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Different types of sheared peridotites from Lesotho (Kaapvaal craton)

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Sheared peridotites give direct evidence for deformation processes in the lithospheric mantle shortly before entrainment by, in our case, Late Cretaceous (90Ma) kimberlites. Here we have studied 12 sheared peridotites (SP) from three localities in Lesotho (11 garnet-bearing and one spinel-bearing). The peridotites exhibit different degrees of depletion, ranging from more fertile (X_{Fo} =91) to depleted (X_{Fo} =93) and are mainly lherzolitic. Textures reveal a bimodal grain size distribution with mm-size porphyroclasts surrounded by neoblasts 10s – 100s µm across. Our suite includes samples with various microstructures from porphyroclastic to fluidal mosaic [1]. We have focused on major and trace element analysis by EPMA to investigate compositional differences between porphyroclasts and the fine-grained (<20µm) neoblasts.

Sheared peridotites from Lesotho are widely known for their deep origin. However, thermoÂbarometric calculations show a more complex story. We find a wide range of P-T-conditions ranging from 4 to >6GPa (mid-lithospheric – LAB?) and 1000 – 1400°C. Our samples can be split into two distinct groups: (i) high-T SP (>1350°C) with a more fertile composition and (ii) low-T SP (<1250°C) with fertile to depleted compositions. In the latter, olivine porphyroclasts have Ti contents <20µg/g (detection limit), but neoblasts contain up to 250µg/g. This metasomatic enrichment was accompanied by a heating event. This increase is comparable to Ti-enrichments in mid-lithospheric SP identified at Kimberley and is related to extensive kimberlitic metasomatism with focused deformation [2]. The high-T SP come from greater depths (LAB?) and have Ti-concentrations <100 µg/g in ol-porphyroclasts and neoblasts.
Crystal preferred orientations (CPO) of olivine as measured by EBSD reveal various types: B-, C-, E-, AG-type and bimodal CPOs, the latter limited to deeper samples (>5 GPa). The CPOs suggest the presence of water [3; 4] or melt (AG-type) [5] during deformation. We demonstrate that the different SP groups are related to different tectonic environments within the lithospheric mantle.

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