

## Melting phase relation of Fe-bearing Phase D up to the uppermost lower mantle

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### ABSTRACT

Dense hydrous magnesium silicates (DHMSs) are considered important water carriers in the deep Earth. Due to the significant effect of Fe on the stability of DHMSs, Fe-bearing Phase D (PhD) deserves much attention. However, few experiments have been conducted to determine the stability of PhD in different bulk compositions. In this study, we provide experimental constraints for the stability of PhD in the  $\text{AlOOH-FeOOH-Mg}_{1.11}\text{Si}_{1.89}\text{O}_6\text{H}_{2.22}$  system between 18 and 25 GPa at 1000–1600 °C, corresponding to the  $P$ - $T$  conditions of the mantle transition zone and uppermost lower mantle.

$\text{Fe}^{3+}$ -bearing PhD was synthesized from the  $\text{FeOOH-Mg}_{1.11}\text{Si}_{1.89}\text{O}_6\text{H}_{2.22}$  binary system with two different  $\text{Fe}^{3+}$  contents. The resultant  $\text{Al,Fe}^{3+}$ -bearing compositions are close to analog specimens of the fully oxidized mid-ocean ridge basalt (MORB) and pyrolite in the  $\text{AlOOH-FeOOH-Mg}_{1.11}\text{Si}_{1.89}\text{O}_6\text{H}_{2.22}$  ternary system. The substitution mechanism of Fe is shown to be dependent on pressure, and  $\text{Fe}^{3+}$  occupies both Mg and Si sites in PhD at pressures below 21 GPa. In contrast,  $\text{Fe}^{3+}$  only occupies Si site at pressures exceeding 21 GPa. The presence of  $\text{Fe}^{3+}$  results in a slight reduction in the thermal stability field of PhD in the  $\text{FeOOH-Mg}_{1.11}\text{Si}_{1.89}\text{O}_6\text{H}_{2.22}$  system in comparison to Mg-bearing, Fe-free PhD. In contrast,  $\text{Al,Fe}^{3+}$ -bearing PhD is more stable than Mg-bearing PhD in both MORB and pyrolite compositions. In this regard,  $\text{Al,Fe}^{3+}$ -bearing PhD could act as a long-term water reservoir during subduction processes to the deep mantle.

**Keywords:** Hydrous minerals, stability region, high temperature and high pressure, Phase D; Volatile Elements in Differentiated Planetary Interiors