Investigating NAM H_2O content in nine-amphibole bearing mantle xenoliths

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Certain mantle processes (e.g., melting and deformation) are controlled, in part, by the availability of H_2O. Determining values of the activity of H_2O (aH_2O) will yield a better understanding of these processes, and these values may be inferred from the H_2O contents of nominally anhydrous mantle minerals (NAMs). However, mantle NAMs may suffer H_2O loss during transport from Earth's mantle to the surface. Therefore, this study compares the H_2O contents of NAMs with values of aH_2O estimated from amphibole equilibria to determine if NAMs have retained their mantle H_2O contents.

Nine amphibole-bearing xenoliths from two different regions, the southwestern U.S.A and Eastern Australia, were analyzed as part of this study. All the samples contain an identical assemblage of olivine + orthopyroxene + clinopyroxene + amphibole + spinel. Mineral equilibria between co-existing minerals was used to estimate values of temperature (T), pressure (P) and aH_2O. P-T estimates for these nine samples range from 1.0 to 1.6 GPa and 820 to 1000˚C respectively.

Low values of aH_2O (≈ 0.02 to 0.18), as inferred from amphibole equilibria, yield predicted olivine H_2O contents that range from 2 to 31 ppm wt. ppm, and these predicted values are generally consistent with the olivine H_2O contents (<7 to 46 wt. ppm) measured using FTIR spectroscopy. The H_2O contents of orthopyroxene and clinopyroxene range from 30 to 151 wt. ppm and 52 to 217 wt. ppm, respectively. The partitioning of H_2O between co-existing olivine, orthopyroxene, and clinopyroxene in these samples is also generally consistent with values obtained by laboratory experiments conducted at mantle P-T conditions. Based on these observations, we conclude that low H_2O contents in NAMs from these nine xenoliths approximate mantle conditions, indicating that only limited H_2O-loss (if any) occurred during xenolith ascent. These results, combined with other measurements of NAM H_2O contents, indicate that the uppermost mantle is heterogeneous with respect to H_2O content.