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Volatiles around monomineralic and interphase grain boundaries in the Earth′s upper Mantle (UNESCO IGCP 557)

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We present here a novel application of high-resolution synchrotron based FTIR measurements, which provides evidence for strongly heterogeneous distribution of volatiles within natural nominally anhydrous minerals such as olivine and garnet from about 150 km depth in the Earth's mantle. It is long known that there can be a substantial amount of volatiles stored in nominally water free minerals such as olivine, pyroxene and garnet. However, since grain boundaries are also known to act as reservoirs of incompatible elements, there could be in fact a lot more water in the Earth's mantle than previously thought. The difficulty is, however, whether, it is possible to quantify the water and other volatiles on grain boundaries, because the water may be extracted during the uplift/extraction of the mantle xenoliths in the first place, and second, the resolution to measure the water on grain boundaries and dislocations simply has been lacking. We have overcome both problems by firstly looking at solid inclusions, embedded completely in the host olivine/garnet and second, we used synchrotron based FTIR at ANKA, Karlsruhe, Germany.

In this study, we focus on spinel, diamond, serpentine and melt inclusions, and also totally embedded inclusion free cracks in thick sections of single olivine and garnet grains. The inclusions have been carefully selected so that they do not interfere through any visible crack. The host minerals olivine and garnet and the internal inclusion were mapped, by using synchrotron based FTIR. The studied areas of the doubled polished olivine and garnet grains are about 1600 μm2 in size. The areas were mapped in 2 μm steps and apertures between 4μm and 8μm has been used. The results of our studies show that the amount of volatiles increases dramatically close to the monomineralic and interphase grain boundaries.