings through a Circular Economy approach, to make them suitable for expanded value chains as geopolymers for construction applications and composite materials for catalytic and CO₂ capture applications; v) assess the social dimension to maximize early social awareness, engagement and acceptance and vi) multiply the project impact through cross-fertilization with other projects and clusters, supporting the mass adoption of UNFC and UNRMS in the raw materials sector.</p>			

P2	Autonomous Exploration and Extraction of Deep Mineral Deposits	PERSEPHONE	webpage
Call: HORIZON-CL4-2023-RESILIENCE-01-02 - Innovative technologies for sustainable and decarbonised extraction (RIA)			
Contact person: N/A		Email: via cordis	
Start Date: 1/1/2024		End date: 31/12/2026	
<p>Project Description: The continuous effort and increased demand of the raw materials are directing the mining companies to excavate minerals at greater depths. This trend is challenging the current mining operations and the existing traditional technologies towards the objective to retain profitability, while achieving the latest Green Deal environmental vision and securing human workers safety. A key enabler, to address these challenges and to foster a sustainable development of the mining industry, is the development and deployment of innovative technologies for resource efficient extraction of the EU's raw materials, as well as near mine exploration of critical raw materials in currently non-extracted ore bodies in existing or abandoned ones.</p> <p>PERSEPHONE is aiming to address these challenges by developing of the pioneering technologies for pushing the limits of EU mining industry and embodiment of autonomous and integrated near mine exploration capability to access deep deposits of critical raw materials through hard-to-reach deep and abandoned mines. The overall concept and vision of PERSEPHONE will be achieved by reducing the size of mining machines currently adapted to the human scale and embedding autonomy for risk-aware navigation and full digitalization of the extraction process by digital twin creation and key enabling technologies validation at TRL 5. Additionally, PERSEPHONE is introducing completely novel approaches in online near mine exploration core analysis and overall integration of related data analytics to the mine expansion. Thus, PERSEPHONE allows to foster green transition by reducing the cost and waste generated from deep-mining operations and foster the vision of zero human presence in highly hazardous areas. These will allow to achieve PERSEPHONE's overall goal to digitalize and automate extraction value chain by creation of new concepts of energy-efficient autonomous drilling machines with advanced perception capabilities for navigation, face drilling, and core extraction, which will enable data-driven digital twin creation and geological modelling for further enhanced decision support and optimal extraction planning.</p>			

P3	A Sustainable Ecosystem for the Innovative Resource Recovery and Complex Ore Extraction	XTRACT	webpage
Call: HORIZON-CL4-2023-RESILIENCE-01-02 - Innovative technologies for sustainable and decarbonised extraction (RIA)			
Contact person: N/A		Email: via cordis	
Start Date: 1/12/2023		End date: 30/11/2026	
<p>Project Description: XTRACT seeks to introduce the novel concept of the Zero Emission Mine of the Future, introducing innovative technologies for sustainable and decarbonised extraction. The XTRACT technological pathways to a lower mining emission future are addressing well-identified emission intensive points of the current mining value chain. XTRACT will add a highly innovative new alternative to the toolbox of how stockpiles and tailings are assessed, relieving the pressure on resources and contributing to the realization of EU Climate Neutrality Goals, with a significant benefit of emission reduction. XTRACT will scale remote sensing systems and analytical resources to allow the systematic and remote monitoring of “hard-to-access” mining sites and waste deposits. XTRACT targets the reduction of ore losses and mining waste, through a novel system for the control of the ore loss and dilution, reducing overall mine emissions and economic loss. The trend towards declining orebody grades and continued development of the pursuit of existing operation to exploit lower grade deposits is likely to continue, in the absence of high-grade project discovery. XTRACT will develop and validate innovative microinvasive technologies and solutions to extract high-tech elements from minerals and wastes, specifically tailored to remote, “hard-to-reach” locations and small quantities, where extraction is unprofitable. The in-situ bioleaching process and membrane treatment will be applied and optimized with the aim to achieve enhanced microbial activity, catalyst production, and therefore, maximum metal recovery from the source. XTRACT will introduce low-TRL green technologies of phytoextraction and phytoremediation, particularly appropriate for mining waste piles and abandoned sites, that represent a solution for mine waste remediation but also for the extraction and recovery of various precious metals. XTRACT will be validated in 5 case studies in Germany, Sweden, Portugal and Greece.</p>			

P4	Decarbonized Titanium Recovery from Aluminium and Titanium Production Residues	EURO-TITAN	N/A
Call: HORIZON-CL4-2023-RESILIENCE-01-02 - Innovative technologies for sustainable and decarbonised extraction (RIA)			
Contact person: N/A		Email: via cordis	
Start Date: 1/1/2024		End date: 30/12/2027	
<p>Project Description: EURO-TITAN will be a pioneer in unlocking continuous Ti resources from metallurgical waste streams from alumina and Ti-dioxide production, developing 54 ktpy of Ti metal making Europe totally independent from Russian Ti-metal sponges imports crucial for alloy production in the transport and medical sectors. On this purpose an industrial driven consortium gaining experience from previous and ongoing projects for metals extraction from industrial wastes (Scavanger,Scale, Scale Up,Valore) will develop a >90% lower CO₂ emission (compared to the conventional Kroll process which produces 10tn per tn of Ti) green hydrogen sourced(ref-hyd) direct Ti reduction process will be scaled to demonstration in the industrial environment at the Bosnian Al-plant to produce tailor-made Ti-metal products for ingots or alloying. Our Ti-metal price will be 15% lower compared to imported ones (rough estimate 6800 €/t Ti compared to current prices from Russia and China at 8500 €/t). Process optimization will be achieved through integration of inline-real time data monitoring, establishing repository of high-quality and trusted datasets, and embedding Artificial Intelligence. This will lead to a 10% reduction of on-site energy and water consumption, while at the same time minimizing production interruption. Finally, circularity is ensured, as the remaining residues are converted into innovative (30% lower CO₂ emissions compared to cement based) construction materials while water will be recycled, and excess heat energy will serve local households.</p>			

P5	Cost-effective processing and refining of lithium into lithium hydroxide from strategic European multi-mineral lithium hard-rock projects	LITHOS	webpage
Call: HORIZON-CL4-2023-RESILIENCE-01-03: Technologies for processing and refining of critical raw materials (IA)			
Contact person: Paivi Kinnunen VTT		Email: via cordis	
Start Date: 1/1/2024		End date: 30/6/2027	
<p>Project Description: On 16 March 2023 the EC published the Critical Raw Materials Act (CRMA) setting “benchmarks along the strategic raw materials value chain and for the diversification of EU supplies”. By targeting the domestic processing and refining of lithium – arguably “the most strategic CRM” – LITHOS directly contributes to the 1st and 2nd CRMA benchmarks (10% domestic extraction; 40% domestic processing). LITHOS processes and refines the ores from three “Strategic Projects” in terms of domestic battery-grade LiOH·H₂O production: two spodumene-bearing pegmatite cases (Keliber’s deposits in the Kaustinen region, Finland; Savannah’s Barroso Lithium Project, Portugal) and one Rare-Metal Granite (RMG) case (Imerys’ Beauvoir mine in France). LITHOS expands and tailors the existing Keliber & M:O flowsheet, which was developed for regular-grade spodumene ores, so that (1) the cut-off grade for spodumene ores is reduced, resulting in larger Li reserves, while (2) allowing the commercialisation of lower-grade pegmatite and RMG deposits. LITHOS triggers innovations along the value chain – mineral processing, concentrate pre-treatment & hydrometallurgical refining – making it possible to deal with different levels and types of impurities in non-spodumene Li minerals (lepidolite & petalite). LITHOS gives specific attention to closed-loop water systems in the mineral processing (KPI: 90% less water consumption). The overall CO₂ emissions of the LITHOS flowsheet will be 50% lower than today’s benchmark (production of spodumene concentrate in Australia & refining in China). This work is enriched by bespoke thermodynamic modelling and digital twins. Supported by FMG & Euromines, LITHOS intends to replicate the LITHOS “responsible mining and refining” concept to the other 24 identified Li-hard-rock deposits in Europe. LITHOS’s meta-objective is to unleash Europe’s full Li-hard-rock ore potential (total: 8.8 Mt Li₂O) so as to become self-sufficient by 2030–35 in terms of made-in-Europe LiOH·H₂O.</p>			

P6	Sustainable European Rare Earth Elements production value chain from primary Ores	SUPREEMO	webpage
Call: HORIZON-CL4-2023-RESILIENCE-01-03: Technologies for processing and refining of critical raw materials (IA)			
Contact person: N/A		Email: via cordis	
Start Date: 1/1/2024		End date: 30/6/2027	
<p>Project Description: SUPREEMO aims to establish the first pre-commercial Rare Earth Elements (REEs) production value chain (TRL7) using European (EU) primary resources as feedstock, developing sustainable, cost-competitive processing, refining and Rare Earth (RE) Permanent Magnet (PM) production technologies in a responsible way complying with local and international safety regulations. This will contribute in securing REE materials supply for the EU industry and strategic sectors which depends 100 % on Chinese imports. The largest end-user of REEs is the PMs industry, that contain neodymium, praseodymium, and dysprosium as key elements to produce high energy-efficient motors, which are vital for electric mobility and renewable energy technologies. SUPREEMO will exploit the primary resources from two major EU sites: Kvanefjeld REE-deposit Greenland (large scale RE project) with ore reserves of >143 Mtonne and Fen deposit Norway (largest carbonatite deposit in EU) with >200 Mtonne grading 1.2-1.5 % Total Rare Earth Oxides. It will capitalise on technologies demonstrated in previous projects and develop an innovative, environmentally friendly, socially and economically sustainable REEs processing technologies. During phase 1, the partners will optimise the stand alone technologies to elucidate the final integrated process flowsheet with the best processing parameters in phase 2, guided by LCA and LCCA. This will be validated at the piloting activities in phase 3. Finally, the production of 50-100 kg of REO at similar cost to commercial value from Chinese production will be demonstrated at TRL7 by processing ~ 10 tonnes of ores, and the production of Rare Earth Alloy for the manufacturing of 50 kg PMs. Results will be communicated and disseminated to key stakeholders and a concrete first business plan will be set to attract more investors and stimulate a competitive, resilient and sustainable REEs production value chain ready for full-scale deployment in the EU market.</p>			

P7	Cost-effective, sustainable and responsible extraction routes for recovering distinct critical metals and industrial minerals as by-products from key European hard-rock lithium projects	EXCEED	webpage
Call: HORIZON-CL4-2022-RESILIENCE-01-07: Innovative solutions for efficient use and enhanced recovery of mineral and metal by-products from processing of raw materials (IA)			
Contact person: Matti Okkonen, VTT		Email: via cordis	
Start Date: 1/1/2023		End date: 30/12/2026	
<p>Project Description: The EU is almost entirely dependent on importing rare earths and lithium (Li) for batteries needed to decarbonise the energy and mobility sectors. This is surprising considering Europe has 27 Li hard-rock (pegmatite and rare-metal granite) deposits. One explanation is the reluctance among Europeans to conduct primary (Li) mining in Europe, despite their enthusiasm about electric vehicles. The EU-funded EXCEED project will develop a new mining paradigm for zero-waste, multimetal/mineral mining. This will be combined with sustainable mineral processing to provide additional critical raw materials and industrial minerals from four lithium mines in Finland, France, Portugal and the United Kingdom. EXCEED's long-term impact includes the replication of its solutions to the other 23 European pegmatite and rare metal granite deposits.</p> <p>Europe is 100% reliant on imports of Li for the Li-ion batteries that are central to decarbonising the energy and mobility sectors. Some fraction of our needs can come from recycling the batteries already in use, but realistically, primary supply will still have to cover 90% of the Li requirement. Paradoxically, Europe hosts 27 Li hard-rock (pegmatite & Rare-Metal Granite) deposits, representing vast lithium resources (8.8–21.7 Mt Li₂O). However, the identified potential remains largely untouched, which is partly due to a reluctant attitude towards primary (Li) mining in Europe. Europeans are very enthusiastic about EVs, but rather less so about the necessary mining & refining of Li-bearing ores to realise them. By upscaling and integrating results from earlier projects, EXCEED's 15 partners develop a new mining paradigm, i.e. zero-waste, multi-metal/mineral mining. This will be combined with sustainable mineral processing to provide us with additional critical raw materials (CRMs: rare earths, Nb, Ta, W, Be) and industrial minerals (quartz, feldspar and micas), coming from 4 lithium mines (as case studies) in Finland (Keliber), Portugal (Savannah), France (Imerys) and the UK (Imerys). The project adopts a mineral-centric, integrated methodology based on an innovative predictive and forensic geometallurgy, supported by enhanced in-line characterisation tools and the development of digital twins. EXCEED develops, upscales and demonstrates cost-effective, sustainable and responsible extraction routes for recovering CRMs and industrial minerals (the latter for use as low-carbon ceramics and cements), as by-products from the 4 Li-bearing hard-rock ores. EXCEED's long-term impact includes the replication of the EXCEED solutions to the other 23 European pegmatite and Rare-Metal Granite deposits, thus boosting domestic CRM production (up to 21.7 Mt Li₂O & 1.5 Mt of other CRMs), in a way that gains public support by respecting the environment and creating local jobs.</p>			

P8	Demonstration of battery metals recovery from primary and secondary resources through a sustainable processing methodology	METALLICO	webpage
Call: HORIZON-CL4-2022-RESILIENCE-01-07 - Innovative solutions for efficient use and enhanced recovery of mineral and metal by-products from processing of raw materials (IA)			
Contact person: Ana Lara Quijano, IDENER		Email: https://metallico-project.eu/About+us/Partners.html	
Start Date: 1/1/2023		End date: 30/6/2026	
<p>Project Description: The European Union has underexploited potential to produce critical raw materials (CRM) and special metals, as stated in the Study on the EU's list of Critical Raw Materials (2020). Concretely, the battery sector is considered as a key strategic sector for the EU due to the increased use of batteries in different important sectors such as electric mobility. Thus, METALLICO proposal presents a new opportunity for the European Union. It is composed by an strategic consortium along the value chain, including mining and industrial sites with primary and secondary sources of critical and battery metals (Li, Co, Cu, Mn, Ni); experienced partners to pilot novel processes for producing battery-grade materials based on previous projects and activities; industrial and SME end-users in the battery, cement, paint, and ceramic sectors; and partners to demonstrate the social-license-to-operate (including the support of government bodies), sustainability and commercial chances that the solution represents. Worldwide, these battery metals are predominantly in Chile, Australia, South Africa, China, and The Democratic Republic of Congo, representing a high risk for the EU in terms of supply shortage. For example, in the case of Li, the EU import reliance is 87% for lithium concentrates and 100% for refined compounds as there is no domestic refining. METALLICO includes 4 cases studies in the EU to recover: battery-grade Li_2CO_3 from a primary spodumene/lepidolite/petalite deposit; Co concentrates and battery-grade CoSO_4 from a mine secondary resource (CLC); and Cu, Co, Mn, and Ni concentrates from metallurgical slag from a Pb refining company (KHGM) and secondary mine tailings (THARSIS). Upscaling of sustainable and innovative upstream and downstream processes will demonstrate the techno-economic recovery and production of these critical and important metals for the EU.</p>			

P9	Innovative digital sustainable aggregates systems	DIGIECOQUARRY	webpage
Call: SC5-10-2019-2020 - Raw materials innovation actions: exploration and Earth observation in support of sustainable mining			
Contact person: N/A		Email: https://digiecoquarry.eu/contact/	
Start Date: 1/6/2021		End date: 31/5/2025	
<p>Project Description: Nearly all fields rely on the mining of metals and minerals. The aggregates extractive industry produces 3 billion tonnes a year in Europe. It is also the largest of the non-energy extractive industries. The EU-funded DIGIECOQUARRY project will develop systems, technologies, and processes to boost the digitalisation and automation of mining operations to make them safer, more sustainable, and competitive. Specifically, artificial intelligence (AI) approaches will be paired with cyber-physical systems and the Internet of things (IoT). The next step will be to pilot these systems in five EU quarries to improve workers' health and safety. The overall aim is to sustainably increase the supply of minerals for the construction sector.</p> <p>The European aggregates extractive industry is, by far, the biggest non-energy extractive industries in the EU (Eurostat 2017): 26000 estimated extraction sites: 81,26% of the total EU mining and quarrying sites, 3000 million ton extracted and supplied to the EU internal market, ~ 220000 persons directly employed. Hence the EU faces the need of sustainable and competitive future for European Raw Materials specially in the construction sector due to a greater anticipated demand for products linked to human well-being, health, safety and sustainability. DIGIECOQUARRY will exploit the aggregates industry's great potential through a coordinated approach towards construction materials management with the final goal of reducing EU external supply dependency as well as leading an efficient use of resources. DIGIECOQUARRY will develop systems, technology and processes for integrated digitisation and automation real-time process control, to be piloted in 5 EU quarries with the target of improving health and safety conditions for workers. The pilot campaigns will lead to improved efficiency of processes maximizing quarry resources and sustainable management of water, energy emissions, minimised environmental impact and expanding the EU aggregates and construction business. Coupling Artificial Intelligence approaches with cyber-physical systems and the Internet of Things concept, make Industry 4.0 approach possible and the smart sustainable extractive site a reality. All phases of the process, from extraction to the end user are covered by DIGIECOQUARRY, ensuring communication with policy makers, social awareness activities and international cooperation with Colombia and South Africa to share knowledge and best practices. The development of innovative an Intelligent Quarrying System (IQS) will increase the sustainable supply of minerals for the construction sector as well as enabling the sustainable extraction of EU's mineral resources in existing and new quarries.</p>			

P10	New Exploration Tools for European Pegmatite Green-Tech Resources	GREENPEG	webpage
Call: SC5-10-2019-2020 - Raw materials innovation actions: exploration and Earth observation in support of sustainable mining			
Contact person: Wolfgang Reimer		Email: https://www.greenpeg.eu/contact.html	
Start Date: 1/5/2020		End date: 31/10/2024	
<p>Project Description: The manufacturing of devices for green energy production and storage in Europe is a fast-growing sector. However, 95 % of the main raw materials needed for green energy devices are imported. For industrial development to be sustainable, domestic deposits need to be secured. Lithium–caesium–tantalum and niobium–yttrium–fluorine pegmatites are quite common in Europe, but they are difficult to explore because most are buried, small and clustered. The EU-funded GREENPEG project aims to develop and test high-level exploration technologies and algorithms that will be integrated and converted into flexible, ready-to-use toolsets for the identification of buried pegmatite ores. The project's results will increase European raw material resources, enhance databases on raw materials and improve the competitiveness of EU companies.</p> <p>The manufacture of devices for green energy production and storage in Europe is a strategic, fast-growing sector which is essential in ensuring that the EU meets its energy and climate targets for 2030. It is worth an estimated €30 Bn in turnover, with investments of €4 Bn in the EU27, and is likely to create c.a. 100,000 jobs over the next 10 years. A major limitation to this is that 95% of the key raw materials for green energy devices are currently imported from outside the EU. Securing domestic deposits is therefore urgent for sustainable industrial development, mainly in retaining a large part of the added value, reducing supply risks and ensuring EU environmental standards for the production of raw materials. Exploration investment in Europe has declined in recent years due to increased technical demand and socio-political debate. Private sector engagement will increase only when technical solutions allow economically viable and environmentally friendly exploration and mining. Geologically, lithium-caesium-tantalum (LCT) and niobium-yttrium-fluorine (NYF) pegmatites are relatively common in Europe, enriched in many CRM needed for energy technologies but difficult to explore because most are buried, small and clustered. The GREENPEG approach will develop and test a set of high-level exploration technologies and algorithms to be integrated and upscaled into flexible, ready-to-use (TRL 7) toolsets for the identification of buried pegmatite ores. Validation of the new approach will be ensured from industry-led trials at locations in Austria, Ireland and Norway, while application studies will also be done in Finland, Portugal and Spain. Many of these target areas have established downstream processing industry, thus extending their value chains. The data acquired will enhance European databases, e.g. adding new petrophysical properties for pegmatite ores, making the toolsets also important for geological surveys and increasing the competitiveness of EU companies.</p>			

P11	Pilot Action for Securing a Sustainable European Next Generation of Efficient RE-free magnets	PASSENGER	webpage
Call: SC5-10-2019-2020 - Raw materials innovation actions: exploration and Earth observation in support of sustainable mining			
Contact person: N/A		Email: passenger.project@imdea.org	
Start Date: 1/5/2021		End date: 30/4/2025	
<p>Project Description: Used in key industrial ecosystems – from renewable energy and e-mobility to space and defence – permanent magnets are essential. However, rare-earth elements are required to produce the majority of magnets used in those technological sectors. The EU-funded PASSENGER project will develop innovative solutions to resolve issues with EU dependency on rare-earth raw materials for permanent magnets. The aim will be to reduce bottlenecks in the material supply-chain and diminish the environmental impact. Applying a sustainable substitution model, the project will rely on resources widely available in Europe and innovative technologies to develop upscaled alternatives. For this purpose, PASSENGER brings together 20 institutions (13 industrial partners) from 8 European countries.</p> <p>PASSENGER addresses to the topic CE-SC5-10-2020 on raw materials innovation under subtopic d) Pilots on substitution of critical and scarce raw materials (2020). PASSENGER aims to develop innovative pilots to address an aspect of high economical, technological, social and environmental relevance: a solution for the EU dependency on rare-earths (REs) for permanent magnets (PMs), avoiding bottlenecks in the material supply-chain and diminishing the environmental impact. Considering the importance of PMs in present and emerging technologies, PASSENGER will develop up scaled alternatives based on widely available resources and innovative technologies. PASSENGER has a clear industrial orientation involving key end users and SMEs/LEs (13 industrial partners) from 8 EU countries. PASSENGER will develop a sustainable substitution pilot in PMs subdivided in 8 innovative pilot activities covering the complete value chain to finish at TRL7 and to guarantee implementation across the EU after the project is finished. The choice of PMs is based on realistic (envisioned up-scaling, low cost and environmental impact) projects results and patents (proven at TRL 4-5) achieved by the partners in successful EU projects: Improved Strontium ferrite (Sr-ferrite), Manganese-Aluminum-Carbon (MnAlC) and related technologies. These RE-free PM alternatives will substitute bonded NdDyFeB-magnets, which are constituted by diverse critical raw materials: REs (Nd and Dy, and Pr in some compositions); Metal (Cobalt). Electromobility has been chosen as a main key-driving sector with three application areas: Class 1: e-scooter; Class 2: e-bikes and e-motorbikes; Class 3: e-cars. The project will be done under premises of sustainability and reduced environmental impact, including Standardisation activities, Life Cycle Assessment (LCA) and Life Cycle Cost (LCC) analysis, recyclability and social-life cycle assessment of PASSENGER's products and technologies.</p>			

P12	A Holistic Digital Mine 4.0 Ecosystem	Mine.io	webpage
Call: HORIZON-CL4-2022-RESILIENCE-01-06 - Sustainable and innovative mine of the future (IA)			
Contact person: N/A		Email: info@mineio-horizon.eu	
Start Date: 1/1/2023		End date: 30/6/2026	
<p>Project Description: Over the last couple of decades, digital twins – virtual representations of real-world entities or processes – have allowed sectors from manufacturing and supply chain logistics to healthcare and retail to test and predict the behaviours of the ‘real’ twin in many scenarios. They support well-informed decision making that enhances product performance, process efficiency, and/or human safety to name only a few. The ambitious EU-funded Mine.io project will extend the application of digital twinning to the mining industry. The manufacturing system architecture in a cloud environment will enable enhanced systematisation of mining industry processes, automation and robotisation of mining exploration and production processes, and sustainable mining and post-mining management.</p> <p>In the context of industrialization, informatization and sustainable development of the mining sector, Mine.io solution will build a novel mining digital ecosystem and a systemic structure for the implementation of Industry 4.0 in mining industrial environments. Mine.io solution will embrace the whole mining value chain from resources’ exploration, extraction, and processing to waste management and post mining activity. Our fundamental concept is the provision of a manufacturing system architecture, under cloud environment, to be applied in the digital twin mining “shop floor”. Mine.io envisions an innovative cloud services system and a novel mining ecosystem of sharing, interconnection, and open cooperation. Mine.io will establish a unified data infrastructure and collaborative platform ecosystem to promote the openness and sharing of data and improve the cooperation environment between mining enterprises. Mine.io aims the enhanced systematization of the basic processes of the mining industry, that involve asset and process equipment optimization, through embedded predictive analytics, and optimization procedures based on completely data-driven processes and the integrated cyber-virtual and cyber-physical systems, automation and robotization of mining exploration and production processes, sustainable mining, and post mining management. To meet the increasing social and environmental concerns, Mine.io will enable a resource optimization and digital transformation framework, embedding specific circular economy and “low-impact mining” strategies. Energy innovations, including the transition to autonomous electric vehicles, will lead to socially conscious profit, while creating a safer and cleaner environment for front-line workers, including higher air quality for those working underground. Mine.io ecosystem will be validated in different demonstration sites, involving 4 operational mine facilities and 2 historic mine sites, in 5 EU countries.</p>			

P13	Digital and innovative mine of the future	DINAMINE	webpage
Call: HORIZON-CL4-2022-RESILIENCE-01-06 - Sustainable and innovative mine of the future (IA)			
Contact person: N/A		Email: https://www.dinamine-project.eu/contact/	
Start Date: 1/1/2023		End date: 30/6/2026	
<p>Project Description: The demand for critical raw materials is increasing at a time when Europe aims to strengthen its resilience in the mining sector. Small- and medium-sized mines play a decisive role in Europe becoming more independent of imports and more competitive in terms of sustainability, both economically and environmentally, through responsible mining practices. In this context, the EU-funded DINAMINE project aims to radically transform and modernise the mining operation value chain. DINAMINE will demonstrate a future mine management approach, relying on data analytics tools for mine-to-port monitoring of performance, mine productivity and recovery rates, and technologies for machine automation and robotisation. The project will identify best practices for carbon-neutral logistics and transportation, energy-efficient processing and reuse of mining waste.</p> <p>Although raw materials are of strategic importance for the European economy in key exponentially growing value chains such as the energy transition where Europe should strengthen its resilience, independence, and competitiveness, European mining operators fail to meet the demand, as they suffer from low productivity, poor waste management, resource-intensity and the consequent environmental impacts. To meet the ever-increasing demand and negative market prospects, while mitigating the environmental and societal impacts, the mining industry needs a drastic transformation. In this context, DINAMINE aims to demonstrate a holistic mine management approach, based on (i) artificial intelligence-based data analytics tools for real-time mine-to-port monitoring of the risks, performance, environmental footprint, maintenance needs, product quality and recovery rates, (ii) machine automation and robotization strategies to enhance safety and productivity, (iii) on-site studies to identify best practices for carbon neutral logistics/transportation, more energy-efficient processing, and waste/tailings handling and valorisation. Our goal is to propose tools that enable a smarter, more efficient, more selective, safer and more sustainable mining industry, with a specific focus on European SMEs. Technologies developed will be upscaled and tested, and studies performed in 2 small-medium scale European mining operations: one open-pit feldspar mine (Portugal), and one underground graphite mine (Norway) and their associated processing plants. The project is brought forward by a high-level industry-led multidisciplinary consortium of 11 partners from 6 European countries, including 3 research institutes, and 6 industries (including 4 SMEs). Via increased selectivity and productivity, DINAMINE will bring several impacts for EU and global mines, helping them to improve their IRR and ultimately contribute to an increase in EU raw materials security of supply.</p>			

P14	Intelligent digital toolbox towards more sustainable and safer extraction of mineral resources	NETHELIX	webpage
Call: HORIZON-CL4-2022-RESILIENCE-01-06 - Sustainable and innovative mine of the future (IA)			
Contact person: N/A		Email: via cordis	
Start Date: 1/1/2023		End date: 30/6/2026	
<p>Project Description: In 2020, the European Commission updated its list of nonenergy, nonagricultural critical raw materials (CRMs). This was based on the scarcity of supply and the importance to the EU industry, comprising 30 CRMs. The European industry and economy depend on sustainable access to CRMs. However, several technological and environmental challenges along the entire production value chain of primary and secondary raw materials prevent secure access. The EU-funded NETHELIX project will demonstrate in real-life settings a toolbox of new technologies for automating and streamlining the extraction process. These technologies will make use of mining and waste deposit processing methods, maximising efficiency, reducing waste production and increasing environmental and human health safety.</p> <p>Europe’s industry and economy depend on a secure access to many commodities. In 2020, the EC updated its list of critical non-energy non-agricultural raw materials (CRMs), based on scarcity of supply and importance to EU industry. Today, the list includes: Antimony, Fluorspar, Magnesium, Silicon Metal, Baryte, Gallium, Natural Graphite, Tantalum, Bauxite, Germanium, Natural Rubber, Titanium, Beryllium, Hafnium, Niobium, Vanadium, Bismuth, HREEs, PGMs, Tungsten, Borates, Indium, Phosphate rock, Strontium, Cobalt, Lithium, Phosphorus, Coking Coal, LREEs, Scandium.</p> <p>Securing sustainable access to CRM, is of high importance for the EU economy. However, the EU is confronted with a number of technological and environmental challenges along the entire production value chain of primary and secondary raw materials. NetHelix demonstrates in real life settings a toolbox of new technologies for automating and streamlining the extraction process, taking advantage of deposits through mining and waste deposits processing methods, maximising efficiency, reducing waste production, and increasing environmental and huma health and safety.</p>			

P15	European Mining in the Green and Digital Era	MASTERMINE	webpage
Call: HORIZON-CL4-2022-RESILIENCE-01-06 - Sustainable and innovative mine of the future (IA)			
Contact person: N/A		Email: via cordis	
Start Date: 1/12/2022		End date: 30/11/2026	
<p>Project Description: Innovative technologies, research and education are required to ensure a sustainable and efficient mining industry. In this context, the EU-funded MASTERMINE project focuses on the top-down axis of culture, strategy and tactics to propose a structural, multi-level change. An understanding of the value of digitalisation and environmental sustainability is crucial for the operation of mines. On ground, MASTERMINE will play a leading role in the digital transformation of mines. The project will promote autonomous operations and ensure safety and stability in critical structures. MASTERMINE will also increase the environmental sustainability of mines by improving energy consumption and water savings, promoting waste valorisation and reducing greenhouse gas emissions while becoming a bridge between the mining industry and the surrounding ecosystem.</p> <p>The industry is facing surmounting challenges today, such as deeper mining, social license to operate, access to land, higher production rates, but at a lower cost and more challenging environments, both underground and on the surface. Innovative mining technologies, research and education are required through bridging of business, research, and education, to enable a sustainable, efficient, and successful mining industry now and in the future.</p> <p>MASTERMINE proposes a structural multilevel change for the mining operations, focusing on the top-down axis of Culture, Strategy and Tactics. Culture refers to the intrinsic change for the EU mines, to understand the value of digitalization and environmental sustainability We address the Strategy pillar for the mine, by designing high-level modules that address real industrial challenges. We lead the digital transformation of mines through CYBERMINE, we foster autonomous and electric operations along with smart monitoring and maintenance through AUTOMINE, we ensure safety and stability in critical structures using GEOMINE, in GREENMINE we enhance the environmental sustainability of the mines by improving energy consumption, air quality and GHG emissions, water savings and waste valorisation. In METAMINE, we build a virtual world for the EU mines, introducing the concept of the mining metaverse hosting all the technologies, along with Digital Twins and Business Intelligence to provide simulation and decision support. Finally, we make the EU mine OURMINE, by bringing the communities together, build trust around the sustainability compliance of the raw material and fostering social innovation.</p> <p>We are going to demonstrate our approach in 5 EU demo cases and one replication demo in South Africa. Our mining partners offer access to a total of 11 mines around Europe, producing 10 different raw materials, including 5 CRMs (Cobalt, Tungsten, Coking Coal, Phosphate Rock and Platinum).</p>			

P16	Multi-scale, Multi-sensor Mapping and dynamic Monitoring for sustainable extraction and safe closure in Mining environments	m4mining	webpage
Call: HORIZON-CL4-2022-RESILIENCE-01-08 - Earth observation technologies for the mining life cycle in support of EU autonomy and transition to a climate-neutral economy (RIA)			
Contact person: N/A		Email: via cordis	
Start Date: 1/1/2023		End date: 30/12/2025	
<p>Project Description: Earth observation data from remote sensing and ground-based platforms are not only indispensable for mineral exploration: continuous monitoring of mining activities reduces accidents, health risks and damage to ecosystems. The EU-funded m4mining project proposes to develop a remote sensing system aboard unmanned aerial vehicles (UAVs). The system will integrate light detection and ranging (lidar), hyperspectral, navigation, computing systems and telemetry to acquire high-resolution oblique data of mine faces and by-products, which will also directly link to satellite-based algorithms. Another key feature will be its ability to directly process and convey spectral and lidar data to on-site users while the UAV is in flight, thus facilitating workflows and decision-making in the case of risk management.</p> <p>The m4mining project aims to provide an integrated remote sensing approach for mapping and monitoring active and inactive mining sites. Hyper- and multispectral imaging combined with 3D surface measurement will be utilised for material identification from the detailed mine face to the site scale using unmanned aerial vehicles (UAVs) and satellite sensors. Central to the proposed work is a synergistic unification of UAV and satellite-based processing algorithms, workflows and decision-making tools at timescales required to impact active operations and environmental and risk management of tailings and waste sites.</p> <p>A novel UAV system will combine hyperspectral, lidar, navigation, on-board computing systems and telemetry to acquire high-resolution oblique datasets from mine faces and tailings. Key innovations will be dynamic processing of spectral and lidar data, communicating initial results to on-site users, allowing interactive presentation and decision-making while the UAV is in flight. In addition, high quality results be rapidly available for integration with site-scale satellite workflows and enhanced classification algorithms. This combined approach offers a step-change in active mine operations and tailings management, paving the way for novel products and services. New applications include improved sorting of material during extraction, material quality assessment, re-mining of secondary raw materials, as well as monitoring environmental impact. m4mining will contribute to reduced energy consumption through faster response times for mine operators and will impact digitalisation of mining. The main result will be technology validation in operational environments: three sites in EU and key EU raw materials import markets will be used, in Cyprus, Greece and Australia.</p> <p>The project consortium is established from internationally leading commercial hardware and software providers, research groups in technology and applications in mining, and public stakeholders.</p>			

P17	Secure and sustainable supply of raw materials for EU industry	S34I	webpage
Call: HORIZON-CL4-2022-RESILIENCE-01-08 - Earth observation technologies for the mining life cycle in support of EU autonomy and transition to a climate-neutral economy (RIA)			
Contact person: N/A		Email: via cordis	
Start Date: 1/1/2023		End date: 30/6/2025	
<p>Project Description: Raw material resources are crucial for most industries. Their price affects the whole process from production to delivery. For this reason, efficient and ecologically friendly solutions for locating and using new sources of raw materials are imperative. The EU-funded S34I project aims to use Earth Observation (EO) data and new methods for data analysis to improve raw materials exploration and location management. At the same time, it will improve current EO analysis methods and build on efforts to combat technical and environmental issues that make the green transition difficult. The project aims to improve social and economic conditions throughout the EU and assist with mining decarbonisation.</p> <p>S34I will research and innovate new data-driven methods to analyse Earth Observation (EO) data, supporting systematic mineral exploration and continuous monitoring of extraction, closure and post-closure activities with the aim to increase European knowledge and autonomy on raw materials resources. S34I uses EO not only for the management of technical and environmental issues for a green transition but also to support mining's social acceptance (SLO) and better legislation. Innovative EO-based products/services will provide new or more accurate RM mineral mapping/exploration, environmental and mine monitoring and mine safety, at different phases of the mine life cycle. S34I will exploit Copernicus and other satellite sensors (optical and radar), while other platforms as airborne, low-altitude platforms, ground-based, in-situ techniques/methods, and fieldwork will serve either for calibration, validation or to complement Copernicus data especially at the very high scale spatial or spectral resolution.</p> <p>S34I will provide 6 new open high added value datasets, 14 new methods to analyze EO data using Artificial Intelligence being utilized at different phases of the mining life cycle, 3 new prototyped EO based services for mining stakeholders, 1 research and innovation agenda on EO for mining, a set of recommendations for better policy, and guidelines for EO uptake by the mining industry. S34I results will be validated at six different locations in different phases of the mining life-cycle: (i) land exploration in Spain; (ii) coastal exploration at the Iberian Peninsula Atlantic coast; (iii) extraction phase in Austria and; (iv) closure/post-closure phase in Finland and Germany. S34I is an EU wide interdisciplinary and complementary team embracing partners from 13 countries and with a 50/50 balance between industrial and research profiles. S34I mining stakeholders will lead the path towards mining de-carbonization while creating social and economic impact through EO uptake.</p>			

P18	Multi-source and multi-scale earth observation and novel machine learning methods for mineral exploration and mine site monitoring	MULTIMINER	webpage
Call: HORIZON-CL4-2022-RESILIENCE-01-08 - Earth observation technologies for the mining life cycle in support of EU autonomy and transition to a climate-neutral economy (RIA)			
Contact person: N/A		Email: via cordis	
Start Date: 1/1/2023		End date: 30/6/2025	
<p>Project Description: Earth Observation (EO) data can aid mineral exploration and mining activities. The EU-funded MultiMiner project will develop innovative data processing algorithms based on machine learning for cost-effective utilisation of EO technologies for mineral exploration and mine site monitoring. In this way, it will unlock the potential of EO data, including Copernicus, commercial satellites, upcoming missions, airborne and low altitude, and in situ data. The project will focus on novel EO-based exploration technologies for critical raw materials to increase the probability of finding new sources within the EU thus reinforcing its autonomy in the raw materials sector. MultiMiner will create generic but highly innovative machine learning solutions with extremely low environmental impact to support the entire mining life cycle.</p> <p>The Multi-source and Multi-scale Earth observation and Novel Machine Learning Methods for Mineral Exploration and Mine Site Monitoring (MultiMiner) project develops novel data processing algorithms for cost-effective utilization of Earth Observation (EO) technologies for mineral exploration and mine site monitoring. MultiMiner unlocks the potential of EO data, including Copernicus, commercial satellites, upcoming missions, airborne and low altitude as well as in situ data, to support the entire mining life cycle including mineral exploration, operational, closure and post-closure stages. This is achieved by creating generic but highly innovative machine learning solutions which do not require any or only little ground truth data. The project focuses on new EO based exploration technologies for critical raw materials (CRM) to increase the probability of finding new sources within EU thereby strengthening the EU autonomy in the area of raw materials. MultiMiner EO based exploration solutions have extremely low environmental impact, and are thus socially acceptable, economically efficient and improve safety. The project's solutions for mine site monitoring increase the transparency of mining operations as environmental impacts can be detected as early as possible and digital information of the currently unexploitable raw materials can be stored for future generations. The applicability of the developed algorithms is demonstrated in 4 European test sites. MultiMiner is a pan-European consortium consisting of 12 partners and 1 associated partner from research institutes, academia, consulting businesses and mining industry with interdisciplinary backgrounds in geology, remote sensing and machine learning. The members come from six EU member states which represent mining regions across Europe with diverse geology with evident potential for various types of CRM resources and thousands of operational and closed mines.</p>			

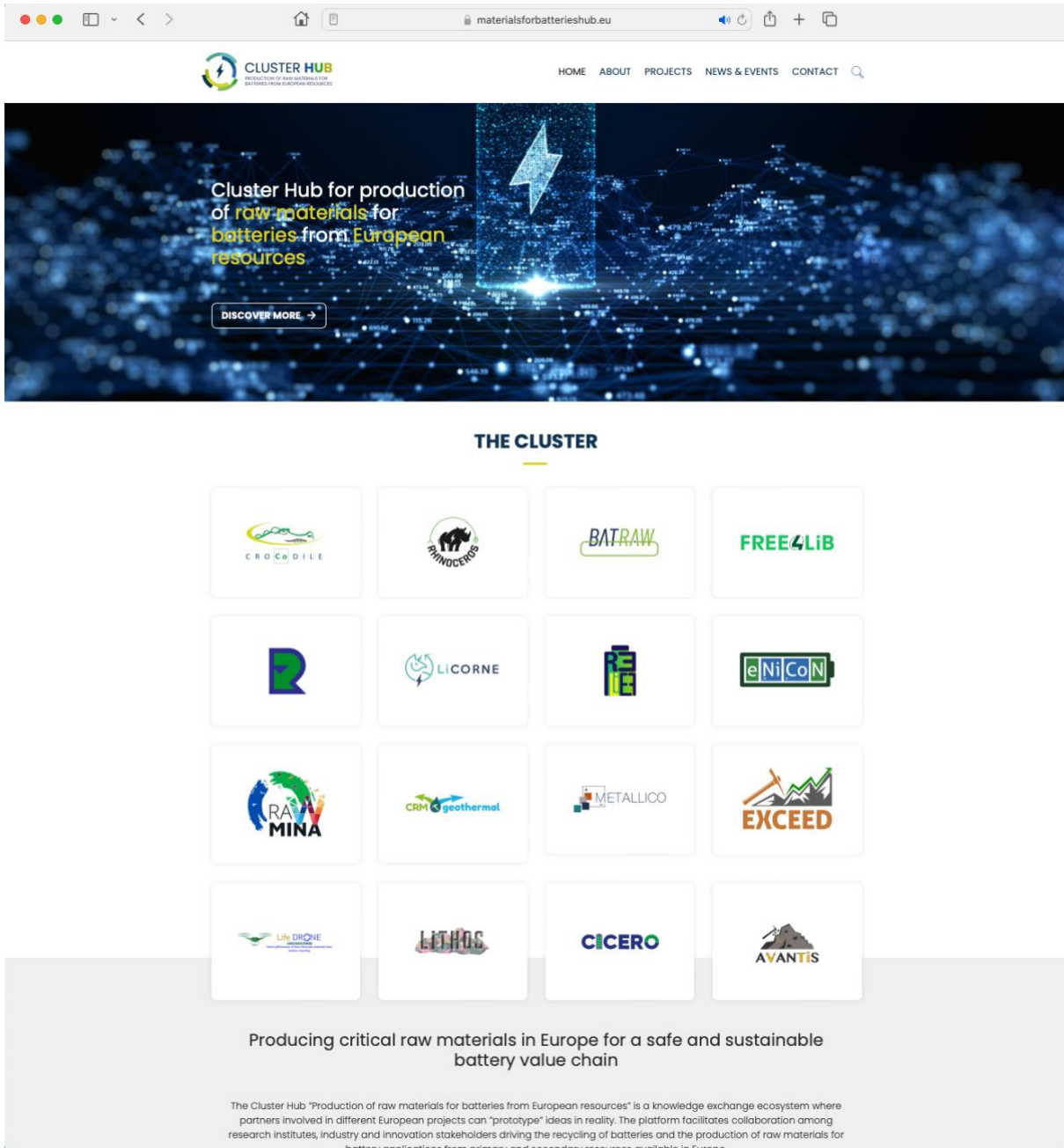
P19	Sustainable exploration for orthomagmatic (critical) raw materials in the EU: Charting the road to the green energy transition	SEMACRET	webpage
Call: HORIZON-CL4-2021-RESILIENCE-01-06 - Innovation for responsible EU sourcing of primary raw materials, the foundation of the Green Deal (RIA)			
Contact person: Shenghong Yang, University of Oulu		Email: via cordis	
Start Date: 1/6/2022		End date: 31/5/2025	
<p>Project Description: Critical raw materials (CRMs) are crucial to Europe’s green energy transition. Orthomagmatic mineral systems host important green transition (critical) raw materials (GTRM) including Ni, Cu, Co, V, Ti, Cr, and platinum-group elements (PGE). Although the EU has the potential for more mines in several member states, there are currently only 2 mines in operation. The EU-funded SEMACRET project will conduct research in Finland, Portugal, Poland, and Czechia to develop socially and environmentally sustainable means of exploration for orthomagmatic CRMs. The project will apply, for the first time in the EU, the mineral systems approach to guide exploration for orthomagmatic CRMs and generate improved ore models for orthomagmatic mineral deposits.</p> <p>Critical raw materials (CRMs) are fundamental to the EU industrial value chains and strategic sectors, particularly with regard to the green energy transition. Currently, the EU domestic supply of primary CRMs is below 3% for many important commodities. To obtain an improved understanding of the EU’s critical raw materials potential, discover new ore deposits and thereby increase the internal sourcing of CRMs and secure its raw materials autonomy, the EU aims to boost the exploration and production of CRMs. Orthomagmatic mineral systems host important green transition (critical) raw materials (GTRM) including Ni, Cu, Co, V, Ti, Cr and platinum-group elements (PGE). There are currently only 2 mines in operation producing these metals in the EU, though there is potential for additional mines in several EU countries. This project is designed to develop socially and environmentally sustainable means of exploration for orthomagmatic CRMs. We will apply, for the first time in the EU, the Mineral Systems Approach to guide exploration for orthomagmatic CRMs. We will thereby generate improved ore models for orthomagmatic mineral deposits which will be translated to mappable exploration criteria to delineate areas of high exploration potential, from regional scale to local scale. Through collaboration between geosciences and social sciences the project will also develop methods to promote social awareness of the importance of responsible exploration and mining. Further, we will map the exploration and production potential of CRM in the EU and key CRM supplier countries. Our research will be conducted at five reference sites in Finland, Portugal, Poland and the Czech Republic representing different geological, social and environmental conditions. The ultimate goal is to promote responsible sourcing of CRMs in the EU and diversify the supply from third countries, thereby securing the continued supply of CRMs for EU industries.</p>			

P20	Agile Exploration and Geo-modelling for European Critical Raw materials	AGEMERA	webpage
Call: HORIZON-CL4-2021-RESILIENCE-01-06 - Innovation for responsible EU sourcing of primary raw materials, the foundation of the Green Deal (RIA)			
Contact person: Jari Joutsenvaara, University of Oulu		Email: via cordis	
Start Date: 1/8/2022		End date: 31/7/2025	
<p>Project Description: Novel methods and technologies are needed to find critical raw materials (CRMs) that will transform Europe into a low-carbon, digital economy, while meeting environmental, economic and societal requirements. The EU-funded AGEMERA project will perform local geological and geophysical surveys to map CRM resources in six EU Member States and Zambia. It will exploit a broad range of data to enhance the genetic mineral system models of deposits that contain CRMs, such as lithium and cobalt. The project aims to reach five million citizens by 2030 through various dissemination activities, including courses for schools and universities. In addition, an open-access database will compile social, cultural, environmental and economic concerns about mining and mineral exploration.</p> <p>New environmental, economic and societal requirements in the EU's transition to a low-carbon and digital economy call for innovative methods, technologies and techniques to be developed and applied in mineral exploration. To unlock the CRM potential in Europe, AGEMERA will conduct local state-of-art geological and geophysical surveys over a total of ~4,700 km² in order to detailly map CRM resources in 6 EU countries and 1 third country (Zambia). The geophysical field trial surveys will demonstrate three novel non-invasive survey methods (at up to a TRL5) based on remote sensing and related data analysis: 1) passive seismic methods, 2) multi-sensing drone system combining magnetic, radiometric and electromagnetic sensing, and 3) muon-based multidetector density detection system. The project will use data from open-access databases (e.g. European Geological Data Infrastructure, EGDl), the data collected from the field by project geoscientists, and various geophysical survey methods to refine and improve the genetic mineral system models of the various deposit types known to contain lithium, cobalt, molybdenum, vanadium, PGMs, niobium, tantalum, bauxite and REE. The project will introduce the existing guidance for the application of UNFC for mineral resources to the partner countries through stakeholders, courses and public events. The project will survey citizens in the project countries, create a CRM educational package targeting schools and universities, publish an online CRM serious game, organise public events, as well as online news flashes, with the aim to reach 5,000,000 citizens by 2030. The project will create an open-access SoftGIS analysis and database on people's social, cultural, environmental and economic concerns related to mining and mineral exploration. These data enable the creation of socio-economic potential maps to be used in parallel with the geological potential maps, consequently ensuring a basis for socially accepted and sustainable mining.</p>			

5. AVANTIS' participation in the Cluster Hub for production of raw materials for batteries from European resources

In the context of clustering activities, AVANTIS has joined, as a full member, the Cluster Hub for production of raw materials for batteries from European resources (<https://www.materialsforbatterieshub.eu>). The cluster hub is a collaboration-driven community which shares the same mission, to foster the knowledge necessary to drive a more sustainable and circular production of raw materials for the European battery industry. Currently the hub has 16 project members and several other projects have already applied for membership. It is worth mentioning that the hub participates in high profile event (i.e. Raw Materials Week), which will assist the objectives of AVANTIS.

Figure 2: The cluster hub's member



The image shows a screenshot of the Cluster Hub website. The browser address bar displays [materialsforbatterieshub.eu](https://www.materialsforbatterieshub.eu). The website header includes the Cluster Hub logo and navigation links: HOME, ABOUT, PROJECTS, NEWS & EVENTS, CONTACT. The main banner features the text "Cluster Hub for production of raw materials for batteries from European resources" with a "DISCOVER MORE" button. Below the banner, a section titled "THE CLUSTER" displays a grid of 16 member logos: CROCODILE, RHINOCEROS, BATRAW, FREE4LiB, R, LICORNE, a battery icon, eNiCoN, RAW MINA, CRM geothermal, METALLICO, EXCEED, Life DRONE, LITHOS, CICERO, and AVANTIS. At the bottom, a grey box contains the text: "Producing critical raw materials in Europe for a safe and sustainable battery value chain" and a paragraph describing the Cluster Hub as a knowledge exchange ecosystem.

THE CLUSTER

Producing critical raw materials in Europe for a safe and sustainable battery value chain

The Cluster Hub "Production of raw materials for batteries from European resources" is a knowledge exchange ecosystem where partners involved in different European projects can "prototype" ideas in reality. The platform facilitates collaboration among research institutes, industry and innovation stakeholders driving the recycling of batteries and the production of raw materials for battery applications from primary and secondary resources available in Europe.

6. Conclusion

This deliverable aims to present all related information regarding EU-funded projects associated with AVANTIS, including the project title, acronym, webpage, related call, contact person's name and email, starting and ending dates, and project description. It involves a detailed description of the procedures for identification of the projects, the procedures towards contacting them, having as a goal to foster joint clustering initiatives. The clustering activities have been initiated with the participation of AVANTIS in the Cluster Hub for production of raw materials for batteries from European resources, as they described in Section 5.

The related information will be constantly updated, through the subsequent version of the deliverable, with the addition of new relevant projects into the list.