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## Challenges in the sampling and characterisation of mining residues for CRMs recovery

**Adriana Guatame-Garcia**<sup>1</sup>, Mike Buxton<sup>1</sup>, Sara Kasmaee<sup>2</sup>, Francesco Tinti<sup>2</sup>, Rachel Horta Arduin<sup>3</sup>, Aina Mas Fons<sup>3</sup>, Françoise Bodenan<sup>4</sup>, and Joachim Schick<sup>5</sup>

<sup>1</sup>Department of Geosciences and Engineering, Delft University of Technology, Delft, Netherlands

<sup>2</sup>Department of Civil, Chemical, Environmental and Materials Engineering, University of Bologna, Bologna, Italy

<sup>3</sup>Université de Bordeaux, Bordeaux, France

<sup>4</sup>Bureau de Recherches Géologiques et Minières, BRGM, Orléans, France

<sup>5</sup>Innovation Center for Extractive Metallurgy, Orano Mining, Bessines-sur-Gartempe, France

The recent Circular Economy Action Plan for Europe<sup>1</sup> considers mine waste a secondary source of minerals. These deposits contain potentially economic concentrations of Critical Raw Materials (CRMs), such as Al, Li, Co and REE, which are strategic for the global economy and energy transition. However, there are significant knowledge and technological gaps that hinder their successful recovery. The INCO-Piles 2020 project<sup>2</sup> is currently working on the recapitulation, establishment and development of innovative technologies for the sustainable extraction of CRMs from the residuals of mining activities, focusing on Regional Innovation Scheme (RIS) strategic areas. The project includes the definition of potential applications, best practices, and the promotion of technology transfer through round tables that count with international experts' participation.

The first Round Table, a hybrid event held in December 2020 with 73 experts from 23 countries, addressed the challenges in recovering CRMs from tailings. The discussions were based on three topics: (1) challenges in sampling and characterisation from mining residue, (2) extraction and processing challenges, and (3) economic and environmental challenges. Regarding the first topic, one of the most significant issues is the inherent heterogeneity of mine waste deposits, which is a product of the mine processing and deposition methods, and the post-depositional weathering reactions. The lack of historical data, particularly for old deposits, hampers the understanding of such processes. A second challenge concerns the specific type of information required for assessing the CRMs potential. Representative geochemical and mineralogical data must be collected and interpreted at different scales (i.e., from individual minerals to tens of meters tall waste rock piles and tailings). The collection of representative samples faces issues related to the accessibility to the mine waste sites, the coverage and the sample contamination (i.e., material mixing) related to sample recovery methods. The scalability can be addressed by a combination of laboratory analyses, in-the-field surveys and remote sensing techniques. Current innovations in the combination of modern analytical instruments for geochemistry and mineralogy (e.g., pXRF, LIBS and portable infrared spectrometers) and the implementation of

machine learning and artificial intelligence techniques will contribute to closing the knowledge and technology gaps.

Lastly, the discussions included the potential hazards faced during the characterisation and re-intervention of old-sites. Well-known mine wastes issues related to human health, environment and license to operate that can hinder a characterisation campaign must be properly considered before the commencement of a CRMs recovery project. The participants also identified transversal challenges for the three discussion topics, such as the need for regulation and professionals with an appropriate background.

All the insights discussed during this First Round Table will serve as a baseline for defining the best practices for characterisation and sampling of CRMs in mine wastes and contributing to increasing the sustainability in the supply of mineral resources and improving old mining sites' environmental quality.

<sup>1</sup> EU Circular Economy Action Plan <https://ec.europa.eu/environment/circular-economy/>

<sup>2</sup> INCO-Piles is a two-year project funded by EIT RawMaterials. More information: <https://site.unibo.it/inco-piles-2020/en>