Water Content, Deformation and Seismic Properties of the Lower Crust Beneath the Siberian Craton: Evidence from Granulite Xenoliths

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Although the continental lower crust is often assumed to be dry and strong, water in nominally anhydrous minerals can significantly decrease viscosity of granulites and affect the mechanical coupling between the crust and upper mantle. Here we measured water content and fabrics of 16 granulite xenoliths from the Udachnaya and Komsomolskaya kimberlites in the central Siberian craton, which were erupted in the Late Silurian. The equilibrium pressure and temperature of the granulite samples are in the range of 0.9–1.3 GPa and 683–822 ºC. The mean water contents in clinopyroxene, garnet and plagioclase are 744±272 ppm, 100±64 ppm, 423±245 ppm, respectively, suggesting the water-rich lower crust. The bulk water contents in granulites are independent on pressure and composition, but show a negative correlation with temperature. Compared with previous studies on granulite xenoliths and terrane granulites, our granulite samples have much higher bulk water contents. The lattice-preferred orientation of clinopyroxene is characterized by activation of the dominant slip system (100)[001], whereas garnet is randomly orientated. Plagioclase developed two dominant slip systems (001)[010] and (001)[100]. Calculated seismic anisotropy indicates that the weak fabric strength of these granulite samples will result in weak seismic anisotropy of the lower crust beneath the Siberian craton. We propose that during eruption of the kimberlite pipes in the Late Silurian, the lower crust of the Siberian craton, at least beneath the kimberlite fields, had high water contents, relatively low strength, weak seismic anisotropy, and high electrical conductivity. Such status may be representative for the lower crust beneath a stable craton. The following Siberian Traps in the end of Permian was associated with the magma underplating, which probably dehydrated and strengthened the lower crust of the Siberian craton.