American Mineralogist, Volume 102, pages 2157–2169, 2017

REVIEW

Do Fe-Ti-oxide magmas exist? Probably not!

DONALD H. LINDSLEY[1,*] AND NATHAN EPLER[2]

[1]Department of Geosciences, Stony Brook University, Stony Brook, New York 11794, U.S.A.
[2]Roux Associates, 209 Shafter Street, Islandia, New York 11749, U.S.A.

ABSTRACT

Many Fe-Ti oxide bodies associated with anorthosite suites and with some tholeiitic plutonic bodies have cross-cutting relationships with their host rocks suggesting that they may have been emplaced as oxide melts. Pure Fe-Ti oxides melt at temperatures much higher than is considered to be geologically realistic, so various fluxes (mainly apatite, fluorine, or carbon) have been called upon to stabilize the melts down to plausible temperatures. This review traces our experimental attempts to test the effectiveness of proposed fluxes and therefore to demonstrate the existence of such melts at geologically realistic temperatures.

Neither F-apatite nor carbon act to stabilize Ti-rich Fe-Ti oxide melts at 1300 °C and below, and we conclude that—unless some totally unforeseen material does serve as a flux—Fe-Ti oxide magmas almost certainly do not exist. Although our data are not conclusive, it appears that increasing contents of FeO (and possibly TiO_2) and P_2O_5 mutually enhance their solubilities in silicate melts, allowing extensive buildup of those components in melts residual to anorthosite. We interpret that oxide orebodies form by gravitational accumulation of crystalline oxides from such liquids. Once those melts become saturated with either Fe-Ti oxides or apatite, both phases will tend to co-precipitate, thus explaining the common occurrence of apatite with oxide orebodies (“nelsonites”). Cross-cutting oxide bodies were probably emplaced as crystalline oxides, possibly lubricated by small amounts of residual silicate liquid. Oxidation of the Fe_2TiO_4 component in initially ulvospinel-rich spinel and concomitant formation of ilmenite grains by granule-oxy-“exsolution” may have weakened the crystalline oxide and facilitated its flow during emplacement.

It seems clear, though, that the presence of carbon does stabilize *Ti-poor* iron oxide melts to very low temperatures (at and even below 1000 °C), consistent with the (disputed!) magmatic origin of the magnetite lavas at El Laco, Chile.

Keywords: Fe-Ti oxides, oxide melts, oxide magmas, orebodies, immiscible melts, anorthosite suite, apatite, flux, Invited Centennial article, Review article