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ABSTRACT BOOK

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Crystal-chemistry and thermo-elastic behavior of chlorite: implications for shear accommodation in subduction zones

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Chlorite is one of the most important water-bearing phases and its behavior at high pressure conditions has a significant role in the modeling of dehydration processes in subduction zones (Poli & Schmidt, 2002; Fumagalli et al., 2014). A previous study on single crystals of natural clinocllore (Val d’Ala, Italy) allowed the determination of its bulk modulus both at room temperature and 600 K (Chrappan Soldavini et al., 2024). Combining with the previous data a synchrotron single crystal X-ray diffraction (SC-XRD) study from 100 K to 930 K performed at room pressure on the same sample, we report the first single-crystal PVT equation of state for clinocllore up to 4.5 GPa. As reported in Chrappan Soldavini et al. (2024), the high pressure (HP) behavior of clinocllore is characterized by two phase transitions, the latter involving a significant volume discontinuity with a volume reduction of 0.7% and a significant effect also on the bulk modulus. This phase transition has been associated to a polytypic phase transition with the stabilization of a chlorite polytype that was predicted theoretically by Brown & Bailey (1962) but never observed before. Despite this polytypic phase transition having been observed at pressure around 8.5 GPa, incompatible with the stability field of clinocllore in multiphase systems, its negative slope boundary in the pressure-temperature space suggests that this could indeed be an important structural variation under higher temperature (HT) conditions, compatible with subduction zones. We report two experiments conducted using the large-volume press combined with synchrotron powder XRD (ID06-LVP, ESRF) starting from the same clinocllore sample and resembling subduction P-T paths. Interestingly, we observed the same phase transition in both experiments. We also performed a SC-XRD compressibility study on a ripidolite sample and observed the same phase transition at around 8.5 GPa, suggesting that the composition of chlorite does not play an important role on its behavior upon compression. Additionally, we report in-situ powder diffraction experiments on natural chlorites with different iron and/or chromium content to assess the crystal-chemical effect on the thermal expansion coefficient of this phase. Our results offer valuable insights on the crystal-chemical and thermo-elastic features of chlorite unveiling the role of polytypic phase transitions in subduction contexts. We suggest that this phase transition, which is related to a relative shifting of the talc-like layers that form the crystal structure, could accommodate shear stresses preventing chlorite from early destabilization. A widening of the chlorite stability field could then have an interesting impact on the water storage and transport to the mantle.

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