

## **Mineralogy, geochemistry and genesis of Manganese ores of Pranghar area, Mohmand Agency, FATA, Pakistan**

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The Study area is a part of the Kot-Pranghar Mélange Zone, which is comprised of rocks of ophiolitic sequence and is located at the northern tip of the Indian plate in the vicinity of Indus Suture Zone (ISZ) or Main Mantle Thrust (MMT) along which a thick imbricated mélange zone of greenschist, blueschist, and serpentinite intervenes between the Kohistan Arc and the Indian Plate. The manganese (Mn) ores of Pranghar are present at Nasir, Razim Dherai and Manrai. These occur as medium-bedded lenses/pods up to a meter thick and several meters in lateral extension. These Mn-ores are associated with serpentinites, greenschists, epidote-amphibolites and quartzites. Medium to thick-bedded quartzite generally overlies and the epidote-amphibolite underlies the manganese ore bodies in the study area. Mineralogically, the manganese ores are mainly composed of braunite with subordinate amount of hematite in the fine-grained quartz matrix. The proportion of hematite is highly variable. It is found in higher amount in the ores of Razim Dherai and Manrai areas. The occurrence of braunite is also confirmed by the x-ray diffractometer.

Geochemically, these deposits are different in terms of MnO and Fe<sub>2</sub>O<sub>3</sub> concentration. Nasir area manganese ores have higher concentration of MnO ranging from 20.23 to 42.88 wt% as compared to that of Manrai-Razim Dherai (i.e., 11.04 to 40.60 wt %) while Fe<sub>2</sub>O<sub>3</sub> is present in higher amount (i.e., 3.05-23.72 wt%) in the Mn-ores of Razim Dherai and Manrai areas as compared to that of Nasir area (i.e., 0.37-2.87 wt%). Rest of the major oxides exhibit more or less same concentration in the Mn-ores of these areas. Trace elements such as Pb, Zn, Cu, Cr, Ni, Co are also having more or less similar amount in all these three Mn-Ore bodies. Various discrimination diagrams as proposed by several workers in order to distinguish manganese ores of various origins have been used to understand the hydrothermal or hydrogenous input during the formation of these Mn-ores. By plotting of the major and trace elements data in these diagrams, it is concluded that the hydrothermal solution is responsible for the formation of the studied ores.

Based on field evidences and geochemical and mineralogical data it is suggested that the studied Mn-ores formed due to exhalation of hydrothermal fluid along the mid ocean ridge in the Tethys Ocean where it was precipitated as concordant bodies due to physiochemical changes. Later on these deposits were obducted onto Indian plate continental landmass, as a part of ophiolitic sequence during Himalayan orogeny. It is also found that Mn ore of Nasir area has more economic significance than the Manrai-Razim Dherai areas.