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The reaction talc + forsterite = enstatite + H_2O revisited: Application of conventional and novel experimental techniques and derivation of revised thermodynamic properties

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Abstract

The reaction 2 talc + 2 forsterite = 5 enstatite + 2 H_2O has been investigated between 1 and 3.5 GPa. Here, we report the results from 2 sets of experiments: (1) "conventional" static quenching experiments performed several years ago in non-end-loaded and end-loaded piston-cylinder apparatus, and (2) a new set of experiments conducted in a novel type of apparatus, a "rocking" piston cylinder. This new technique was employed for the reinvestigation to overcome segregation problems encountered during static experiments. The run-products of the latter experiments are homogenous throughout the entire capsule. The reaction was bracketed to 680–690 °C at 1 GPa, to 660–680 °C at 1.7 GPa, to 650–660 °C at 2.5 GPa, to 600–640 °C at 3 GPa, and to 550–600 °C at 3.5 GPa. The location of the reaction in *P-T*-space is consistent with low-pressure experimental data of Chernosky et al. (1985), and is in reasonable agreement with the "conventional" high-pressure experiments of this study. The new experimental results were used to refine the existing thermodynamic properties of talc within the framework of the Holland and Powell (1998) database. The standard state enthalpy and entropy amount to H°_{f298} = 5912.358 kJ/mol and S°_{298} = 239.1 J/(K·mol). The refined standard entropy is about 9% lower than the entropy obtained calorimetrically. When the clinoenstatite-orthoenstatite transition is taken into account, S°_{298} of talc improves by ~6 J/K. We assume that a further increase of the standard state entropy of talc can be achieved by varying the activity of H_2O in the fluid as a function of pressure and temperature.

Keywords: MgO-SiO_2-H_2O system, experimental petrology, high pressures, uncertainties, thermodynamics, database, entropy, enthalpy