

## **The Bi sulfates from the Alfenza Mine, Crodo, Italy: An automatic electron diffraction tomography (ADT) study**

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### **ABSTRACT**

We report about three bismuth sulfates from mineralized quartz dikes from Alfenza (Crodo, Italy), two new phases and a rare mineral, cannonite, all growing on bismuthinite. The first new phase occurs as white, “hortensia-like” aggregates of pseudo-hexagonal platelets, with perfect basal cleavage, ~20  $\mu\text{m}$  wide and few micrometers thick. The approximate composition is  $\text{Bi}_2\text{O}_2(\text{SO}_4)$ , and cell parameters and symmetry, as determined by automatic diffraction tomography, are  $a = 22.0(4)$ ,  $b = 16.7(3)$ ,  $c = 15.9(3)$   $\text{\AA}$ ,  $\beta = 102.9(5)^\circ$ , space group  $Pc$  or  $P2_1/c$ . A major stacking disorder is detected by HR-SEM images and electron diffraction data.

The second new phase was detected only by TEM. It can be distinguished by its random orientation on the TEM grid (i.e., absence of preferential parting), the higher resistance under the electron beam, and different cell parameters and structure, whereas the composition is similar ( $\text{Bi}/\text{S} \sim 2.2/1$ ), apart for the presence of tellurium up to ~6 cations percents. The unit cell is hexagonal, space group  $P\bar{6}2c$ ,  $a = 9.5(2)$  and  $c = 15.4(3)$   $\text{\AA}$ . In this case, a structure model was obtained ab initio from electron diffraction data. Interestingly, the mineral has a porous structure with one dimensional porosity (diameter of the channel ~7  $\text{\AA}$ ).

Finally, within the same centimeter sized hand-specimens, we detected also cannonite. Its identification was done by automatic diffraction tomography. The measured cell parameters are  $a = 7.7(2)$ ,  $b = 13.9(3)$ ,  $c = 5.7(1)$   $\text{\AA}$ ,  $\beta = 109.8(5)^\circ$ , the space group  $P2_1/c$ . Cannonite at Alfenza forms radiating, acicular aggregates of colorless, transparent crystals with “scalpel-like” habit, elongated along **c**, up to 200  $\mu\text{m}$  in length.

**Keywords:** Electron crystallography, automatic diffraction tomography, bismuth sulfate, cannonite, porous phase