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Geochemistry of Fe-Ti oxides and related Ni-Cu-Fe sulfides from the Tete Gabbro-Anorthosite Suite, Mozambique: Evidence for magmatic evolution and ore genesis

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The evolution and origin of gabbro-anorthosite suites and related Fe-Ti oxide and Cu-Ni-Fe sulfide deposits have been discussed over the decades without reaching an agreed conclusion. The Tete Suite is the main source of magmatic Fe-Ti oxide ores and Cu-Ni-Fe sulfides ores in Mozambique. The suite is an allochthonous, elongated and sub-horizontal sheet-like Mesoproterozoic intrusive complex consisting of gabbro, leucogabbro, anorthosite, Fe-Ti oxide ores, minor pyroxenite and several dolerite dikes. The Tete Suite is in tectonic contact with the basement rocks, while overlain unconformably by the Karoo Supergroup. Based on mineral chemistry, we discuss (1) the origin and evolution of the Fe-Ti oxides and Cu-Ni-Fe sulfides, (2) their cooling history, (3) the influence of hydrothermal processes on the suite and (4) a possible linkage between the suite and other intrusions in Mozambique.

The Fe-Ti oxides, mainly ilmenite and magnetite (<5 vol.%), are interstitial to the silicate assemblage of plagioclase and pyroxene, implying a late crystallizing nature. The primary oxide in gabbro, integrated from the composition of host magnetite and exsolved phases, is titanomagnetite with an average chemical composition of 43 wt.% FeO, 34 wt.% Fe_2O_3, 12.6 wt.% TiO_2, 6.8 wt.% Al_2O_3, 0.6 wt.% MgO, 0.3 wt.% MnO and 0.9 wt.% V_2O_3. The aluminous-rich nature of this primary oxide suggests saturation at near 5 kbar.

The suite was subjected to extensive subsolidus re-equilibration during cooling. Subsolidus Fe-Ti oxides, with almost intermediate composition of the magnetite-ulvospinel solid solution, occurring as exsolution lamellae in pyroxene suggest that Fe-Ti rich pyroxene was initially crystallized from Fe-Ti rich magmas.

The Fe-Ni-Cu sulfides (<0.1 vol.%) occur (1) filling the pores and microfractures in magnetite, (2) around silicate and oxide grains and (3) as minor inclusions. Cobalt is present in pyrite (0.07–1.2 wt.%), pentlandite (0.2–4.4 wt.%), pyrrhotite (0.1–0.2 wt.%) and chalcopyrite (380–990 ppm). Zinc is incorporated in pyrrhotite (80–610 ppm) and chalcopyrite (280–620 ppm). Gold is present in pyrite (120–420 ppm), pyrrhotite (120–380 ppm), chalcopyrite (120–240 ppm) and pentlandite (230 ppm). Pyrite shows low ratios of Co/Sb = 12–14, Se/As = 1–4 and Co/Ni = 0.1–5.5, suggesting late-stage hydrothermal overprints.