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Densities of melts in the CaO-MgO-Al_2O_3-SiO_2 system

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Abstract

Density measurements have been performed on 4 Mg-aluminosilicate melts and 4 melts in the CaO-MgO-Al_2O_3-SiO_2 system (including stoichiometries corresponding to the mineral compositions åkermanite, diopside, enstatite, and cordierite) in the temperature ranges from their respective melting points up to 1800 °C, using the very precise Ir-based double-bob Archimedean method. The measured densities of the melts range from 2.67 to 2.42 g/cm^3.

Together with our previous density measurements in the CaO-Al_2O_3-SiO_2 system, the present results were analyzed using a regression equation, including a non-ideal mixing term between CaO and SiO_2, from which the partial molar volume of each oxide liquid component was obtained by the method of least squares. This procedure yields partial molar volumes of 12.66, 20.66, 36.67, 27.30 cm^3/mol at 1873 K for MgO, CaO, Al_2O_3, and SiO_2, respectively. A calculation scheme for melts in the CaO-MgO-Al_2O_3-SiO_2 system is proposed, involving an excess volume term between SiO_2 and CaO that is capable of reproducing the liquid molar volumes to within 1% except for extremely Ca-, Mg-, and Al-rich compositions. Better constraints on melt volumes in those extreme composition ranges requires new very high-temperature data.

The volume of fusion of various minerals was calculated and implications for the structure of their respective melts are also discussed. In addition, the volumes of fusion from this study are also compared to that obtained using the Clausius-Clapeyron equation.