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Pressure-induced phase transitions in Ni-bearing ferrosilite (Ni-$En_{31}Fs_{65}$)

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Abstract

Orthopyroxene is an abundant mineral in subducting slabs. Studying its phase transitions at high pressure is important to the understanding of mineralogy of subducting slabs in the deep Earth. Synchrotron-based single-crystal X-ray diffraction experiments were conducted on a synthetic Ni-bearing ferrosilite (Ni-$En_{31}Fs_{65}$) at pressures up to 33.8 GPa. Three phase transitions were observed at 12.1(6), 15.6(6), and 31.3(25) GPa. The first two phase transitions in Ni-$En_{31}Fs_{65}$ resemble the previously described phase transitions in Ni-free Fe-rich orthopyroxenes, i.e., the initial α-opx (*Pbca*) transforms to β-opx ($P2_1/c$), then the latter transforms to γ-opx (*Pbca*). This indicates that the incorporation of a few mol% $NiSiO_3$ does not influence the phase transition path of Fe-rich orthopyroxene. After the third phase transition, the structure ($P2_1ca$) of Ni-$En_{31}Fs_{65}$ resembles the previously reported β-popx observed in En_{90} at high pressure, although the onset pressure of the phase transition in Ni-$En_{31}Fs_{65}$ is ~7 GPa lower than that in En_{90}. β-popx has a post-pyroxene structure that contains fivefold- and sixfold-coordinated Si cations. Our results indicate that the post-pyroxene structure is β-popx ($P2_1ca$) for either Fe-poor or Fe-rich orthopyroxenes, although the phase transition path before the pyroxene → post-pyroxene is compositionally dependent. Additionally, unlike the second and third transitions, whose onset pressures are monotonously decreased by increasing Fe content, the Fe effect on shifting the first transition is much more significant for orthopyroxenes within En <50 mol% than that within En >50 mol%.

Keywords: Pyroxene, phase transition, single-crystal X-ray diffraction, high pressure