Geochemical characteristic of magmatic Fe-Ti-oxide ore deposits of Chhotanagpur granite gneiss complex, eastern India

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The Fe-Ti-oxide ore deposits occur in the south-eastern part of Chhotanagpur Granite Gneiss Complex (CGGC), a Proterozoic mobile belt of eastern Indian shield. The east-west trending ore deposits are present as discontinuous lensoid bodies hosted within gabbro-noritic rocks. The deposits consist of Ti-magnetite, ilmenite and magnesio-hercynite cumulates. The magmatic origin of this deposit is identified by Ti vs V diagram [1]. Presence of magnesio-hercynite cumulate crystals along with Ti-magnetite and ilmenite, make this deposit different from standard magmatic magnetite deposit. The Fe-Ti-oxide ores contain 65.6 – 72.6 wt % Fe_2O_3 and 19.25 – 21.3 wt % TiO_2 along with 3.61-5.02 wt% Al_2O_3. Petrographic study and trace element signature in the ore minerals indicate co-crystallization of ilmenite, magnetite and syn to late crystallization of magnesio-hercynite. Positive correlations between compatible elements like Fe, Co, Al, Mg in ore minerals indicate similar trend of elemental fractionation during crystallization. The V contents of the Ti-magnetites of the studied ore range from 3165 to 3726 ppm which indicates crystallization at higher fO_2 condition (FMQ +2 to FMQ + 3.5). The composition of melt in equlibrium with ore deposits has been calculated by equilibrium distribution method (EDM) [2]. In the equlibrium melt, negative Eu anomaly indicates plagioclase fractionation . The chondrite normalized REE pattern of equilibrium melt shows variably enriched LREE (La/Yb_{cn}=3.5-47.5) and slightly depleted HREE pattern (Gd/Yb_{cn}=0.97-2.87). HREE depletion in residual melt is possibly the result of retention of garnet in the mantle source during partial melting. The equilibrium melt is likely to have generated by low degree of partial melting of garnet peridotite as evident by high values of (8.9 to 119.06) $(Ti/Y)_{cn}$ ratio. In Zr/Ti vs Nb/Y diagram [3], the calculated equilibrium melt compositions lies mostly in the transitional field between alkali basalt and foidite, and also in foidite field. Moreover, the normalized trace element pattern of the equilibrium melt shows significant similarity with tephrite, alkali basalt and foidite melt.

[1]Nadoll (2014) Ore Geology Reviews 61: 1–32; [2]Bedard (1994) Chemical Geology 118:143-153; [3] Pearce (1996) Geological association of Canada, 12:79-113