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P-V-T equation of state of the calcium aluminosilicate CAS phase, up to 24 GPa and 2100 K

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The CAS phase is a Ca-rich aluminosilicate that has been first observed with the composition of $\text{Ca}_{0.8}\text{Al}_{3.6}\text{Si}_{2.4}\text{O}_{11}$ (with small amount of Na_2O and K_2O) in the decomposition product of sediments and continental crust composition at P,T conditions of mantle transition zone [1]. Later experiments also found the CAS phase as a liquidus phase in melting experiments on Mid-Ocean Ridge Basalts (MORB) compositions at 26-27 GPa and ~2500 K [2, 3]. According to those former studies, the CAS phase could represent up to 10 vol% of the subducted continental crust or 30 vol% of the solid fraction of partially molten MORBs in the deep mantle. Also, naturally occurring CAS phase has also been discovered in shocked martian meteorites [4]. Thus, the CAS phase might be an important constituent mineral of sediments and basalts subducted in the deep mantle.

The pressure-volume-temperature relations of the CAS phase with the composition of $\text{CaAl}_4\text{Si}_2\text{O}_{11}$ was examined in situ up to 24 GPa and 2100 K by energy dispersive X-ray diffraction, using a Kawai-type multi-anvil press apparatus coupled with synchrotron radiation in SPring-8 (Japan). At 300 K, we found that the CAS phase would be ~25% more compressible than Ono et al. [5]. From our high-temperature data we report for the first time the thermoelastic parameters of the CAS phase and discuss its compressibility and thermal expansivity relative to the lattice parameters variation at high-P,T.

These new data enables the accurate estimate of density of the CAS phase in the deep mantle for various temperature profiles (i.e. adiabatic mantle or cold slab geotherms). Our results suggest that with increasing the mineral proportion of the CAS phase, the density of slabs would increase when subducted in the mantle transition zone. On the other hand, because of lesser densities compared to lower mantle minerals, the CAS phase is expected to remain buoyant in the lowermost part of the transition zone.

References

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