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Geochemical investigations and Fluid inclusion studies on iron ores from Qatruyeh area, Sanandaj-Sirjan zone, SW Iran: implications for a hydrothermal-metasomatic genetic model

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The Qatruyeh iron deposits are located in the eastern edge of the NW-SE trending Sanandaj-Sirjan metamorphic zone of southwestern Iran and are hosted by a Late Proterozoic to Early Paleozoic sequence dominated by metamorphosed carbonate rocks. The ores occur as layered bodies, with lesser amounts within disseminated magnetite- and hematite-bearing veins. Geochemical analyses of the high-field strength, large ion lithophile, and rare earth elements (REE) indicate that mineralization within the low-grade layered magnetite ores was related to magmatic process accompanied by Na-Ca alteration. The stage is shown by metasomatic replacement textures, gradational contact between layered magnetite and host rock and mineral assemblages of actinolite + titanite + siderite + tourmaline (dravite) + quartz + paragonite. Chemical analyses on layered magnetite show Zn, Cr, LREE and Co/Ni ratio were enriched, whereas V and HREE were depleted.
Subsequent to formation, low-temperature hydrothermal activity produced hematite ores with associated propyllitic-sericitic alteration with hematite (specularite) + chlorite + epidote + muscovite + quartz assemblages.
The metacarbonate host rocks are LILE-depleted and HFSE-enriched due to metasomatic alteration. REE were relatively immobile during host rock alterations. Microthermometric analyses generally, have been described and measured only on primary inclusions of two-phase liquid +vapor (type A), and two-phase vapor +liquid with (type B). Type A inclusions are dominated by more than 80 vol % of H2O at room temperature. The first ice temperature of melting (Tm) often occurs around -24.5° to -19.5° C. Salinities determined by last ice Tm were 3.5 to 15 weight percent NaCl equivalent (size of inclusions between 2.5 and 15μm) for inclusions trapped in whole quartz samples. The average of homogenization temperature (Th) values change between 300 and 345°C and Tm measurements range from -11.3° to -3.5°C. Homogenization temperature exists for primary types (A) of fluid inclusion may indicate episodes of hydrothermal activities in mesothermal systems for Fe deposits in this region.
Type B inclusions, characterized by much more gas bubble within an aqueous liquid are commonly found in all selected samples. Type B inclusions are dominated by more than 60 vol % H2O-CO2 at room temperature. In the Type B inclusions liquid-CO2 homogenize to vapor in the temperature range 396° to 410°C. A general increase in Th values is observed for Type B inclusions in comparison to Type A. Values of Tm of type B inclusions fall within a narrow range from -54.9 to -55.4oC. Salinities determined by last ice Tm were 2.8 to 3.9 weight percent NaCl equivalent.
These fluids consist of mixtures of H2O and CO2, the most common fluids released during metamorphic reactions. Fluid inclusion data indicate that the ore forming fluids at Qatruyeh were CO2-bearing, low to moderately saline, NaCl-MgCl2-CaCl2-H2O rich fluids.
Fluid mixing, cooling and effervescence played an important role in the formation of the Qatruyeh deposits.
Therefore, The range of homogenization temperatures, presence of CO2 in quartz fluid inclusions and an increase in pH indicate that the mixing of fluids and reaction with dolomitic-marble host rock were the most important mechanisms for deposition of magnetite.