

The Mg(Fe)SiO₃ orthoenstatite-clinoenstatite transitions at high pressures and temperatures determined by Raman-spectroscopy on quenched samples

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ABSTRACT

The phase boundaries limiting the stability fields of the three different Mg(Fe)SiO₃ phases [orthoenstatite (Oen), low-temperature clinoenstatite (LCen), and high-pressure clinoenstatite (HCen)] that occur at the pressure-temperature conditions prevailing in the Earth's upper mantle are inferred from Raman spectroscopy on quenched samples from high *P-T* experiments. There are subtle but significant differences between the spectra of Oen and the spectra of samples quenched within the stability field of HCen or LCen. The most prominent differences are additional peaks at 369 and 431 cm⁻¹ in the spectrum of Cen and a systematic shift of the peak at 236 cm⁻¹ in the Oen spectrum to 243 cm⁻¹ in the Cen spectrum. However, no distinction can be made between samples quenched from the HCen and LCen stability fields. This is consistent with the fact that the HCen phase is non-quenchable and that the pyroxene phase observed in the experimental products is LCen as verified by powder X-ray diffraction.

Experiments performed in the pressure-temperature range 1.2–14 GPa and 750–1900 K have been used to constrain the Mg(Fe)SiO₃ phase diagram. Pyroxene compositions cover the range from pure MgSiO₃ to Mg_{0.9}Fe_{0.1}SiO₃ with minor amounts of Al, Ca, Na, and Cr. The results are similar to previous determinations from X-ray and optical studies and tightly constrain the HCen–Oen phase boundary, which can be expressed by the equation P (GPa) = 0.00454 T (K) + 1.673. The LCen–Oen boundary is not as well constrained, but the data are sufficient to locate the invariant point where all three MgSiO₃ phases coexist at 6.6 GPa and 820 °C.