

Measurements of fusion enthalpy of anorthite and diopside by combining techniques of drop calorimetry and solution calorimetry

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Enthalpy of fusion of rock-forming minerals is required to calculate enthalpy of multicomponent silicate liquid and are of considerable importance in thermodynamic consideration and phase equilibrium calculation in igneous process. Fusion enthalpy of diopside has been measured by various methods. In contrast, few study has been reported an enthalpy of fusion of anorthite. We developed a twin conduction calorimeter and determined enthalpies of fusion of diopside and anorthite by combining drop calorimetry for molten diopside and anorthite and solution calorimetry for glasses.

First, differences of enthalpy of diopside and anorthite liquids between 1873-1773K and 273K were measured by drop calorimetry. Enthalpies of solution of the drop quenched glasses, anorthite glass annealed at 1100K for 72h and synthetic crystals of diopside and anorthite were determined by a hydrofluoric acid solution calorimetry. Measuring system of twin conduction calorimeter consists of sample and reference Teflon vessels placed on copper block and is immersed in a water thermostat. Approximately 50mg sample powders were reacted with 23wt% hydrofluoric acid solution, and then temperature difference of solution between both vessels was measured by thermistors. Enthalpy was calibrated by heating a resistance element.

Enthalpy of vitrification determined from difference of enthalpies of solution for quenched glass and crystal are 87.3 ± 7.0 kJ/mol for diopside and 83.4 ± 6.5 kJ/mol for anorthite. Enthalpy of fusion at melting point was calculated from the enthalpy of vitrification, relative enthalpy measured by drop calorimetry and published heat capacity of minerals. The enthalpy of fusion determined for diopside is 138.7 ± 7.0 kJ/mol at 1665K and is consistent with values reported in previous four studies (137-139kJ/mol). The enthalpy of fusion of anorthite at melting point (1830K) is 145.0 ± 6.5 kJ/mol and 146.1 ± 7.5 kJ/mol when enthalpies of solution for quenched and annealed glasses are used, respectively. This is 10% higher than a value reported by Richet et al. (1984) (137.0 ± 7.0 kJ/mol). This discrepancy is probably caused by error in fictive temperature of glass sample used in solution calorimetry estimated in previous study.

Keywords: Silicate melt, Enthapy of fusion, Enthalpy of solution, Calorimetry