

Composition, Fe³⁺/ΣFe, and crystal structure of non-asbestiform and asbestiform amphiboles from Libby, Montana, U.S.A.

**MICKEY E. GUNTER,^{1,*} M. DARBY DYAR,² BRENDAN TWAMLEY,³ FRANKLIN F. FOIT JR.,⁴
AND SCOTT CORNELIUS⁴**

¹Department of Geological Sciences, University of Idaho, Moscow, Idaho 83844-3022, U.S.A.

²Department of Earth and Environment, Mount Holyoke College, South Hadley, Massachusetts 01075, U.S.A.

³University Research Office, University of Idaho, Moscow, Idaho 83844-3010, U.S.A.

⁴Department of Geology, Washington State University, Pullman, Washington 99164-2812, U.S.A.

ABSTRACT

Compositional data and Fe³⁺/ΣFe ratios obtained by electron microprobe and Mössbauer analyses are given for a suite of three amphibole and amphibole-asbestos samples collected from the former vermiculite mine near Libby, Montana. A crystal structure analysis, compositional data, and Fe³⁺/ΣFe values for two samples from a previous study are also reported. The results confirm the conclusion drawn in the previous study that these amphiboles are dominantly compositions ranging from winchite to richterite. Mössbauer spectroscopy yielded Fe³⁺/ΣFe ratios from 58% to 72% for the five samples.

The crystal structure was determined for a single crystal selected from a bulk sample. Its formula (as determined by electron microprobe analysis and Mössbauer spectroscopy) is (K_{0.19}Na_{0.32})_A(Na_{0.85}Ca_{1.12}Mn_{0.03})_B(Mn_{0.01}Mg_{4.43}Fe_{0.34}³⁺Fe_{0.19}²⁺Ti_{0.01}Al_{0.02})(Al_{0.03}Si_{7.97}O₂₂)(OH_{1.63}F_{0.37}). The refinement was carried out based on space group *C2/m*, with *a* = 9.879(2), *b* = 18.024(3), *c* = 5.288(1) Å, β = 104.377(3)° and using data collected at room temperature. Mg is partitioned among the M1, M2, and M3 sites. All of the Fe³⁺ occupies M2, while Fe²⁺ is split between M2 and M3; Ca and Na fill the M4 site, while Na and K occupy the partially filled A site. The A-site occupancy is calculated as 0.51 based on chemical data, but only 0.48 based on X-ray diffraction results. Minerals with the former values would be classified as richterite and those with the latter as winchite.