Coupling Life Cycle Assessment and modelling tools to inform sustainable mineral resource management

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The need for decarbonisation cannot be decoupled from an increase in demand for critical metals and minerals required for the green energy transition. The mining sector is, however, a major user of scarce resources, i.e. water and energy. Important environmental aspects must therefore be carefully considered to ensure mineral beneficiation processes adhere to sustainability principles. Life Cycle Assessment (LCA) is a well developed tool to assess environmental impact, but challenges remain regarding its application in mining and mineral processing operations. While the importance of coupling process simulators with LCA has been highlighted in the literature, applications of such an approach in mineral processing are scarce. Indeed, the limited use of LCA in the mining industry contrasts with its wide applicability in other industrial sectors. In particular, adequate inventory information required for LCA studies is usually not readily available.

This PhD project will further develop the coupling between process simulation and LCA. The aim is to develop a robust and holistic framework to support well-informed design of mineral processing chains, in order to optimise technical, economic and environmental performance. The integration of process simulation software and LCA will allow several case studies to be considered, with an emphasis on metals critical to renewable energy technologies.

The modelling approach will account for variabilities in the mineralogy of the mined ore and in the plant performance (with uncertainty propagation). Process simulation will enable to complement existing (and widely used) Life Cycle Inventory databases, integrating data associated with a number of process chains currently not represented. It will also support the accounting of dissipative flows in Life Cycle Inventories of mineral processing chains, and therefore the consideration of more meaningful resource indicators in LCA. In addition, the holistic assessment will be supported by the combination of LCA and Multi-Criteria Decision Analysis tools to account for a variety of indicators that are often in conflict with each other.

The PhD student working on this project will join a vibrant and multidisciplinary research group in the Department of Earth Science and Engineering at Imperial College and will work closely with colleagues at the French Geological Survey (BRGM), where they will have the opportunity to spend time during t heir PhD.

Previous experience with the LCA methodology and/or mineral processing modelling is highly desirable.

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