Geophysical Research Abstracts
Vol. 13, EGU2011-2490, 2011
EGU General Assembly 2011

Melt triggered deformation of the upper mantle: examples from xenoliths from Kimberley, South Africa and the Letseng-la-Terae kimberlite, Lesotho (UNESCO IGCP 557)

Christoph Hauzenberger (1) and Juergen Konzett (2)

(1) University Graz, Department of Earth Sciences, Graz, Austria (christoph.hauzenberger@uni-graz.at), (2) Institute of Mineralogy and Petrography, University of Innsbruck, Austria

Most of the peridotitic mantle xenoliths constitute coarse grained and undeformed rocks, which were probably to some extent metasomatically overprinted. However, some mantle xenoliths are deformed to various degrees. The degree of deformation can vary from locally recrystallized tiny olivines aligned along melt infiltrated veins within large crystals of olivine to a mylonitic peridotite which comprises a completely recrystallized fine grained olivine matrix with remnants of large olivine crystals, orthopyroxene, ±clinopyroxene and ±garnet (Grt) porphyroclasts. Deformed peridotitic xenoliths from two localities were investigated: (1) from the Kimberley area, South Africa and (2) from the Letseng-la-Terae diamondiferous kimberlite, Lesotho. While sheared mantle xenoliths were already described before for the Kimberley area, the occurrence of this type is probably less known for the Letseng-la-Terae kimberlite.

Deformed samples from Kimberley show all stages of deformation, from incipient shearing to mylonitic. The application of various geothermobarometers involving major- and trace element exchange between the primary lherzolite phases yields P-T conditions of ∼1100°C and ∼5 GPa for the highest deformed samples, slightly lower PT conditions are found in the less deformed peridotites. Compositional zoning was not observed in the individual phases. However, trace element compositions obtained by LA-ICPMS revealed that the small recrystallized olivines contain higher amounts of Al, Ti, and Ca compared to the large olivine remnants. We attribute this difference in trace elements to small amounts of an infiltrating melt phase which reduced the strength of olivine significantly. Shear bands developed and olivine recrystallized to the fine grained aggregates, incorporating higher amounts of the incompatible elements Ti, Al, and Ca. In some samples orthopyroxene is also highly deformed and recrystallized to tiny equigranular grains. The difference in trace element composition is less pronounced than in olivine.

Samples from the Letseng-la-Terae kimberlite contains a suite of xenoliths, mainly peridotites and pyroxenites, some of which show evidence for metasomatism. The suite of xenoliths include: 1) fine grained (Grt-) lherzolites, 2) coarse grained (Grt-) lherzolites, 3) harzburgites, 4) foliated (deformed) (Grt-) lherzolites, 5) phlogopite-rich lherzolites, 6) lamprophyric lherzolites, and 7) crustal xenoliths. The degree of deformation in mantle xenoliths is usually less than in the Kimberley samples, but metasomatic overprint by a melt phase is more evident Secondary clinopyroxene grows at the expense of olivine and orthopyroxene or occurs as recrystallized rim around larger clinopyroxene crystals. Various geothermobarometers involving major- and trace element exchange between the primary lherzolite phases yields P-T conditions of ∼1350°C and ∼7.5 GPa. The recrystallized and/or newly grown mineral phases observed in the deformed areas yield significantly lower PT conditions, which are ∼1230°C and ∼4.5 GPa. Melt infiltration and deformation must have occurred at shallower levels (quite similar to the Kimberley samples) and at a later stage within the upper mantle than the equilibration of the primary mineral assemblage.

The financial support by the Austrian Acadamy of Science is gratefully acknoledged. This is a contribution to UNESCO IGCP 557.