

In situ X-ray diffraction investigation of lawsonite and zoisite at high pressures and temperatures

KLAUS-D. GREVEL,* ELKE URSULA NOWLAN, DETLEF W. FASSHAUER, AND MICHAEL BURCHARD

Ruhr-Universität Bochum, Institut für Mineralogie, D-44780 Bochum, Germany

ABSTRACT

The P - V - T behavior of synthetic lawsonite [$\text{CaAl}_2(\text{Si}_2\text{O}_7)(\text{OH})_2\cdot\text{H}_2\text{O}$] and synthetic zoisite [$\text{Ca}_2\text{Al}_3(\text{SiO}_4)(\text{Si}_2\text{O}_7)\text{O}(\text{OH})$] has been determined under high pressures and high temperatures up to 7 GPa and 1000 °C using a MAX 80 cubic anvil high-pressure apparatus. Several experimental runs were carried out for both minerals, first compressing the samples at room temperature and then heating them until a breakdown reaction occurred. Generally, the samples were mixed with vaseline to ensure hydrostatic pressure transmitting conditions, NaCl served as an internal standard for pressure calibration. The pressure data at room temperature were fitted to a Birch-Murnaghan equation of state (K_{T_0} assumed to be 4), yielding isothermal bulk moduli $K_{T_0} = 106.7 \pm 1.3$ GPa for lawsonite and 125.1 ± 2.1 GPa for zoisite, respectively. These values agree well with recent results. The high-temperature high-pressure data were fitted to the high-temperature Birch-Murnaghan equation of state. In contrast to other investigations, $(\partial K_T / \partial T)_P$ is slightly negative for lawsonite. The sign is not affected by considering the thermal expansion data at ambient pressure. Similar calculations for zoisite yielded a positive $(\partial K_T / \partial T)_P$ without using high-temperature data at atmospheric pressure whereas a negative sign resulted from calculations taking into account the 1 bar thermal expansivity. Calculations of several mineral equilibria involving zoisite and lawsonite with the Berman data set supplemented by the P - V - T data presented here correspond well to experimentally determined pressure stability limits of these phases.