American Mineralogist, Volume 85, pages 753–759, 2000

Hydrogen deficiency in mantle-derived phlogopites

DAVID VIRGO[1] AND ROBERT K. POPP[2,*]

[1]Geophysical Laboratory, 5251 Broad Branch Road N.W., Washington, D.C. 20015, U.S.A.
[2]Department of Geology and Geophysics, Texas A&M University, College Station, Texas 77843, U.S.A.

ABSTRACT

The substitution mechanisms of Fe and Ti have been determined in phlogopite megacrysts from an ultramafic lamprophyre dyke from the Okenyenya igneous complex, northwestern Namibia. Mica separates were heat-treated from 800 to 900 °C, 1 atm to 10 kbar, and f_{H_2} from that of the IQF solid-state buffer to that of air. Iron oxidation states and H_2O contents of the run products were determined using ^{57}Fe Mössbauer spectroscopy and a vacuum fusion, U-furnace manometry system, respectively.

The least-squares fit between the univalent anion content (OH + F) and molar Fe^{3+} atoms per formula unit (apfu) has a negative slope with a high correlation coefficient and, at the 95% confidence level, is consistent with the Fe-oxy reaction,

$$Fe^{2+} + OH^- = Fe^{3+} + O^{2-} + 1/2\ H_2$$

By adding O^{2-} to the univalent anion content in 2:1 molar proportions to the Ti, the total anion content in the OH site of the natural phlogopite is, at the 95% confidence level, close to the theoretical value of 4.0 (O = 24 apfu) for the mica structure. It is proposed that the total H deficiency in the natural phlogopite can be explained by both Fe- and Ti-oxy substitution mechanisms. Principal Components Analysis carried out on exchange components for the experimentally treated phlogopite confirms the operation of the oxy-substitution mechanisms.

Both oxy-substitutions dominate in the compositions of natural igneous micas from a variety of tectonic environments. The dehydrogenation of Fe oxy-components in micas from silicic lavas may be a source of water that can be liberated into crustal melts and play an important role in the mechanism for initiating volcanic eruptions.