Geological Survey of Finland

2023

EU SuperCluster Lapland Geoconference – October 30–31, 2023, Hotel Santa Claus, Rovaniemi, Finland

Abstracts

Vesa Nykänen, Nick Cook and Juha Kaija (eds)

GTK Open File Research Report 55/2023

Funded by the European Union

GTK

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Edited by Vesa Nykänen, Nick Cook and Juha Kaija

Figures in each abstract are prepared by the author(s) of that specific abstract.

Front cover: EU SuperCluster Lapland Geoconference – Abstracts.
Picture by LGI Sustainable Innovation, Paris, France.

Layout: Elvi Turtiainen Oy

Espoo 2023

Nykänen, V., Cook, N. & Kaija, J. (eds) 2023. EU SuperCluster Lapland Geoconference – October 30–31, 2023, Hotel Santa Claus, Rovaniemi, Finland. *Geological Survey of Finland, Open File Research Report 55/2023*, 212 pages, 69 figures and 9 tables.

The EU SuperCluster Lapland Geoconference brings together representatives from academia, research institutions and industry to discuss important issues related to critical raw materials within the European Union. The SuperCluster Geoconference included 28 talks and 21 poster presentations covering topics related to innovative mineral exploration, earth observation in exploration and mining, environmental, social and governance in exploration and mining, critical raw materials supply, and new frontiers for exploration. The compilation of the extended abstracts of the oral and poster presentations given in the EU SuperCluster Lapland Geoconference forms this proceedings publication of the Geological Survey of Finland.

Keywords: mineral exploration, geology, mining, critical raw materials, sustainable development, European Union

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REUSING SECONDARY MINERAL RESOURCES FOR THE ENERGY TRANSITION: THE PROJECT START EXAMPLE

by

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In an era characterised by environmental challenges and growing awareness of the finite nature of fossil fuels, the need for a global shift from traditional energy sources to clean and sustainable alternatives have never been more urgent. The shift towards these alternatives not only curtails carbon emissions but also reduces air and water pollution, leading to improved public health and a revitalised environment. Additionally, this shift has a wide-ranging impact on various aspects of society, the environment, and global economies, namely: a) Environmental Impact (Climate Change Mitigation, Air Quality Improvement), b) Energy Security (Reduced Dependence on Imports), c) Economic Impacts (Job Creation, New industries, Diversification), d) Technological Innovation (Research and Development, Technological Breakthroughs), e) Global Relations and Diplomacy (Reduced Geopolitical Tensions, Increased Collaborative Efforts), f) Energy Access and

Equity, g) Infrastructure and Urban Development (Decentralisation, Sustainable Cities), h) Natural Resource (land/water) Preservation, i) Long-Term Sustainability (Extended Resource availability and Environmental legacy) and j) Carbon emission reduction and policy incentives. All focused in the ambitious objectives of the EU's Green Deal in 2019 and the EU Action Plan on Critical Raw Materials in 2020.

The project START (Sustainable Energy Harvesting Systems Based on Innovative Mine Waste Recycling, Horizon Europe Grant Agreement ID: 101058632, www.start-heproject.com) is contributing to these objectives by researching the feasibility of using secondary resources from mine dumps and tailings. The final goal is to build an innovation ecosystem in the EU related to the development of sustainable tellurium-free thermoelectric (TE) devices with the highest economic efficiency, suitable to be applied in waste heat recovery systems, such as the heat rejected from industrial processes, and in other applications including wearables. The START project is formed by a consortium of 15 entities from 11 European countries, has a duration of 4 years and a co-funded budget of around 9.2 M€ (Fig. 1).

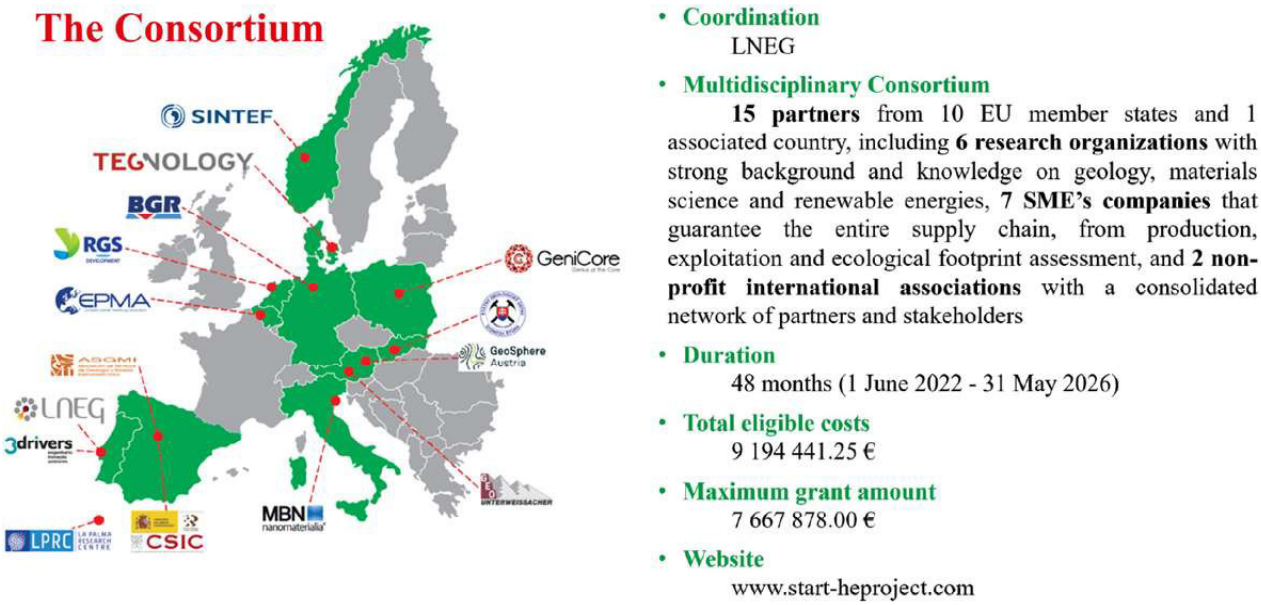

Fig. 1. START project key facts.

PROJECT SCOPE

Current commercial thermoelectric devices incorporate p-type semiconductor materials that are produced from expensive and rare elements, namely tellurium, which is toxic and predominantly sourced in China. As an alternative approach for the replacement of the tellurium-based p-type semiconductor materials, START proposes a unique technological solution and value-chain based on a "waste material-waste heat to power" methodology. This approach implies the production of sulphide p-type semiconductor materials that will incorporate, amongst others, discarded mining waste sulphides, mainly consisting of the tetrahedrite-tennantite mineral series. Thus, the project concept also includes the stages of material processing, device design and production, testing and validation (Fig. 2). The aim is to produce a TE device reaching TRL6, with the START TE device demonstrated in industrial processes. As a first step, several historical European mining sites have

been targeted for collection of tetrahedrite-tennantite minerals, namely: a) Austria: Leogang (Nöckelberg, Barbarastollen) and Schwaz (Sandpocher, Antonihalde, Sigmundhalde), b), Germany: Rammelsberg mine, Bergwerkswohlfahrt mine, c) Portugal: Neves Corvo, Barrigão and Brancanes mines, d) Slovakia: Rožňava mine, e) Spain: La Sierrecilla, El Corriellu, Peña Negra, Torres de Albarracín, Lanteira mines, amongst others. The collected minerals are undergoing processing and will feed the material processing in the upcoming stages.

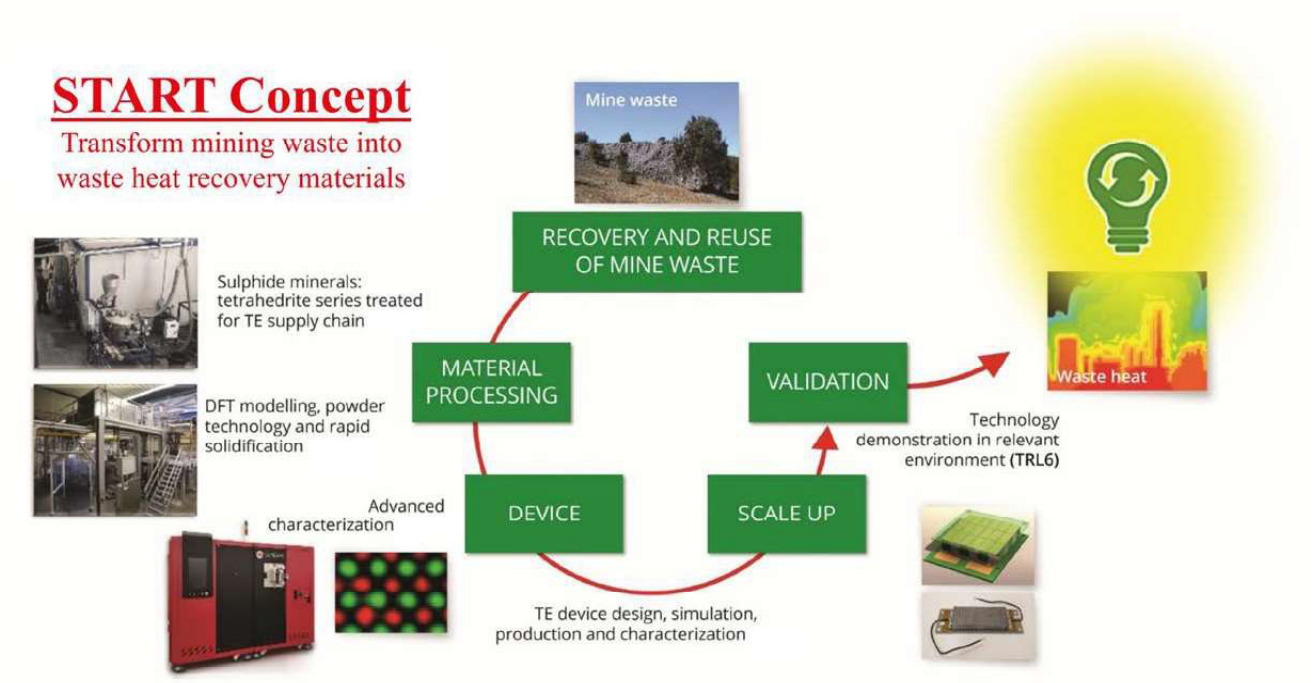

Fig. 2. Project concept with description of the main activities being implemented.

Fig. 3. Some of the environment and locations where samples were collected for the START project.

PROJECT IMPACT

The START project proposes the use and transformation of the tetrahedrite-tennantite mineral series into thermoelectric materials for waste heat recovery. This represents an opportunity for an efficient use of the EU's discarded secondary resources, reducing its waste and dependency on third countries and offers a competitive solution for the development of renewable energy ecosystems in a sustainable manner using thermoelectric systems. Thus, START expected impacts are as follows:

- Development of a resilient and sustainable critical raw materials supply chain for thermoelectric-based renewable energy ecosystems.
- The incorporation of p-type thermoelectric materials produced from tetrahedrite-tennantite minerals collected in mine wastes, which is an earth-abundant mineral and available in European mine wastes, offers a simple and economically competitive solution and increase the EU raw materials supply capability and added value. Recycling and usage of mine wastes, more specifically of the tetrahedrite-tennantite mineral series that presently have no useful use and have low economic value, to produce new products will positively influence the resilience of the EU raw materials supply capability by reducing the EU dependency on raw material imports from third countries.
- Creation of new market opportunities for mineral raw materials sustainably produced in the EU. The conversion of secondary mineral resources, collected in European mine wastes, into useful and value-added products will create new market opportunities.
- Environmental impact. Reprocessing of sulphide-containing mining residues, will act as remediation of potential acid mine drainage. Additionally, the use of energy harvesting systems offers a contribution to the reduction of fossil fuels consumption with a great impact on the increase of the overall efficiency of energy production and consumption systems, as well as on the reduction of the greenhouse gas emissions.
- Innovative value chain. START will create an innovative value chain linking secure European mineral resources and renewable energy harvesting production. The mining industry, which is increasingly aware of its environmental footprint, as well as the materials and energy harvesting system producers, which rely on more abundant materials while maintaining high performance, will benefit strongly from the project outcomes.
- Create new circular business models with a convincing and quantified socio-economic impact. START will establish a new rapid growth commercial ecosystem that will attract new stakeholders exploiting market opportunities for replication and market development and an opportunity for European SMEs to join in. The START commercial ecosystem will be maintained through the creation of a new business entity, the START Service Company.

CONTRIBUTION TO CRITICAL RAW MATERIALS ACTION PLAN

The START project contributes to the implementation of the following actions of the EU Action Plan on Critical Raw Materials:

> Action 3 – Launch research and innovation on waste processing, advanced materials and substitution of critical raw materials.

Action 4 – Map the potential supply of secondary critical raw materials in Europe and identify viable recovery projects.
Action 5 – Identify priority mining and processing projects for critical raw materials in the EU.
Action 8 – Develop research and innovation projects to reduce environmental impacts of raw materials extraction and processing.
Action 9 – Develop strategic international partnerships to secure a diversified supply of sustainable critical raw materials, starting with pilot partnerships with Canada, interested countries in Africa and the EU's neighbourhood. (partially)

CONTRIBUTION TO THE UN SUSTAINABLE DEVELOPMENT GOALS

START also contributes to the following UN Sustainable Development Goals, namely:

Goal 7 – Affordable and clean energy
Goal 9 – Industry, Innovation, and infrastructure
Goal 11 – Sustainable cities and communities

FUNDING AND ACKNOWLEDGEMENT

START project (project number: 101058632) is co-funded by the European Union. Views and opinions expressed are however those of the authors only and do not necessarily reflect those of the European Union or the European Health and Digital Executive Agency. Neither the European Union nor the granting authority can be held responsible for them.