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Geochemistry of iron-oxide ore and country rocks from the Takab region, North Western Iran

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Most of the iron ore deposits are located in the NE and central Iran, while the late Proterozoic iron ore deposits from the NW part (Takab region) are little known. They consist of (1) massive magnetite in metavolcanic rocks and (2) disseminated, layered and nodular ore types in calcschists.
1-The massive magnetite contains 55 wt.% $Fe2O_3$, 22.5 wt.% FeO, 1.7 wt.% $Al2O_3$, 30-88 ppm for Cu, Co, W, Zn and Zr; 15-25 ppm for V and Sr; <10 ppm for As and U. The epidotized and amphibolized metavolcanic host contains 54 wt.% SiO_2, 10 wt.% $Al2O_3$, 3.2 wt.% $Fe2O_3$, 6.6 wt.% FeO, 7.7 wt.% MgO, 8.8 wt.% CaO and 3.2 wt.% Na2O.Traces are higher than in the ore, 70-270 ppm for Cr, Ni, V; 170-440 ppm for Sr and Ba. As and U are similar.
2-The disseminated, layered and nodular type iron ores occur in calcschists rich in chloritized biotite. The calcschists contain 20 wt.% SiO_2, 1.2 wt.% $Al2O_3$, 0.4 wt.% $Fe2O_3$, 0.4 wt.% FeO and high CaO (42 wt.%), CO_2 (31 wt.%) and Sr (160 ppm) related to calcite. As and U are < 0.5 ppm.
• The disseminated ore consists of euhedral slightly hematized magnetite in a quartz, minor K-feldspar and phengite matrix. The feldspar hosts P (U, Th)-bearing phases, zircon and barite. $Fe2O_3$ (5-15 wt.%) and $Al2O_3$ (0.2-14 wt.%) are inversely correlated. Traces are variable and higher than in the massive magnetite: Ba, 900-2450 ppm; Rb, V, Zr, W, 20-370 ppm; As, 31 ppm; U < 2 ppm.
• The layered ore consists of partially hematized magnetite surrounded by goethite, also present in veins. Magnetite grew around detrital zircon and hosts pyrite relics and droplet-like inclusions of PbS and ZnS. The quartz matrix hosts Mn-Ba-oxides, barite, and rare uraninite. $Fe2O_3$ (12-55 wt.%), FeO (0.56-12 wt.%) and $Al2O_3$ (0.8-0.33 wt.%) are variable. High Ba (15 wt.%) and S (4.6 wt.%) are related to barite. As, V, Zn (80-110 ppm) are higher than in other ore types.
• The nodular ore is composed of magnetite -not metasomatized- and quartz. Magnetite includes phosphates, Mn-Fe carbonates and uraninite. Magnetite contains high $Fe2O_3$ (60 wt.%) and FeO (11 wt.%) and low $Al2O_3$ (0.1 wt.%). Pb, Zn (1000 ppm) and Cd (60 ppm) are high, Ba low (<2000 ppm), As and V similar than the other ore types.
The massive magnetite shows no Eu anomaly and a positive Ce anomaly, while its metavolcanic host has a strong Eu positive anomaly. The three iron ore types from calcschist have similar REE patterns with positive Eu and negative or no Ce anomalies. The calcschist has a negative Ce anomaly. The Ba richest layered ore is poorest in LREE. These results confirm the previously proposed scenario based on petrology and ∂56Fe data (Orberger et al. 2017, 2018): A hydrothermal (volcano-) sedimentary environment includes the influx of Ba and S in some layered ores, while Pb and Zn are preferentially related to nodular ore.