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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 CO_2-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 SiO_2 (>60 wt.%) and Al_2O_3 (>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 SiO_2 (~43.6 wt.%) and high Al_2O_3 (~15.5 wt.%), Na_2O (~11.9 wt.%) and H_2O (~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 CO_2-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., H_2O, 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 H_2O globally in the lithospheric mantle where hydrous minerals are stable and along the lithosphere-asthenosphere boundary in younger oceanic and continental plates.