Sourcing of critical elements and industrial minerals from mine waste to solve the mine waste problem

B. DOLD[1]

[1]Luleå University of Technology, Luleå, Sweden; Bernhard.Dold@ltu.se

In metal mining, in most cases only a minor percentage of the extracted materials are the target elements (e.g. Fe or Al ores 20-70 %, Zn 2-15%, Pb 1-10%, Cu 0.2-6%, REE 0.1-0.5%, Au 1-20 g/t). Thus, the vast majority of the extracted material is defined as waste, which is deposited in disposal facilities like tailings impoundments, lakes or the sea and in waste dumps, or is backfilled into open pits or underground mines. These mine wastes are the source of environmental pollution (through acid and alkaline drainages; oxidic and reductive dissolution) and catastrophic dam failures like recently in January 2019 in Brumadhino, Brazil. These are the key problems leading dirctly to the loss of the social lisence to operate of the mining industry. To minimize the risk from mine waste in the future, its volume has to be reduced. This applies for both, fresh mine waste and historical waste. Latter can still contain important metal contents (specifically the overlooked critical metals like REE, PGE, and battery metals like Co, Ni, Li, Mn), and have therefore a high potential for successful exploration. From a mineralogical point of view, the material extracted in mining can be differentiated in different mineral groups here ordered with decreasing solubility and increasing volume: 1. Sulfates and chlorides < 2. Fe, Al, Mn hydroxides < 3. oxides < 4. sulfides < 5. silicates. Thus, from an environmental point of view, the first 4 mineral groups are the most critical, but contain also most of the economically valuable elements. The major volumes of silicates are non-hazardous and, if separated accurately, can be used as industrial minerals or for construction material. Important efforts are currently under way to find solution to use tailings as filler and binders like geopolymers, replacing the CO_2 emission intensive Portland cement. But also high-tech applications can be found for these materials as for example quartz for solar cell production and glass industry or micas and pyrite for semi-conductors. Automated Quantitative Mineralogy allows nowadays quantifying accurately the different minerals and combined with micro analytical geochemical techniques the element association to each mineral can be quantified. With this information, a sequential separation can lead to different mineral concentrates, which are the resources for different industrial application, allowing to reduce importantly the final effective waste volumne.