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# Phase relationships of a lherzolite from the Roberts Victor Mine, South Africa: A study of chemical and physical parameters in the Kaapvaal Craton.

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The Roberts Victor kimberlite pipe-dike system is well known as type locality for intensively studied eclogitic xenoliths. Since more than 95% of the Roberts Victor xenoliths are rather of eclogitic than of peridotitic type, mineralogical data of lherzolitic peridotites from the mine is extremely rare. In fact, there is no detailed petrological study of peridotitic mantle xenoliths from the Roberts Victor Mine up to the present day. As the lherzolitic xenolith nodules from the Roberts Victor Mine are strongly altered, due to contact with the aqueous fluid of the ascending kimberlitic melt bulk chemistry analyses result in too low $SiO_2$ and too high MgO concentrations. Thus, Roberts Victor lherzolites provide a distorted image of the sampled mantle regions. To avoid inaccuracies in composition, we used mineral analyses of the rock forming minerals from lherzolithes from the Roberts Victor Mine and implemented a planimetric method to recalculate a proper bulk rock composition that is free of volatiles and representative of a garnet lherzolite from the Kaapvaal Craton. The recalculated bulk chemistry for the four-phase lherzolite composition Ol-Opx-Cpx-Gt is; $SiO_2$≈45.83 wt.%, $TiO_2$≈0.04 wt.%, Cr2$O_3$≈0.51 wt.%, Al2$O_3$≈1.84 wt.%, FeO≈6.27 wt.%, MnO≈0.07 wt.%, MgO≈43.51 wt.%, CaO≈0.53 wt.%, Na2O≈0.10 wt.%. As our bulk composition fits accurately the composition range of lherzolites from the Kaapvaal Craton, analysed by Carswell and Dawson (1970), it is seen to represent the chemistry of the upper mantle beneath South Africa. By the use of the Gibbs minimization software Perple_X (Connolly, 2005) we created a petrological p-T phase diagram for a water saturated lherzolite from 473-2073 K and 10-100 kbar, based on the recalculated bulk composition, to estimate the proportion of lherzolite in the lithospheric-asthenospheric mantle of the Kaapvaal Craton. Furthermore and more importantly, we used Perple_X to model the modal distribution of the phases Atg, Br, Chl, Cpx, Gt, Ol, Opx, Sp as well as chemical and physical and thermodynamic parameters of the lherzolitic mantle, such as density, P- and S-wave velocities, bulk and shear modulus, Poisson ratio and Grüneisen thermal ratio. To verify the results and to test the thermodynamic tool box Perple_X more profoundly modelled data have been additionally obtained for enthalpy, entropy, expansivity and heat capacity. Modelling of density resulted in ≈3327.30 kg/m3 at 125 km and in ≈3340.60 kg/m3 at 175 km and is very close to the maximum density values of lherzolites from the Kaapvaal Craton presented by Kuskov et al. (2006). However, modelled VP and VS data show a negative velocity anomaly between 100 and 225 km which we assume to be indicative for a “hot” or a “wet” spot in the studied Kaapvaal Craton area.