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Structural chemical model to calculate and predict the viscosity of magmatic melts in full range of composition and conditions

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Data on the viscosity of magmatic melts in the wide P-T range and melt compositions are of prime importance for understanding much of the processes of origin and evolution of magmas as well as their dynamics under the natural conditions of their existence in the Earth's crust and upper mantle and during volcanic processes.

In spite of a rather long history, up to now only the viscosity of silicate and magmatic melts from acidic to basic composition at the atmospheric and relatively low pressures, corresponding to the Earth's crust is well studied. The highly essential investigations of the water-bearing ultrabasic melts, as well as the study of the viscosity of magmatic melts under the mantle P-T parameters are rather limited. The mechanism of negative anomaly of pressure dependence of magmatic and aluminosilicate melt viscosities is still under discussion. Moreover, an experimental study the viscosity of magmatic melts diversity seems to be impossible. There has been considerable work on parameterizing the viscosity of silicate and magmatic melts as a function of major element composition (Bottinga & Weill, 1972; Shaw, 1972; Persikov, 1984, 1991, 1998; Dingwell & Mysen, 1985; Mysen, 1988; Hess & Dingwell, 1996; Richet et al. 1996; Giordano & Dingwell, 2003; Zhang et al., 2003; Whittington et al., 2003; Vetere et al., 2006). However, the development of a physical-chemical model for calculating and predicting the viscosity of magmatic melts remains a burning problem especially at P-T parameters of the upper mantle. The most appropriate model (Persikov, 1991, 1998) allows the prediction with high enough accuracy the concentration and temperature dependences of viscosity of acid- basic magmatic melts. However, the mentioned model can be only applied to the range of crust depths and pressure

dependence of viscosity in this model is purely empirical.

The new model is advanced version of the previous one (Persikov, 1991, 1998) developed on the same principles: 1) structural-chemical approach; 2) ultimate simplicity of analytical dependences; 3) high precision of prediction ($\pm$30 % relative), commensurate with the uncertainties of experimental data on viscosity of aluminosilicate and magmatic melts, especially at high pressures. For the first time this model allows of the calculating and predicting the viscosity of near-liquidus magmatic melts in full range of composition and conditions as a function of the next parameters: 1) total and fluid pressures; 2) temperature; 3) melt composition, including volatiles content (H_2O, OH^-, CO_2, CO_3^{2-}, F, Cl); 4) cation rations such as $Al^{3+}/(Al^{3+} + Si^{4+})$, $Fe^{2+}/(Fe^{2+} + Fe^{3+})$, $Al^{3+}/(Na^+ + K^+ + Ca^{2+} + Mg^{2+} + Fe^{2+})$; and

5) volume content of crystals and bubbles.

The computer program has been developed for a very easy and fast calculating of the viscosity of such melts using this model.

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