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SPECIAL COLLECTION: FROM MAGMAS TO ORE DEPOSITS

Association of cumulus apatite with compositionally unusual olivine and plagioclase in the Taihe Fe-Ti oxide ore-bearing layered mafic-ultramafic intrusion: Petrogenetic significance and implications for ore genesis

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Abstract

In many large, layered, mafic-ultramafic intrusions worldwide cumulus apatite commonly occurs in the highly fractionated Fe-Ti oxide-rich lithological units at the top of the intrusions and the associated plagioclase and olivine, if present, have An content <50 mol% and Fo content <40 mol%. These are not true for several Fe-Ti oxide ore-bearing mafic-mafic intrusions in the Emeishan large igneous province, SW China. A good example is the Taihe intrusion, which is described in this paper. In this intrusion the associated olivine and plagioclase are significantly more primitive, containing 69 mol% Fo and 59 mol% An, respectively. MELTS simulation reveals that such unusual association is the result of previous cotectic crystallization of Fe-Ti oxides with silicate minerals during magma evolution under oxidizing condition close to that of nickel–nickel oxide buffer. Supports for this new model include the observed upward decrease in plagioclase An contents coupled by lack of significant change in original olivine Fo contents in the Fe-Ti oxide ore-bearing sequence below the apatite-rich horizon, which is in turn supported by the facts that Fe-Ti oxide crystallization has a counter effect on MgO/FeO, but no effect on CaO/Na_2O in the residual magma and that the addition of Fe-Ti oxides in the cumulus assemblage expedites the arrival of apatite on the liquidus. Our new findings support the interpretation that the oxide ores in the Taihe intrusion formed by gravitational accumulation of Fe-Ti oxides crystallizing from a basaltic magma, not a Fe-Ti-P-rich immiscible liquid segregated from such magma.

Keywords: Cumulus apatite, Fe-Ti oxides, olivine, plagioclase, magma differentiation, layered intrusion