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THE OCCURRENCE AND ROLE OF FLUIDS IN THE LITHOSPHERIC MANTLE

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Recent studies have shown that the asthenospheric mantle contains significant amounts of H_2O, mostly occurring as protons (hydrogen ions) in defects in nominally anhydrous phases such as olivine, pyroxene, and garnet, as well as in perovskites in the lower mantle. “Free” fluids are rare to non-existent in the asthenospheric mantle, with most “water” and other volatile species hosted in minerals and melts.

While less is known concerning volatile abundances, distribution, and speciation in the asthenospheric mantle, considerable information on the volatile budget of the lithospheric mantle (LM) is available from studies of xenoliths brought to the surface from the LM in mainly basaltic or kimberlitic magmas. Volatile-bearing minerals, such as phlogopite, and the presence of volatile-bearing melt inclusions and fluid inclusions in mantle xenoliths, all provide evidence for the presence of volatiles in the LM. For the past 40 years Dr. Csaba Szabó and his students and colleagues in the Lithosphere Fluid Research Lab at Eötvös University have been at the forefront of research to understand the role of fluids in the LM, with much of the work centered on the Nógrád-Gömör volcanic field in northern Hungary and southern Slovakia. Szabó and coworkers were among the first to use data obtained from CO_2-rich fluid inclusions (FI) in mantle xenoliths, combined with textural evidence for re-equilibration of the FI, to infer that the FI were originally trapped below the MOHO and transported to the MOHO in ~36 hrs at an average ascent rate of 0.1 m/sec. Following an unknown period of storage in the LM, the xenoliths were transported from the MOHO to the surface in ~1.5 hrs at 5m/sec. More recent work by Szabó and colleagues has confirmed that FI from the LM previously thought to contain pure CO_2 contain small but geochemically significant amounts of H_2O, and that these fluids are capable of mobilizing various trace elements during metasomatism of the LM. These and other studies by the LFR group led by Professor Szabó have significantly advanced our understanding of the important role that fluids play in the evolution of the lithospheric mantle.