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Experimental study of quantitative calorimetry under high pressure using DTA

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Reactions which happen under pressure, such as melting and dehydration, cannot be bypassed when the dynamical properties of earth interior are considered. The reactions are rarely investigated directly under pressure though the phase boundaries are well investigated by quenching and in-situ x-ray observation methods so far. We performed experiments for the purpose of observing the reactions directly and obtaining the enthalpy change quantitatively. Differential Thermal Analysis (DTA) technique was used in this study. DTA measurement has been performed under high-pressure conditions so far in order to detect phase relations of minerals because of the simplicity. DTA apparatus can also be used in principle for quantitative measurement of enthalpy change because the mechanism of DTA is very similar to that of the heat-flux type Differential Scanning Calorimetry. In spite of the similarity, there are few attempts to estimate a quantity of enthalpy change involved in a phase transition using DTA under pressure. We discuss the possibility of using High Pressure DTA (HP-DTA) system as the quantitative calorimetric apparatus.

Because this calorimetric technique with DTA is an indirect method and cannot determine the absolute enthalpy change, the standards are measured before an enthalpy change of a reaction is treated. The enthalpy of Mg(OH)2 brucite dehydration was measured using this system as the first step of this study. The heat of the dehydration can be estimated thermodynamically because the properties of brucite and the products, periclase and water, are well investigated under pressure. Therefore, the heat of this dehydration is used as the standard for the quantitative HP-DTA.

The dehydrations of brucite were detected with this system at some pressure temperature conditions. The estimated enthalpies of the dehydration which are calculated were 1.5-2.0 J at the conditions. The comparison between the calculated enthalpy changes with thermodynamic properties and the areas of the DTA signals yields the system calibration factor for the high pressure cell. The results indicate that this system can detect enthalpy change less than a few Jules quantitatively. This system is sensitive enough to detect enthalpy of mineral fusion. The results of mineral melting will be reported.