High-temperature behavior and dehydration of the natural borate colemanite

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Colemanite, $CaB_3O_4(OH)_3 \times H_2O$, is the most common natural hydrous calcium borate and one of the most important mineral commodities for boron. It is mainly extracted from Turkish deposits, which form from relatively diluted waters of lacustrine basins, hosted in continental semi-arid to arid environments and fed by B-rich hydrothermal springs related to a local volcanic activity (e.g. Helvaci & Alonso, 2000). Due to its common occurrence in waste rocks at extraction sites, several studies have been focused in the recent past on the exploitation of colemanite as raw material, for example as an additive in the production of lightweight cements (Targan et al., 2003) or radiation shielding materials (Glinicki et al., 2018). However, despite the utilizations of colemanite, we still have only a partial knowledge of the high-temperature behavior of this mineral compound.

In this study, we investigated the high-temperature behavior of a natural sample of colemanite from the Bigadiç deposit (Turkey), by means of in situ powder synchrotron X-ray diffraction, performed at the MCX beamline of Elettra (Trieste, Italy), using a hot blower device.

The refined unit-cell parameters show a significantly anisotropic thermal expansion, which is only accommodated along the **b** and **c** crystallographic axes, whereas the **a** axis, corresponding to the direction of the chains of B-coordination polyhedra, is almost unaffected. Between 275 and 325 °C, a reduction in the unit-cell volume and a decrease in the refined occupancy of the H_2O-oxygen site, reveal the occurrence of a dehydration phenomeno, which is followed by a complete and irreversible amorphization between 325 and 375 °C.

Merging the *V*-*T* data of this experiment with those obtained in a previous low-*T* experiment on the same natural sample (Lotti et al., 2018), a thermal Berman-type equation of state was refined in the range from -171 to 250 °C (104-525 K), yielding a thermal expansion coefficient at ambient-*T* (a_{V298K}) of $4.5(1)\times10^{-5}$ K^{-1} and $a_1 = 5.7(8)\times10^{-8}$ K^{-2}.

Glinicki, M.A., Antolik, A. & Gawlicki, M. (2018): Evaluation of compatibility of neutron-shielding boron aggregates with Portland cement in mortar. Constr. Build. Mater., 164, 731-738.

Helvaci, C. & Alonso, R.N. (2000): Borates Deposits of Turkey and Argentina: A Summary and Geological Comparison. Turkish J. Earth Sci., 9, 1-27.

Lotti, P., Gatta, G.D., Demitri, N., Guastella, G., Rizzato, S., Ortenzi, M.A., Magrini, F., Comboni, D., Guastoni, A. & Fernandez-Diaz, M.T. (2018): Crystal chemistry and temperature behavior of the natural hydrous borate colemanite, a mineral commodity of boron. Phys. Chem. Minerals, in press DOI: https://doi.org/10.1007/s00269-017-0929-7.

Targan, S., Olgun, A., Erdogan, Y. & Sevinc, V. (2003): Influence of natural pozzolan, colemanite ore waste, bottom ash, and fly ash on the properties of Portland cement. Cement Concrete Res., 33, 1175-1182.