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New data and structural model for tobermorite 9 Å

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The tobermorite group is composed by a group of calcium silicate hydrates, widely studied for their relationship with the main binding agent of Portland cement and for their potential technological applications. The phases belonging to this group differ for their basal spacings (14, 11, and 9 Å), related to their water content. The 11 Å members of the group differ also for their thermal behaviour, which can be described as "normal" (tobermorite 11 Å shrinks to a 9 Å phase at 300˚C) or "anomalous" (tobermorite 11 Å does not shrink). It is matter of debate if the natural phase with a 9 Å basal spacing, $i.e.$ riversideite, actually exist. However, the 9 Å phase can be obtained by heating "normal" tobermorite 11 Å at 300˚C.

We studied specimens of "normal" tobermorite from Montalto di Castro and Vallerano (Latium, Italy) and from Bashenov (Ural, Russia).

Using the specimen from Montalto di Castro, the thermal behaviour of "normal" tobermorite was studies by means of thermo-gravimetric analysis, in situ X-ray diffraction experiments, and spectroscopic techniques. TG-DSC and *in situ* X-ray diffraction studies showed the transformation of tobermorite 11 Å into tobermorite 9 Å at about 300˚C; the latter recrystallized into wollastonite above 800˚C. During the transition from the 11 to the 9 Å phase, a 11 Å clinotobermorite-like phase seems to form.

The single crystal X-ray diffraction study of the sample from Bashenov allowed us to determine the average structure of tobermorite 9 Å. A realiable model of the real structure of the dehydration product of tobermorite 11 Å was derived on the basis of the OD theory and of all the experimental evidences. In addition, the close relationships and the distinctive features of clinotobermorite 9 Å and tobermorite 9 Å were investigated. Tobermorite 9 Å is characterized by the same kind of complex modulus shown by the 11 Å, composed by a layer of seven-fold coordinated Ca polyhedra parallel to (001), decorated on both sides by wollastonite-like chains. Whereas these silicate chains are double in the 11 Å phase, they are single in tobermorite 9 Å, in agreement with spectroscopic data.