

structures of 1, 2, 3, 4, 5, 7 it is tetragonal and pentagonal (deformed octahedra and pentagonal bipyramids, respectively), in the structure of 6 uranium atoms have  $UO_8$  and  $UO_7$  coordination, and in the structures of 8 and 9 three different uranyl ion coordinations – tetragonal, pentagonal and hexagonal are realized (actually, this is the first actinide compounds with the actinyl cation in three different coordinations). The configuration of the CCIs in these structures differ: dimers in 1 and 3, two types of trimers in 2, 4 and 5, pentamers in 8 and 9, in the structure of 6 circular hexamers are realized, and in the structure of 7 observes a one-dimensional array of two- and three-center cation-cation bonds. The configurations of CCIs realized in the structures of 5, 6, 7 and 8 have been observed for the first time. It should be mentioned that all compounds except 1 and 3 crystallized in new structure types.

**Keywords:** uranium compounds; crystallography inorganic; crystallochemistry

#### FA2-MS01-O4

**The Tobermorite-Like Layer in Non-Tobermorite Minerals.** Elena Bonaccorsi<sup>a</sup>, Stefano Merlino<sup>a</sup>. <sup>a</sup>University of Pisa – Earth Science Department Via S. Maria 53, 56126 Pisa, Italy.

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The tobermorite-like layer (TLL) is a characteristic feature in all the structures of the natural and synthetic compounds of the tobermorite group [1]. In those structures eptahedra of calcium cations, characterized by ‘a pyramidal part on one side and a dome part on the other side joining the equatorial oxygen atoms’, form columns through edge sharing; the columns are connected each other, once again through edge sharing, and adjacent columns present the pyramidal apical ligands on opposite sides of the resulting infinite layers. These layers, decorated with wollastonite chains on both sides, build up the ‘complex layers’ which are the basic structural module in all the phases of the tobermorite group (Fig. 1).

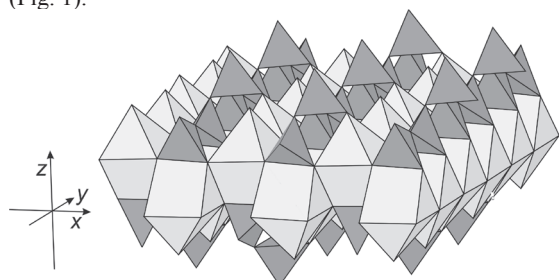


Fig. 1. The tobermorite-like layer decorated with wollastonite chains on both sides, as it appears in the structures of the natural and synthetic compounds of the tobermorite group.

TLL is a recurrent feature in several natural phases belonging to distinct mineral groups. In the structures of the compounds of the rinkite group the TLL is decorated on both sides by disilicate groups and is accompanied by an infinite ‘octahedral’ layer in building up the structural arrangement. Dovyrenite [2] and roumaite [3] are closely related to the minerals of the rinkite group and differ only

in the way of decoration of the TLL by the disilicate groups. Fukalite [4] too presents the TLL, decorated on both sides by four-repeat silicate chains and carbonate groups; tilleyite-type polyhedral layers are also present as distinct modules in building up the structural arrangement. The ubiquitous occurrence of TLL is related to its chemical and structural flexibility: the chemical and geometrical variations of the TLL in the different structures are described and discussed.

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**Keywords:** layered silicates; crystal structures; mineralogical crystallography

#### FA2-MS01-O5

**Byzantievite, the First Silicate-Borate-Phosphate Mineral.** Elena Sokolova<sup>a</sup>, Leonid Pautov<sup>b</sup>, Atali Agakhanov<sup>b</sup>, Frank Hawthorne<sup>a</sup>. <sup>a</sup>Department of Geological Sciences, University of Manitoba, Winnipeg, Canada. <sup>b</sup>Fersman Mineralogical Museum, Moscow, Russia.

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Byzantievite, ideally  $Ba_2(Ca,REE,Y)_{22}(Ti,Nb)_{18}(SiO_4)_4[(PO_4)_4(SiO_4)]_4(BO_3)_9O_{22}[(OH),F]_{43}(H_2O)_{1.5}$ , is the only mineral which contains three different oxyanions:  $(BO_3)$ ,  $(SiO_4)$  and  $(PO_4)$ . They occur in the ratio 9:5:3. Byzantievite occurs in the moraine of the Dara-i-Pioz glacier, the Alai mountain ridge, Tien-Shan Mountains, northern Tajikistan. Byzantievite has no natural or synthetic analogues. The crystal structure of byzantievite, a 9.1202(2), c 102.145(5) Å,  $\gamma$  120°, V 7357.9(5) Å<sup>3</sup>, sp. gr. *R3*, Z=3,  $D_{calc}$  4.151 g/cm<sup>3</sup>, was solved by direct methods and refined to an R index of 13.14%. In the crystal structure, there are fifty cation sites. Twenty-three sites are fully occupied and twenty-seven sites are characterized by partial occupancy: six sites are more than 50% occupied and twenty-one sites are less than 50% occupied. In the crystal structure of byzantievite, there are two distinct parts that alternate along the c axis. Part one is characterized mainly by fully occupied cation sites and part two, mainly by partially occupied cation sites. Part one has a local inversion centre whereas part two does not. Hence the crystal structure of byzantievite lacks an inversion centre. For better understanding of this framework structure, we describe it as sheets of polyhedra stacked along [001]. Sheet a is composed of [12]-coordinated Ba atoms. Ti-dominant octahedra and B-triangles share common vertices to form sheet b. [8]-coordinated (Ca,REE, Y) polyhedra and B triangles share common vertices and edges to form sheet c. Sheet d is composed of [10]-coordinated (Ca,REE, Y) polyhedra and P tetrahedra. Sheet e is formed by [8]-coordinated (Ca,REE, Y) polyhedra, Si tetrahedra and B