Secondary minerals formed in Acid Mine Drainage environment: the case of Libiola mine: characterization and stability

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The sulphide-ore of the Libiola mine (Sestri Levante, eastern Liguria, Italy) occurs as massive-, stockwork- and disseminated-mineralizations within pillow and brecciated basalts of the northern Apennine ophiolites. They mainly consist of pyrite-chalcopyrite mineralizations with minor sphalerite and pyrrothite. Gangue minerals are mainly represented by quartz with minor chlorite, magnetite, hematite, carbonate, and serpentine minerals. The Libiola mine represent one of the most important Italian exploited sulphide-ore, already known in the Bronze Age. Nowadays, the mining area is completely abandoned. Underground and superficial waters are mostly Acid Sulfate Waters, due to active Acid Mine Drainage processes triggered by oxidation of pyrite-chalcopyrite mineralizations, with high dissolved concentrations of Cu, Al, Zn, Ni. Mine wastes are acid generating because they contain a high amounts of partially altered sulphide-rich mineralizations.

Secondary minerals directly form within dumps, streams, and outcropping mineralized bodies through precipitation from contaminated solutions. They are within stream sediments of the creek and stream of the area or on and within waste-rock dumps. In this last setting, they occur as cement waste-rock fragments and as coating on rock surfaces or between the mineralized clasts, where they partially or completely replace both ore and gangue minerals. They are mainly represented by iron oxyhydroxides and oxyhydroxysulphate (such as goethite, ferrihydrites, lepidocrocite, hematite, and schwertmannite), sulphates (such as jarosite, brochantite, gypsum, epsomite, bieberite, bonattite, siderotil, halotrichite, chalcanthite, pickeringite, melanterite, copiapite, hydrowoodwardite, and basaluminite) and Cu-carbonates (such as malachite and azurite). Locally, native copper, chrysocolla, and alunogen are abundant as fracture fillings or as coating and occur in both superficial and underground settings.

The presence of these minerals and the evaluation of their stability fields are of environmental concerns because they can play an important role in attenuating the contaminant load of mine effluents. Stability of sulphate deposits and ochreus phases have been studied in laboratory leaching experimentswith focus on pH changes and metal release.

The comprehensive overview of the mineralogy and geochemistry of secondary minerals that formed in the Libiola mine, provide a detailed mineralogical knowledge about the genesis and the evolution of the authigenic secondary phases. The knowledge about the types of mineral phases allow to understand the short and long-term fate of the ecotoxic metals, initially studies in this work. All these information are paramount parameters for any predictive models and also to define effective remediation strategies

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