

## **Experimental determination of the equilibria: rutile + magnesite = geikielite + CO<sub>2</sub> and zircon + 2 magnesite = baddeleyite + forsterite + 2 CO<sub>2</sub>**

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### **ABSTRACT**

The *P-T* conditions of both equilibria were determined precisely by reversal experiments in a piston-cylinder apparatus. On the basis of 8 experiments, brackets for the rutile-magnesite-geikielite equilibrium are 7.0–7.1 kbar at 800 °C, 8.6–8.7 kbar at 850 °C, and 10.5–10.7 kbar at 900 °C. On the basis of 9 experiments, brackets for the zircon-magnesite-baddeleyite-forsterite equilibrium are 7.1–7.7 kbar at 800 °C, 9.2–9.4 kbar at 850 °C, and 10.7–10.9 kbar at 900 °C. Considering experimental uncertainties in *P* ( $\pm 300$  bars) and *T* ( $\pm 3$  °C), equilibrium curves calculated from both the Berman and the Holland and Powell databases pass through all brackets. Molar Gibbs free energy of formation from the elements at 1 bar and 298 K for geikielite and zircon, derived from the experiments and consistent with the Berman database, are  $-1481.94 \pm 0.67$  kJ and  $-1917.54 \pm 1.25$  kJ, respectively. Corresponding values consistent with the Holland and Powell database are  $-1479.30 \pm 0.74$  kJ and  $-1918.47 \pm 1.49$  kJ. Application of the two equilibria indicate that: (1) the mole fraction of CO<sub>2</sub> in fluid was 0.54–1.00 when geikielite and baddeleyite formed during contact metamorphism of siliceous dolomites in the Ballachulish aureole, Scotland; (2) the activity of CO<sub>2</sub> could have been as low as  $2 \cdot 10^{-5}$  during ultra-high pressure metamorphism of magnesite-bearing eclogites; and (3) the activity of CO<sub>2</sub> was  $< 0.18$  during one instance of mantle metasomatism.