



Effect of iron oxidation state on silicate melts viscosity

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Iron is the most abundant transition metal in the Earth's interior, even excluding the iron-rich core. In magmatic systems, Fe can be found in a variety of coordination environments ranging from tetrahedral, to pentahedral to octahedral and in both its bivalent and trivalent oxidation states. Naturally, both coordination number and oxidation state of iron can strongly influence the physical properties of magmatic liquids, even at low concentrations. For example, recent determinations of the viscosity of iron-bearing silicate liquids have revealed strong variations in viscosity as a function of composition (Potuzak et al., 2004), highlighting the importance of understanding the structural role of iron in magmas and how it is linked to their rheological properties. Here we present new viscosity data for a wide range of natural rhyolitic, trachytic, molaritic, andesitic, latitic, pantelleritic, basaltic and basaltic compositions as well as wet chemistry and synchrotron analysis. Dry Newtonian shear viscosities were investigated at high temperature (1050-1600°C) and low temperature (616-860°C) using the concentric cylinder apparatus and the micropenetration technique, respectively. The glasses obtained by fast quenching the melted sample, during the high temperature viscometry, were used for determining, via potassium dichromate (PD) titration, the Fe²⁺/Fe³⁺ ratio. Wet chemistry analyses were found consistent with high-T prediction of Kress and Carmichael (1991) and Ottonello et al. (2001) empirical models. The structural role of iron species was also investigated by Fe K-edge XANES spectroscopy performed at ESRF (Grenoble). High resolution XANES spectra were collected at the BM-8 of the ESRF storage ring operating at 6 GeV and with the ring current ranging from 150 to 200 mA. The energy position of the pre-edge peaks was found intermediate between those of Fe²⁺ and Fe³⁺ model compounds, indicating the presence of both Fe oxidation states in the samples examined. The position of

the spectral features of the pre-edge peaks has been found compatible with oxidation states intermediate between those of Fe²⁺ and Fe³⁺ in both 4 and 5 coordination states. Fe K-edge XANES spectra and wet chemistry analyses allowed to interpret the rheological measurements in terms of structural played by iron species. Kress and Carmichael 1991, *Contrib. Min. Petrol.* 108, 82 Ottonello et al. 2001, *Chem. Geol.* 174, 157 Potuzak et al. 2004, EGU 2004 Nizza France