

## **Structural and spectroscopic characterization of a suite of fibrous amphiboles with high environmental and health relevance from Biancavilla (Sicily, Italy)**

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### **ABSTRACT**

This study reports new spectroscopic and structural data of fibrous amphiboles from the volcanic area of Biancavilla (Sicily, Italy) that generated interest because of an anomalous increase of pleural mesothelioma of inhabitants. Each of the four samples is made of loose fibers, which show an edenite-winchite (fluorine) compositional trend, with significant tremolite component. Small amounts of iron (3.6–6.0 wt% FeO<sub>tot</sub>) were identified in all samples, and the Fe<sup>3+</sup>/Fe<sub>tot</sub> ratios were evaluated by Mössbauer spectroscopy: two samples are characterized by Fe<sup>3+</sup>/Fe<sub>tot</sub> ratios between 50 and 70%, and the other two have Fe<sup>3+</sup>/Fe<sub>tot</sub> ratios higher than 90%. The OH-stretching region was investigated by FTIR, and no absorption bands were observed. Structural investigation was carried out by X-ray powder diffraction using the Rietveld method. Cell parameters, positional parameters for all the atoms, and site scattering for M1, M2, M3, M4, A, and A(*m*) were refined. The most important differences with respect to prismatic fluoro-edenite are the decrease of  $\beta$ , *a*, and *c* with decreasing Ca content, A-site occupancy, and tetrahedral Al content, respectively. By combining chemical, spectroscopic, and structural data, possible site occupancies were obtained. In particular, it was found that Fe<sup>2+</sup> is distributed between M1 and M2 sites; moreover, for the two samples enriched in Fe<sup>2+</sup>, it is also present at M4. Fe<sup>3+</sup> is generally ordered at M2 site; however, for the two samples enriched in Fe<sup>3+</sup>, minor amounts are partially disordered between M1 and M3 sites.

For the Biancavilla amphibole fibers, the large compositional variation observed in every sample makes the classification very difficult, so that the regulatory agencies would not classify as “asbestos” the whole mineral series, because of the large components of edenite and winchite in addition to tremolite. Many common features were found with respect to amphibole fibers from Libby, Montana, including Fe contents and oxidation state. Preliminary results of *in vitro* toxicological tests on Biancavilla fibers confirmed their high reactivity, and suggest that the samples with the highest Fe<sup>2+</sup> contents induce a rapid start to cell mortality.

**Keywords:** Amphiboles fibers, fluoro-edenite, Biancavilla, Mössbauer spectroscopy, Rietveld method, crystal chemistry, environmental and health relevance