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Water and the compressibility of silicate glasses and melts

P. Richet (1), A. Whittington (2) and A. Polian (3)

(1) Physique des Minéraux et des Magmas, Institut de Physique du Globe, 4 place Jussieu 75252 Paris cedex 05, France

(2) Department of Geological Sciences, University of Missouri-Columbia, Columbia MO 65211-1380, USA

(3) Laboratoire des milieux condensés, Université Paris 6, France

Recent experimental advances have allowed the strong influence of water to be determined on a number of physical properties of magma. For instance, it has been found that the depressing effects of water on viscosity depend markedly on silicate composition and polymerization, being much greater for silica-rich than for silica-poor melts.

Along with viscosity, density is another property of fundamental importance to understand mass transfer involving melts. Although it should be known as a function of temperature and pressure, very few measurements have been made at high pressures because of considerable experimental difficulties. It follows that the influence of water on melt density is poorly known. From PVT measurements made by Burnham and Jahns (1971), however, Ochs and Lange (1999) have derived a temperature- and pressure-dependent partial molar volume for water in silicate melts that is independent of silicate composition.

As a first step toward checking this lack of composition dependence, we have measured the compressibility of six series of hydrous glasses previously investigated for viscosity, heat capacity and thermal expansion. In all series, the compressibility is a linear function of water content. But more important is the fact that the partial molar compressibility of water depends very strongly on silicate composition. It is, for example, 5 times greater for rhyolite than for tephrite glasses. The important implications of this strong composition dependence for the high-pressure density of hydrous melts and for water solubility mechanisms will be discussed.