

SCG009-07

Room:301A

Time:May 23 16:30-17:00

Alkali effect in silicate melts ? A new vision on an old hypothesis

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Rheological properties of silicate melts govern both magma ascension from the mantle to the surface of the earth and volcanological eruptions styles and behaviors. In this mind, it is very important to understand what parameters influence these properties. Up to now, we know for example that viscosity of silicate melts is dependent of temperature, pressure and chemical composition (Bottinga and Weill, 1972; Urbain et al, 1982). In this work, we will focus on the Na₂O-K₂O-Al₂O₃-SiO₂ system, which is of a prime importance because it deals with a non-negligible part of natural melts, like for instance Vesuvius (Italy) or Erebus (Antartica) magmas. We will first present our viscosity data, and then the Adam and Gibbs theory that allows theoretically modeling Na-K mixing in aluminosilicate melts using the so-called mixed alkali effect. On the basis of these rheological results, the Na-K mixing cannot be explained with this mixed alkali effect. To go further and as rheological properties are directly linked with structural properties, we will present our first results obtained by Raman and NMR spectroscopy. These last ones provide important structural informations on the polymerization of glasses and melts, and also on the environment of tetrahedral coordinated cations. These structural results are directly linked with viscosity measurements and shown that substituting Na by K in aluminosilicate melts induces structural changes in both alkali environment and aluminosilicate network. This implies that Na and K atoms are non-randomly distributed in the aluminosilicate network. Na melts present a network with some channels and a random distribution of Al and Si. K networks are different, they present a non-random distribution of Al and Si, with two sub-networks: one rich in Si and fully polymerized, the other containing Al and K. On this view, mixing Na and K melts returns to change these configurations and induces complicated and non-linear effects.

Keywords: glass, melt, aluminosilicate