

The high-pressure phase transition of anhydrite (CaSO₄) at 2 GPa – how anhydrous is anhydrite?

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Mineral reactions in which H₂O takes an essential role have a great influence on the P-T relations and provides important information on the properties of this compound. This may be demonstrated by the system CaSO₄ – H₂O that is characterised by two dehydration reactions

- gypsum = bassanite + 0.5 H₂O (CaSO₄*2 H₂O = CaSO₄*1.5 H₂O + 0.5 H₂O)
- bassanite = anhydrite + 1.5 H₂O (CaSO₄*1.5 H₂O = CaSO₄ + 1.5 H₂O).

Both dehydration boundaries, recently re-examined up to 3 GPa (Mirwald, 2003 and 2006), show a fine structure which has been related to anomalous PVT behaviour of H₂O (Mirwald, 2005a, b).

The bassanite/anhydrite boundary exhibits, in addition, a triple point (2.175 GPa /250°C) related to a high pressure phase transition of anhydrite at 2 GPa discovered by Stephens (1964) in room temperature compression experiments. Crystallographic studies (Borg & Smith, 1975; Crichton et al., 2005) revealed that the high pressure phase has a monzonite type structure.

In context with the above referenced dehydration work, the high-pressure transition of anhydrite was studied in more detail in its stability range. The experiments were conducted in a piston cylinder apparatus using DPA-technique (Mirwald & Massonne, 1982; Mirwald, 2005).

Runs with anhydrite + H₂O in the temperature range 200–500° C where the sample was produced by dehydration of gypsum in the closed capsule produce a sharp phase transition boundary of slight negative dP/dT slope (-0.3 MPa/K). The metastable extrapolation of the boundary to room temperature yields a transition pressure of 2.25 GPa compared to the previous value of 2 GPa (Stephens, 1964).

Another series of experiments was conducted with anhydrous synthetic or natural anhydrite that was carefully dried before encapsulation. The experiments were performed in the temperature range 25–500° C. The data obtained show a considerable range of transition, between 1.7 and 2.0 GPa. The averaged data of these anhydrous experiments yield a boundary that is located at pressure which 300 MPa lower than the hydrous ones. Extrapolation of this boundary by using that slight negative dP/dT slope to room temperature yields a pressure of 1.9 GPa.

Comparison of the two kind of experiments shows clearly that i) the presence of H₂O stabilises the phase transition towards higher pressure by considerable 300 MPa and ii) it facilitates a rapid phase transition process. This striking influence of H₂O leads simultaneously to the question: how anhydrous is anhydrite?

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