

Crystal chemical and structural characterization of fibrous tremolite from Susa Valley, Italy, with comments on potential harmful effects on human health

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ABSTRACT

This study is part of a broad research project devoted to the “amphibole fibers environmental problem” as related to the proposed excavation of the Susa Valley railway tunnel. In this locality, tunnel excavations are planned through metamorphic formations containing amphibole asbestos minerals, and this may give rise to worker health and public environmental issues. The Susa Valley tremolite shows a marked fibrous character, a small reduction of fiber size under grinding, and a consistent increase of the surface area. From the toxicological point of view, such tremolite fibers have been shown to be very effective in the generation of reactive oxygen species. They exhibit a very high cellular reactivity as a consequence of their morphology, structure, and crystal chemistry. Results of combined electron microprobe analysis, Mössbauer spectroscopy, and parallel-beam X-ray powder diffraction are reported for fibrous tremolite from a serpentine-schist from the “Unità Oceanica della Bassa Val di Susa” collected near Condove, Susa Valley, Italy. Data indicate that Fe^{2+} (84% of Fe_{tot}) is located at both the (M1 + M3) and M2 sites and that Fe^{3+} is at M2, in an approximate 3:2:1 ratio, respectively. No evidence of a split M4 site has been observed. The presence of $^{\text{M1+M3}}\text{Fe}^{2+}$ is confirmed by FTIR spectroscopy to be distributed 70% at M1 and 30% at M3. Both the composition $(\text{Ca}_{1.95}\text{K}_{0.01}\text{Na}_{0.05})_{\Sigma 2.01}(\text{VIAl}_{0.01}\text{Fe}_{0.02}^{3+}\text{Fe}_{0.11}^{2+}\text{Mg}_{4.84}\text{Mn}_{0.02})_{\Sigma 5.00}\text{Si}_{8.00}\text{O}_{22}(\text{OH}_{1.96}\text{F}_{0.03}\text{Cl}_{0.01})_{\Sigma 2.00}$ and the cell volume $907.37(1) \text{ \AA}^3$ of the fibers are close to those expected for end-member $(\text{Ca}/\text{Mg} = 2/5)$ tremolite.

Keywords: Fibrous tremolite, amphibole crystal chemistry, Mössbauer spectroscopy, Rietveld method, electron microprobe analysis, Susa Valley, Italy, Trans European Network