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Multiple application of FTIR spectroscopy for nominally anhydrous mantle minerals and their fluid inclusions in mantle xenoliths from the Cameroon Volcanic Line, Cameroon

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We carried out classical petrographic, geochemical, fluid inclusion and FTIR studies on the nominally anhydrous mantle minerals (NAMs) and their fluid inclusions on eight representative ultramafic xenoliths from Nyos and Barombi Mbo Lakes in the continental sector of the Cameroon Volcanic Line (CVL) to track the interaction between mantle rocks and migrated fluids. The studied xenoliths are spinel lherzolites, which have protogranular (Barombi region) to porphyroclastic (Nyos region) textures. Barombi xenoliths are less depleted in basaltic elements relative to Nyos xenoliths. Barombi xenoliths show only a small degree of partial melting. On the other hand Nyos xenoliths show cryptic and modal metasomatism (amphibole in modal proportion). The two xenolith series show different crystal preferred orientation patterns (CPO) indicating different deformation regimes.

Based on fluid inclusion petrography we studied the first generation of fluids with negative crystal shape (from 6 to 100 microns) that occur randomly or along healed fractures in olivine and pyroxenes. Solid phases inside the inclusions were identified under polarized microscope. Microthermometric measurements show similar melting and homogenization temperature ranges (melting temperatures in the Barombi -57.9 to -56.6 °C, in the Nyos samples between -58.1 and -56.6 °C, the lowest homogenization temperatures are -48,2 and -27,8°C in the Barombi, and -50,9 to -30,1°C in the Nyos). Raman analyses were conducted at room and elevated temperatures (up to +150°C) following the method of Berkesi et al. (2009). The fluid inclusions from both localities show the same fluid components, as CO_2 (96-99mol%), H_2O (1-3 mol%) and some cases H2S (0-1 mol%). With Raman spectroscopy some solid phases were detected which appear to have magnesitic composition.

FTIR measurements were used for the nominally anhydrous minerals and their fluid inclusions to identify the water content of the two mantle regions and to identify and map the solid phases inside the fluid inclusions. The water content of nominally anhydrous silicates in Nyos xenoliths (olivine: 1.4 – 2.0 ppm, orthopyroxene: 58 - 90 ppm, clinopyroxene: 261 - 334 ppm) are lower than in Barombi xenoliths (olivine: 5.0 - 9.1 ppm, orthopyroxene: 105 - 300 ppm, clinopyroxene: 368 - 513 ppm). The NAMs in Barombi xenoliths show moderate concentrations (total H_2O=100-130 ppm), whereas Nyos xenoliths show slightly lower concentrations (total H_2O=10-60 ppm).

With infrared spectroscopy using synchrotron radiation we can detect and map the fluid inclusions' composition, their solid phases and H_2O content. Solid phases was detectable inside the fluid inclusion, the absorbance characteristics of which correspond to phlogopite, serpentine, and sometimes the combination of both pargasite and phlogopite in the OH-stretching range.

The Barombi xenoliths have high water contents and their fluid inclusions contain phlogopite (and serpentine), whereas Nyos xenoliths have lower water contents and their fluid inclusions contain both phlogopite and pargasite.

Berkesi et al. (2009), Journal of Raman Spectroscopy, 40, 1461-1463.