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Partial molar volumes for lanthanide sesquioxides in silicate melts

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One of the key to the petrogenetic modelling of magmatic processes and to determine the phase diagrams of lanthanide host phases is the accurate determination of the physico-chemical and thermodynamic properties of lanthanide-containing materials, such as the volumetric properties of lanthanide-bearing silicate melts. In addition, the high formal charge of lanthanide cations is expected to have a strong influence on melt structure and the variation of the volumetric properties of lanthanide-bearing silicate melts may reflect this influence. Such a volumetric data set may also contribute to a first order prediction of the pressure dependence of the mineral-melt partitioning of lanthanides. Therefore, we have undertaken to provide a reliable volumetric data set for lanthanide-bearing silicate melts which allows the available models in the literature to be extended to lanthanide-bearing melts.

For this purpose, the densities of various lanthanide-bearing silicate melts distributed along various pseudo-binary joins have been measured using the Pt- double-bob Archimedean method. Investigated materials were series of liquids synthesised by the addition of one lanthanide oxide in various proportions (i.e., La_2O_3, Ce_2O_3, Pr_2O_3, Nd_2O_3, Sm_2O_3, Eu_2O_3, Gd_2O_3, Tb_2O_3, Dy_2O_3, Ho_2O_3, Er_2O_3, Tm_2O_3 and Yb_2O_3) to base melt compositions (i.e., either the sodium disilicate or the one atmosphere anorthite-diopside eutectic).

From the density data thus gained and from the analyses of the samples recovered from experiments, the molar volumes have been calculated. The present work suggests an ideal behaviour with respect to the molar volume for melts containing up to 6-7 mol% of lanthanide oxide. However, this ideality may not be valid for lanthanide-rich silicate melts. In addition, the molar volumes of the present melts were independently

analysed as a function of composition and temperature in order to obtain the partial molar volumes of the lanthanide sesquioxides in silicate melts that are appropriate to calculate the molar volumes of lanthanide-bearing silicate melts within the lanthanide oxide-Na_2O-SiO_2 and lanthanide oxide-CaO-MgO-Al_2O_3-SiO_2 systems for compositions with a lanthanide concentration up to 6-7 mol%.