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Orientation of exsolution lamellae in mantle xenolith pyroxenes and implications for calculating exsolution pressures

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Abstract

Exsolution lamellae in pyroxene occurring in mantle lherzolite xenoliths in Cenozoic basalts from the Mingxi area, Fujian Province, China, have been investigated by electron backscattered diffraction (EBSD) to determine epitaxial relationships between host and lamellae. Clinopyroxene (diopside) hosts developed two sets of lamellae: one of orthopyroxene (pigeonite-enstatite) lamellae and the other of clinopyroxene (augite) lamellae. Orthopyroxene (enstatite) hosts developed a single set of clinopyroxene (augite) lamellae. A zone crossing method has been used to determine Miller indices of lamellae, which appear as linear traces on thin sections tested by EBSD. In clinopyroxene hosts, the index of orthopyroxene lamellae is (100) and that of clinopyroxene lamellae is ~(401) at 22° to the *c*-axis. In orthopyroxene hosts, the index of clinopyroxene lamellae is (100). Published high-pressure crystallographic data for compositions approximating those of the lamellae and host are used to compare cell parameters of lamellae and hosts at different pressures. Exact phase boundary theory is applied to estimate the exsolution pressure, and the data uncertainty of composition, cell parameters and orientation of the lamellae have been analyzed. Uncertainties of composition and cell parameters give rise to only small uncertainties in the exsolution pressure, but that of the orientation of the lamellae generates large uncertainty. Independent high accuracy measurement of the angle between lamellae and *c*-axis by TEM or other techniques combined with exact phase boundary theory would give more reliable estimates of exsolution pressure.

Keywords: Exsolution, pyroxene, crystallographic orientation, mantle xenoliths, error-analysis, EBSD