High water contents in the Siberian cratonic mantle: an FTIR study of Udachnaya peridotite xenoliths

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Water is believed to be a key factor controlling the long-term stability of cratonic lithosphere [1], but mechanisms responsible for the water content distribution in the mantle remain poorly constrained. Water contents were obtained by FTIR in olivine, pyroxene and garnet for 20 well-characterized peridotite xenoliths from the Udachnaya kimberlite (central Siberian craton) and equilibrated at 2-7 GPa [2]. Water contents in minerals do not appear to be related to interaction with the host kimberlite. Diffusion modeling indicates that the core of olivines preserved their original water contents. The Udachnaya peridotites show a broad range of water contents in olivine (6.5±1.1 - 323±65 ppm H_2O (2σ)), and garnet (0 - 23±6 ppm H_2O). The water contents of olivine and garnet are positively correlated with modal clinopyroxene, garnet and FeO in olivine. Water-rich garnets are also rich in middle rare earth elements. This is interpreted as the result of interaction between residual peridotites and water rich-melts, consistent with modal and cryptic metasomatism evidenced in the Siberian cratonic mantle [3-4]. The most water-rich Udachnaya minerals contain 2 to 3 times more water than those from the Kaapvaal craton, the only craton with an intact mantle root for which water data is available [5-6]. The highest water contents in olivine and orthopyroxene in this study (≥ 300 ppm) are found at the bottom of the lithosphere (> 6.5 GPa). This is in contrast with the Kaapvaal craton where the olivines of peridotites equilibrated at > 6.4 GPa have < 1 ppm H_2O. The latter "dry" olivine may make the base of the Kaapvaal cratonic root strong and thus protects it from erosion by the convective mantle

[5-6]. The calculated viscosity for water-rich Udachnaya peridotites at > 6 GPa is lower or similar (8.4×10^{16} to 8.0×10^{18} $Pa.s^{-1}$) to that of the asthenosphere ($\leq 3.7 x 10^{18}$ $Pa.s^{-1}$ [7]). Such lithologies would not be able to resist delamination by the convecting asthenosphere. However, seismology studies [8] as well as the high equilibration pressures of our samples indicate that the Udachnaya cratonic lithosphere is 220-250 km thick. Consequently, the water-rich peridotites are likely not representative of the overall Siberian cratonic lithosphere. Their composition is linked to spatially limited melt metasomatism in mantle regions above asthenospheric upwellings responsible for the kimberlite magmatism prior to their ascent and eruption.

[1] Pollack,1986 *EPSL* **80**,175-182. **[2]** Ionov *et al.*, 2010 *JP* **51**, 2177-2210. **[3]** Doucet *et al.*, 2012 *EPSL* **359–360**, 359–360. **[4]** Doucet *et al.*, 2013 *CMP* **165**, 1225-1242. **[5]** Peslier *et al.*, 2010 *Nature* **467**, 78-81. **[6]** Baptiste *et al.*, 2012 *Lithos* **149**, 31-50. **[7]** Larsen *et al.*, 2005 *EPSL* **237**,548-560. **[8]** Priestley *et al.*, 2003 *GRL* **30**, 1118.