An electron microprobe, LAM ICP-MS and single-crystal X-ray study of the effects of pressure, H_2O concentration and fO_2 on experimentally produced basaltic amphiboles

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Amphiboles were crystallized in sub-liquidus experiments at 0.5-2.0 GPa and 1000-1050 °C from hydrous nepheline basanite and olivine basalt starting compositions. Both amphiboles and coexisting melts were analysed for major, minor and trace elements by a combination of electron microprobe and LAM ICP-MS. Individual amphiboles were also characterized by single-crystal X-ray structure refinement, which allowed estimates of dehydrogenation. The amphiboles display compositional variation that can be interpreted both as: (1) a crystal-chemical response to increasing pressure; and (2) a response to changes in the activity of H_2O and fO_2. As pressure increases Al^{IV} at the T1 site is replaced by Si, and enters the M2 site as Al^{VI}. This results in a decrease in the *c* and *b* cell edges. However, the overall decrease in cell volumes is small because *a sin*ß either decreases only slightly or actually increases with increasing pressure. This is due to increased ^{B}(Fe, Mg) contents, and facilitates the entry of K at the A site and of Cl at O3 (K_Ds for both increase with pressure). The degree of dehydrogenation at O3 correlates inversely with the H_2O concentration in coexisting melts. Dehydrogenation is locally balanced either by ^{M1}Ti (because O^{2-} is often < 2 Ti, Ti often distributes over the M1 and M2 sites) and by $^{M1}Ti + {}^{M1,3}Fe^{3+}$ (at high fO_2 conditions). $D^{amph/melt}$ values for Ti, Zr, Hf, Nb and Ta also correlate positively with O^{2-} suggesting that dehydrogenation favours the incorporation of high-charged cations at the M1 site ($^{M1}R^{4+} + 2\ {}^{O3}O^{2-} \leftrightarrow {}^{M1}R^{2+} + 2\ {}^{O3}OH^-$). However, D_{HFSE} also correlate positively with Al^{iv} consistent with the incorporation of HFSE in both M1 and M2 sites. D_{REE} correlate positively with Al^{iv} and negatively with Al^{vi}. Increased fO_2 results in increased Fe^{+3}, Al^{iv} and D_{REE}, but does not produce a noticeable increase in O^{2-} or in D_{HFSE}.