The baric behaviour of Bloedite at low and high *T*: A contribution to the study of icy satellites

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Bloedite [$Na_2Mg(SO_4)_2 \cdot 4H_2O$], $P2_1/a$ space group, is a common constituent in evaporitic sedimentary environments and it has been suggested to be stable on icy satellites (Europa, Ganymede). The knowledge of the release of water from its structure as a function of pressure and temperature is of great interest to planetary scientists since it can be used to explain the presence of a deep ocean under the icy crust, and to understand the cryovolcanism phenomena observed from Voyager data. However, to date, there are no available data to predict possible structural modifications of bloedite (*i.e.* dehydration conditions) as a function of pressure, particularly at low temperature.

We performed *in situ* synchrotron X-ray powder diffraction experiments on natural bloedite at pressures up to 10 GPa and temperatures from ~100 K to ~570 K using diamond anvil cell technique at GSECARS, Advanced Photon Source (Argonne, USA).

The resulting negative linear thermal expansion coefficients from ambient pressure and low-*T* experiments are: $\alpha_c = 4.4(4)\cdot 10^{-5}$ K^{-1}, $\alpha_b = 1.4(3)\cdot 10^{-5}$ K^{-1}, $\alpha_a = 0.7(2)\cdot 10^{-5}$ K^{-1}, and $\alpha_V = 5.8(7)\cdot 10^{-5}$ K^{-1}. From high-*T* runs, the calculated thermal expansion coefficients are: $\alpha_c = 3.7(1)\cdot 10^{-5}$ K^{-1}, $\alpha_b = 2.5(3)\cdot 10^{-5}$ K^{-1}, $\alpha_a = 2.5(3)\cdot 10^{-5}$ K^{-1}, and $\alpha_V = 8.3(6)\cdot 10^{-5}$ K^{-1}. Non-linear thermal expansion coefficients for *a* and *V* parameters and linear for *b* and *c* were measured at 10 GPa up to 570 K. Both compression and expansion behaviours of bloedite are strongly anisotropic with *a* parameter more deformed with respect to *b* and *c*, in good agreement with Comodi *et al.* 2013 [1] where a strongly anisotropic compressibility was observed under H*P* at room temperature.

Thermogravimetric analyses were also performed at ambient pressure showing three endotherms at 410 K, 500 K and 1000 K, with weight losses of approximately 11%, 11% and 43% related to partial dehydration, full dehydration and sulphate decomposition, respectively. However, no evidence of dehydration were observed up to 570 K and 10 GPa.

Measurements of the lattice parameters of bloedite at the experimental conditions would suggest that pressure can stabilize the water molecules in the bloedite structure with implications for the extent of a thick icy crust.

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K- and La- doped smectite under high pressure and temperature conditions: Implication on mantle metasomatism

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The lithospheric mantle is depleted in incompatible elements and basically anhydrous or nearly anhydrous. This region can be rehydrated and re-enriched in these elements through subduction processes that brings, among others, pelagic material. In subduction zones, smectite is one of the most important minerals that could bring together water and trace elements into the mantle. In order to test the influence of smectite in the mantle metasomatism, we are developing phase diagrams under high pressure and temperature (HPHT) in K- and La-doped smectite. Our results show that La-smectite is stable under pressures of 2.5GPa, 4.0 and 7.7GPa at temperatures up to 250°C, ~300°C and 350°C, respectively, above which they transform into a muscovite-like structure, being irreversible in such conditions. K-smectite, however, is stable at temperatures around 250° C, independently of any pressure. Above this temperature, it transforms into a I/S structure previously to changing into a muscovite structure at ~450°, 350° and ~300°C, under 2.5, 4.0 and 7.7GPa, respectively. These results show that pressure does not affect the stability of K-smectite, which remain stable up to 250°C under pressures up to 7.7GPa. On the other hand, higher pressures enlarge smoothly the La-smectite stability field in a very limited extension. Transformation of La-smectite into muscovite occurs directly, but K-smectite transformation occurs via I/S structure. When our results are compared to water/ice stability, we observe that La-smectite/muscovite transformation is in perfect agreement with ice/water transformation. Once ice became water, La-smectite became muscovite. However, K-smectite does not have such straightforward influence on ice/water transformation due to the existence of the I/S stability field.

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