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Water storage capacity of davemaoite constrained by in-situ volume measurements using a multi-anvil press

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1.Introduction

Water significantly influences physical and chemical properties of Earth's mantle. Experimental and petrological studies suggest that the Earth's mantle transition zone is a large water reservoir. On the other hand, the water storage capacity of the lower mantle is still under debate. Although major lower-mantle minerals of bridgmanite and ferropericlase have limited water solubility, recent experimental and theoretical studies suggest davemaoite (CaSiO3 perovskite), a major lower-mantle mineral, can accommodate few weight percents of water [1,2]. Previous studies using a laser-heated diamond anvil cell showed negative volume changes up to 2 % under hydrous conditions and their link with significant hydrogen incorporation into the crystal structure. However, the water solubility is still unclear due to its unquenchable nature and previous difficulty to precisely collect in-situ experimental data.
In this study, we examined water solubility of davemaoite up to top-lower mantle conditions (30 GPa and 2100 K) based on in-situ precise volume measurements by means of advanced multi-anvil technology in combination with synchrotron X-ray diffraction [3,4].

2.Results

Our results showed volume difference of davemaoite under dry and hydrous conditions is limited (consistent within errors) at mantle expected temperatures. In addition, the crystal structure of davemaoite is cubic even under hydrous conditions along mantle geotherms. These results imply that limited water in the crystal structure.
Based on our findings, we suggest that peridotite is nearly dry after dehydration of hydrous minerals in the lower mantle, whereas crustal materials such as basaltic crust are likely serves as significant water reservoirs, providing new insights into the deep Earth's water cycle.

3.References

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