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Life Cycle Assessment (LCA) has been recently intensively used to quantify the environmental impacts of metal production, in particular considering copper. In this context, this study aims at coupling simulation of mineral processing with LCA to assess the environmental performance of metal production in a life cycle perspective. Process simulation builds on reported experimental data measured from a complete sampling campaign, so that process flowrates and composition for all the water and material circuit streams are assessed. However, standard process simulation usually primarily focuses at resource efficiency (how much metal is recovered?). The coupling with LCA is implemented to additionally account for the process "eco-efficiency" in the assessment of its performance (what are the environmental impacts that the process induces?).

Coupling process simulation and LCA could have several benefits: it would allow providing a consistent view of the whole process chain, in particular by covering the upscaling step and filling the data gaps. The coupling of both methods is applied to the case of a process chain for copper production from a black shale rich ore. This process chain includes standard concentration operations (comminution, classification and flotation) and further operations in hydrometallurgy (bioleaching and metal recovery).

Experimental work has namely been performed with a view to optimizing the recovery of metals in some flotation steps. In this study, the mass balance is calculated, operation by operation. A process simulation is performed by using the process simulation software USIM PAC™, including complete flow sheet definition, choice of models for the unit operations and adjustment of the simulator to the operation mass balances. For the simulation outputs to be complete for the derivation of the process chain Life Cycle Inventory (LCI), the models already implemented in USIM PAC™ are complemented by additional models that link emissions to the environment and consumptions of reagents to the processed ore all along the process chain. The inputs/outputs relative to each operation are accordingly calculated through mineral processing simulation. These data are further used as inputs to LCI modeling and subsequent Life Cycle Impact Assessment, by using standard LCA database software (i.e. ecoinvent & SimaPro). The calculated environmental impact indicators enable to determine the key environmental issues related to the developed process chain, in particular through a hotspot analysis (highlighting which operations and which emissions are the highest contributors to the environmental impacts of the analyzed system). Finally, the potentialities for applying simulation of mineral processing coupled with LCA in support to the environmental assessment of mineral processing chains is demonstrated by modeling the effect of ore changes and technological innovations through sensitivity analysis, by taking into account their related specific parameters when performing their environmental assessment.