

The stability of Cu-sulphides in on-land and submarine mine tailings: Case studies from the Røros and Repparfjord disposal sites, Norway

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Tailings, a residual material after separation of a valuable fraction of an ore, represents an environmental risks such as generation of acid mine drainage (AMD) and leaching of heavy metals. Traditionally, tailings have been deposited on-land, but in several countries including Norway, submarine disposal is common. The potential environmental impact of the tailings disposal strongly depends on the origin of ore mineralization, the mineral composition and the chemical composition of ore and gangue minerals. In this study, we have performed a comparison of field and laboratory observations from two historical Cu- sulphide mine tailing sites in Norway: on-land Røros and submarine Repparfjord tailing disposal sites.

The Røros Cu district, located in eastern Norway, hosts numerous Cu deposits of volcanogenic massive sulphide (VMS) type. The mineralization is hosted by metagraywacke, tuffites, metagabbro, metabasalts. The main ore minerals are chalcopyrite, pyrite, sphalerite and galena (Sandstad et al. 2012). In the period between 1644 and 1977, twelve mines were in production and nowadays numerous piles of mine waste are placed around the former mining sites.

The submarine mine tailings deposited in Repparfjorden are from the exploitation of the stratiform sediment-hosted Cu-sulphide Ulverggen deposit. The mineralization, represented mostly by chalcopyrite, bornite and chalcocite is predominantly hosted by arkosic sandstones, siltstones and conglomerates. Minor amounts of pyrite occurs as well. Calcite and quartz are the major gangue minerals. The Ulverggen deposit was mined from 1972 to 1978/79 and about 1Mt of mine waste was disposed the fjord (Kvassness and Iversen, 2013).

Thermodynamic modelling demonstrated that the stability of Cu sulphides and pyrite is predominantly controlled by the redox potential of the system. In on-land conditions (high redox potential, low salinity, low pH) Cu sulphides and pyrite are unstable. Tenorite is the only stable Cu phase, while pyrite is replaced by Fe hydroxides. In contrast, in anoxic marine conditions (low redox potential, moderate salinity, near neutral pH) the sulphides are more stable.

Ore mineral observations confirmed thermodynamic modelling and showed extensive pyrite oxidation in the mine tailings around the Røros mining area. Tenorite trapped by secondary Fe hydroxides was observed. Mine tailings disposed in Repparfjorden have well preserved bornite and pyrite. Chalcopyrite is partly oxidized in the uppermost part of the tailings, whereas in the deeper portions of the tailings are well preserved.

References

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