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Temperature and pressure dependences of kimberlite melts viscosity (experimental-theoretical study)

Eduard Persikov (1), Pavel Bykhtiyarov (1), and Alexsander Cokol (2)

(1) Institute of Experimental Mineralogy RAS, Russian Federation (persikov@iem.ac.ru), (pavel@iem.ac.ru), (2) Institute of Geology and Mineralogy SBRAS, Russian Federation (Institute of Experimental Mineralogy RAS, Russian Federation (sokola@igm.nsc.ru)

Experimental data on temperature and pressure dependences of viscosity of model kimberlite melts (silicate 82 + carbonate 18, wt. %, 100NBO/T = 313) have been obtained for the first time at 100 MPa of CO_2 pressure and at the lithostatic pressures up to 7.5 GPa in the temperature range 1350 oC – 1950 oC using radiation high gas pressure apparatus and press free split-sphere multi – anvil apparatus (BARS). Experimental data obtained on temperature and pressure dependences of viscosity of model kimberlite melts at moderate and high pressures is compared with predicted data on these dependences of viscosity of basaltic melts (100NBO/T = 58) in the same T, P – range. Dependences of the viscosity of model kimberlite and basaltic melts on temperature are consistent to the exponential Arrenian equation in the T, P - range of experimental study. The correct values of activation energies of viscous flow of kimberlite melts have been obtained for the first time. The activation energies of viscous flow of model kimberlite melts exponentially increase with increasing pressure and are equal: E = 130 ± 1.3 kJ/mole at moderate pressure (P = 100 MPa) and E = 160 ± 1.6 kJ/mole at high pressure (P = 5.5 GPa). It has been established too that the viscosity of model kimberlite melts exponentially increases on about half order of magnitude with increasing pressures from 100 MPa to 7.5 GPa at the isothermal condition (1800 oC). It has been established that viscosity of model kimberlite melts at the moderate pressure (100 MPa) is lover on about one order of magnitude to compare with the viscosity of basaltic melts, but at high pressure range (5.5 - 7.5 GPa), on the contrary, is higher on about half order of magnitude at the same values of the temperatures. Here we use both a new experimental data on viscosity of kimberlite melts and our structural chemical model for calculation and prediction the viscosity of magmatic melts [1] to determine the fundamental features of viscosity of kimberlite and basaltic magmas at the T, P – parameters of the Earth's crust and upper mantle.

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[1] Persikov, E.S. & Bukhtiyarov, P.G. (2009) Russian Geology & Geophysics, 50, No 12, 1079–1090.