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The stability of clinopyroxene in the system CaO-MgO-SiO_2-TiO_2 (CMST)

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ABSTRACT

To investigate the substitution of Ti^{4+} for Si^{4+} on tetrahedral sites in clinopyroxene, a series of Ti-bearing clinopyroxene compositions was synthesized in the system CaO-MgO-SiO_2-TiO_2 (CMST) at pressures from 1 atm to 2 GPa and temperatures from 800 to 1200 °C. Along the join $CaMgSi_2O_6$(diopside)–$CaMgTiSiO_6$, clinopyroxene crystallizes, depending on coexisting phases, as binary solid solutions (diopside-$CaMgTiSiO_6$) or ternary solid solutions (diopside-$CaMgTiSiO_6$-enstatite). The solubility of Ti increases with increasing temperature, whereas it decreases with increasing pressure. The binary clinopyroxene has an invariant composition $(CaMgSi_2O_6)_{93}(CaMgTiSiO_6)_7$ (mol%) corresponding to a Ti content of 2.6 wt% at 1000 °C and 1 atm. Magnesium substitutes in the M2 site in ternary clinopyroxene and its solubility mainly increases with increasing temperature. The substitution of Si^{4+} by the larger Ti^{4+} cation on tetrahedral sites causes a linear increase in a, b, c, β, and V by 0.0020 Å, 0.0012 Å, 0.0016 Å, 0.01°, and 0.28 $Å^3$ per mol% $CaMgTiSiO_6$, respectively.