Hydrous nano-silicate melt inclusions in the lithospheric mantle, Persani Mountains Volcanic Field (Transylvania)

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Mantle metasomatism plays an important role in the continuous rheological and geochemical change of the Earth’s mantle. During fluid-mediated mantle metasomatism, simultaneous micro- and nanoscale fluid-solid interactions occur, yet there is scarce evidence regarding the similarity or difference of the micro- and nanoscale reactions. Therefore, we conducted transmission electron microscopy (TEM) studies on amphibole lamellae and nano-silicate melt inclusions in an amphibole-bearing mantle xenolith from the Persani Mountains Volcanic Field, southeastern Transylvania (Romania).

Based on petrography, the amphibole lamellae formed as a result of post-entrapment reaction between the host clinopyroxene and the trapped CO2-rich fluid in the fluid inclusion. After amphibole formation, fluid escape occurred along the clinopyroxene-amphibole interface that formed nano-silicate melt inclusions that were mapped by TEM. The inclusions consist of ~ 80 v% silicate glass and ~ 20 v% bubble. The silicate glass has high SiO2 (>60 wt.%) and Al2O3 (>20 wt.%) and low CaO, FeO and MgO (sum <8 wt.%). The original bulk composition of the nano-silicate melt inclusions was calculated by Monte Carlo simulation using hydrated fluid complexes. Based on the results, the nano-silicate melt inclusions originally had a low SiO2 (~43.6 wt.%) and high Al2O3 (~15.5 wt.%), Na2O (~11.9 wt.%) and H2O (~30.3 wt.%) content.

The composition of the studied nano-silicate melt inclusion suggests that significant compositional change occurs during nano-scale fluid formation from the parent CO2-rich fluid. Therefore, our results suggest hydrous mineral precipitation and growth takes place along mineral interfaces. Furthermore, we propose that fluid metasomatism in the lithospheric mantle (e.g., H2O, Na, Al consumption during amphibole formation) can continue at the nanoscale after a metasomatic event. Eventually, our results also provide information about the interactions of H2O globally in the lithospheric mantle where hydrous minerals are stable and along the lithosphere-asthenosphere boundary in younger oceanic and continental plates.