Genesis of Manganese Ore Deposits of the Imini District (Morocco)

by

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SUMMARY. — Metallogeny aims to reconstruct the genesis and distribution of ore deposits, focusing on their relationships in space and time. For decades, Europe is highly dependent on imports of mineral resources. Characterizing and quantifying the petrological, mineralogical and chemical contents of the ores outside Europe enable to recognize their economic potential. Manganese is a little-known element occurring in natural environments in the form of silicate (Braunite; Mn_{7}SiO_{12}), carbonate (Rhodocrosite; MnCO_{3}) or oxide (Pyrolusite; MnO_{2}). It is the 12th abundant element in the earth crust and the 4th produced element worldwide in 2011 (International Manganese Institute). It holds a major role in the world market due to its use as alloys in steelmaking processes (90% of the Mn uses).

The large amounts of Mn-oxides occurring along the WSW-ENE 30 kilometers ore belt give to the Imini district a key role on manganese production in Morocco with raw concentrations reaching more than 72-88 wt. %. The three stratabound layers of approximately 1 meter-thick, trapped in a 14 meters-thick dolostone of Cenomanian-Turonian in age (100.5 to 89.8 million years old – hereafter noted Ma), show mainly pyrolusite (MnO_{2}) and small amounts of hollandite group minerals [(Ba,K,Pb)Mn_{8}O_{16}], romanechite [(H_{2}O,Ba)_{2}Mn_{9}O_{10}] and lithiophorite [(Al,Li)MnO_{2}(OH)_{2}]. These minerals are responsible of the high grade of the deposits without any major contamination such as of Fe, Si, P, S … By coupling field observations, microscope analyses and X-ray diffraction we can provide some evidences about the ore formation. Deposition and concentration of manganese oxides follow a two steps mineralizing sequence with (1) a replacement of the host rock dolostone followed by (2) the formation of banded concretions in an open system enhanced by fluid circulation. These mineralogical observations coupled with geochemical and chronological data indicate a multistage formation in a high oxygenized karstic environment. After dolostone formation (100.5-89.8 Ma), the mineralized layers were formed in several stages according to Ar-Ar and K-Ar ages of ~70 Ma, ~50-45 Ma and ~20-14 Ma. The manganese oxide minerals of the Imini district may occur coevally to two tectonic phases in the Atlas Mountain of Morocco. Although the source of Mn is still debated, the WSW-ENE orientation of the ore belt may indicate a tectonic link to the mineralization. This structural relationship and the more permeable character of the host rock dolostone compared to surrounding rocks explain the location of manganese oxides in the Imini area.