

THE CRYSTAL STRUCTURE OF AN APPARENTLY NEW  
MAGNESIUM SILICATE MINERAL: A POLYTYPE OF CARLOSTURANITE ?

U. Kolitsch<sup>1</sup>, E. Belluso<sup>2</sup>, A. Gula<sup>1,2</sup> & G. Ferraris<sup>2</sup>

<sup>1</sup>Institut für Mineralogie und Kristallographie  
Universität Wien, Geozentrum, Althanstrasse 14, A-1090 Wien, Austria

<sup>2</sup>Dipartimento di Scienze Mineralogiche e Petrologiche  
Università degli Studi di Torino, Via Valperga Caluso, 35, I-10125 Torino, Italia

Preliminary results will be presented on the crystal structure and physico-chemical properties of an apparently new magnesium silicate mineral which may be a polytype of carlosturanite,  $M_{21}[T_{12}O_{28}(OH)_4](OH)_{30}\cdot H_2O$  (where M = Mg, Fe, Ti, Mn, and Cr; and T = Si and Al) [1-3]. Carlosturanite (CST) is a water- and Mg-rich, Si-poor, serpentinite-like, asbestiform mineral, which is locally common in low-grade serpentinite rocks in the Italian Western Alps [4]. On the basis of chemical composition, XRPD and TEM data, a structure model of CST differing from that of lizardite only by substitution of rows of  $[Si_2O_7]^{6-}$  by  $[(OH)_6H_2O]^{6-}$  groups was proposed [2]. However, subsequent HRTEM images suggested possible variants of the proposed model [5].

The present studies used samples from two very close localities in the Po Valley, Cuneo, Piedmont, Italy. Fibrous samples intergrown with a not well identified layer silicate, from the first locality, were investigated by TEM, XRPD, SEM-EDS and EPMA, and results suggested a close relation to CST. Well-crystallised samples from the second locality provided brownish, transparent to translucent, lath-shaped crystals (platy on (100) and elongated along [010]) suitable for a single-crystal structure determination (Mo-K $\alpha$  radiation, CCD area detector,  $2\theta_{max} = 60^\circ$ ,  $R_{int} = 1.8\%$ ). These crystals are monoclinic, space group  $C2/m$ , with  $a = 14.583(3)$ ,  $b = 9.414(2)$ ,  $c = 18.306(4)$  Å,  $\beta = 102.09(3)^\circ$ ,  $V = 2457.4(9)$  Å<sup>3</sup>, and  $Z = 2$ . By the transformation matrix (102/010/-100) an F-centred cell with  $a = 36.46$ ,  $b = 9.414$ ,  $c = 14.583$  Å,  $\beta = 100.93^\circ$  is obtained. This cell orientation suggests a close, polytypical relation (see below) to CST which has the unit cell  $a = 36.70$ ,  $b = 9.41$ ,  $c = 7.291$  Å,  $\beta = 101.1^\circ$ ,  $V = 2470.8$  Å<sup>3</sup>, space group  $Cm$  [1, 2]. The structure has been solved and refined to  $R1 = 3.0\%$  and  $wR2_{all} = 9.4\%$  for 6643 'observed' reflections with  $F_o > 4\sigma(F_o)$ .

The structure refinement gave the formula  $(Mg,Fe,Ti,Mn)_{24}(Si,Al)_{12}O_{32}(OH)_{32}$ , which appears richer in octahedral cations than that given for CST. However, because only a TEM-based structure model is known for CST [2], and the determination of its correct chemical formula was hampered by intergrowths with serpentine minerals and fibrous diopside, the chemical formula of CST may in fact be very close to that of the new mineral. The X-ray powder diffraction patterns of both species are very similar, especially if the probable influence of preferred orientation is considered.

The structure is characterised by two interpenetrating octahedral sheets composed of  $MgO_6$  octahedra: one sheet parallel to (-201) and another, staggered sheet parallel to (001). At the intersection, both sheets are vacant and a [010] tunnel corresponding to an empty row of octahedra occurs. Thus, the octahedral sheets actually consist of two kinds of [010] strips: one is six-octahedra wide and parallel to (-201); the other is two-octahedra wide and parallel to (001). Silicate strips with a fixed width run along the b-axis. They are built from 6-membered rings linked along [010] via a single common  $O_{Si}$  atom. These silicate strips decorate the (-201) octahedral sheets in an alternating way (strips attached to the sheet bottom alternating with strips attached to the top; both 'bottom' and 'top' strips are linked to each other along [102] via two common  $O_{Si}$  ligands, thus resulting in 4-, 6- and 8-membered rings. The presence of silicate strips decorating octahedral sheets reveals some structural relations to the strip-like members of the 2:1 sheet silicates (ganophyllite/eggletonite, tamaite, minnesotaite, bannisterite, ajoite).

A refinement of the occupancies of all 8 Mg positions confirmed, along with polyhedral distortions of these positions, that most of these sites host variable but minor amounts of Fe and Ti (and very minor Mn), in agreement with the EPMA data.

It appears likely that the crystal structure of CST can be obtained from that of the apparent new polytype by shifting one *TO* layer of *b*/2. In this way, the periodicity of 14.583 Å is halved and the F-centred cell mentioned above becomes the C-centred cell reported for CST [1, 2]. Simulation of HRTEM images of both phases is in progress.

G. C. Piccoli and M. Ciriotti are thanked for kindly providing the studied samples. Financial support by the Austrian Science Foundation (FWF) (Grant P15220-N06) is gratefully acknowledged.

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