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Dehydrogenation of kaersutitic amphibole under electron beam excitation recorded by changes in $Fe^{3+}/\Sigma Fe$: An EMP and SIMS study

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Abstract

We present in situ microanalyses of $Fe^{3+}/\Sigma Fe$ in mantle-derived kaersutites as measured by electron probe microanalysis (EMP) based on the "self absorption induced Fe$L\alpha$ peak shift" method. The EMP results are not in agreement with bulk (wet chemistry) data. The heterogeneities revealed for some kaersutite megacrysts, when comparing bulk and EMP $Fe^{3+}/\Sigma Fe$ results, cannot explain the differences with the EMP measurements. It is thus proposed that any EMP overestimation of $Fe^{3+}/\Sigma Fe$ results from a beam-induced dehydrogenation and a subsequent oxidation of Fe^{2+} to Fe^{3+} according to the known relation: $Fe^{2+} + OH^- = Fe^{3+} + O^{2-} + 1/2\ H_2$. To demonstrate this phenomenon, H losses were measured by secondary ion mass spectrometry (SIMS) after EMP irradiation at different beam currents on two amphiboles with 1.1 and 1.7 wt% H_2O, respectively. In both amphiboles, H losses were observed under high beam currents (240 and 100 nA). No dehydrogenation is observed under lower beam currents for the 1.1 wt% H_2O amphibole, but still occurs, down to at least 50 nA, for the amphibole with the greatest H_2O contents. Amphiboles with low H_2O contents (below ~0.5 H^+) are less affected by beam damage. For amphiboles with higher H_2O contents, the electron beam current density should be reduced with consideration given to the resulting high statistical errors.

Keywords: $Fe^{3+}/\Sigma Fe$, EMP and SIMS measurements, amphibole, H loss