CO_2-RICH FLUIDS IN THE MANTLE: A COMPARATIVE FLUID INCLUSION STUDY

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Study of negative crystal shaped fluid inclusions enclosed in spinel lherzolites from five different locations all around the world were the subject of a detailed fluid inclusion study. Samples were studied from: the Central Pannonian Basin (Hungary), Cameroon Volcanic Line (Cameroon), Jeju Island (S-Korea), Rio Grande Rift (New Mexico, USA) and from Queensland (Australia). As a result, CO_2-rich fluids within the fluid inclusions could be studied and compared. The main aim to study fluid inclusion of mantle xenoliths (from the aforementioned locations) was to understand the properties of fluids and processes (e.g., interaction) in the deep lithosphere.

High (spectral) resolution Raman spectroscopy (available at Eötvös Loránd University, Budapest, Hungary) at different temperatures revealed that fluids in inclusions are heterogeneous and contain in small amounts species other than CO_2. One of the main advantages of the use of high spectral resolution Raman microspectrometer was the discovery of nitrogen (N_2) in some of the fluid inclusions. We prove, in addition, that nitrogen can be present in the dense fluid and is more common than that was previously thought. Sulphur in the fluid at room temperature can be present either as H_2S or as SO_2, however these species never occur together at the same location. In addition, following fluid inclusion exposure by the FIB-SEM (Focused Ion Beam-Scanning Electron Microscopy, available at Eötvös Loránd University, Budapest, Hungary) technique, the complexity of S-bearing solid phases has also been identified: sulphides and sulphates were also found within the fluid inclusion cavity. OH-bearing solids were also identified in some cases within the fluid inclusions.

H_2O is present in almost all of the inclusions, and was identified by the combination of stepwise heating experiments and Raman spectroscopy (BERKESI *et al.*, 2009). Our results show that, although H_2O is a minor component in mantle fluids, its relative amount varies among different locations, which has not been previously recognized.

However, using only Raman spectroscopy, no information can be obtained for the volume percentages of the solid phases, which is crucial to model the entrapped fluid composition. Stepwise exposure technique, involving FIB-SEM, was able to obtain highly precise volume proportions of even submicron-sized solid phases from mantle-derived fluid inclusions. The exposure procedure was carried out in two steps. After having exposed the inclusions, Raman spectroscopy was applied for precise identification of solid phases. As a result, combination of Raman spectroscopy with FIB-SEM technique proved the presence of carbonates (magnesite in enstatite-hosted fluid inclusions, whereas dolomite in diopside-hosted ones) and α-quartz that are interpreted as a reaction product of the trapped CO_2 and the host pyroxene.

We can conclude that, similar to the solid phases involved in the composition of the subcontinental lithospheric mantle, the coexisting fluid can also be heterogeneous in the mantle, although the dominant component in each case is CO_2.

Reference

BERKESI, M., HIDAS, K., GUZMICS, T., DUBESSY, J., BODNAR, R.J., SZABÓ, Cs., VAJNA, B., & TSUNOGAE, T. (2009): Journal of Raman Spectroscopy, 40: 1461–1463.