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Past and present climate controlling the formation of Zn-(Pb) supergene Nonsulfide ores

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Supergene Nonsulfide Zn-(Pb) deposits (NSZ) are a relatively common ore type [1][2]. They were the earliest source of mined zinc, and in recent years have enjoyed a renewed interest due to new processing technologies. These deposits contain hydrated zinc silicates and carbonates such as hemimorphite and hydrozincite, clay minerals as sauconite, or the most common carbonate smithsonite. Lead can be contained in cerussite and/or anglesite. The best example of an economic supergene Nonsulfide Zn deposit is the Skorpion operation in Namibia [3].

Supergene deposits represent the product of oxidation in situ of primary sulfide bodies and of their mobilization and subsequent deposition in karstic cavities or in alteritic covers, after mechanical and/or chemical transport. Supergene alteration of primary Zn-(Pb) sulfides, eventually followed by precipitation of secondary ore minerals, represents a peculiar case of weathering process, which is mainly controlled by climate. Therefore, to detect the mechanisms associated with the weathering (or paleo-weathering) phenomena plays a crucial role in understanding this kind of deposits. The most important factors for the genesis of economically important Zn-(Pb) Nonsulfide deposits are [1]:
a) the existence of a pre-existing sulfide concentration, with an important content of Fe-sulfides, necessary for the generation of acid fluids; b) strong uplifts and/or a constant lowering of the water table (related to local or global phenomena); c) conditions favouring deep seasonal weathering; d) permeable host rocks, allowing groundwater circulation; e) effective traps to concentrate the newly formed minerals. We can easily assume that the formation of Nonsulfide Zn-(Pb) deposits is also primarily controlled by two main factors: protore composition and structure of the wall rocks. In particular, we need to combine and decode the effects of tectonics, climate and hydrogeology, which cause the dissolution of primary sulfides together with the role of (mainly) carbonate host rocks with their buffering effect. Another problem regards the temporal constrains of the oxidation processes, which have generated the Nonsulfide ores and their preservation under evolving climates.

Recent developments in processing technologies for the treatment of NSZ deposits (acid-leaching, AmmLeach®, pyrometallurgy, electrowinning) have caused a revival in exploration for NSZ ores throughout the world. Nevertheless, at several mines the processing plants are underperforming relative to initial expectations, which has resulted in delays in the development of NSZ deposit exploitation. Capital and operating costs, as well as metal recoveries have not completely met the feasibility study expectation, and several NSZ resources are still battling with technical and/or political issues. However, many technical problems can be mitigated by a better identification of the mineralogical association of the metallic and nonmetallic minerals, whose precipitation was differently controlled by local climate and nature of the host rock [2]. This should be a fundamental step in the exploration of NSZ deposits, because their extraction process is highly sensitive to mineralogy. Therefore, before metallurgical processing methods are chosen, it is necessary to take into account both the physical and chemical properties of the ores and their gangue minerals.

References

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