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Magnesio-ferri-hornblende, $\square Ca_2(Mg_4Fe^{3+})[(Si_7Al)O_{22}](OH)_2$, a new member of the amphibole supergroup

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Abstract

Magnesio-ferri-hornblende, ideally $\square Ca_2(Mg_4Fe^{3+})[(Si_7Al)O_{22}](OH)_2$, is a new mineral of the amphibole supergroup from the Husite granitic complex related to skarn-type Fe-Cu mineralization in the Western Tianshan, Xinjiang, northwestern China. The new species and the new name have been approved by the IMA-CNMNC (2021-100). Magnesio-ferri-hornblende is dark green to green-black with a vitreous luster and a pale gray-green to gray-white streak. It occurs mostly as subhedral-columnar crystals with lengths of 0.5 to 3 mm and shows well-developed {110} cleavage. It has a Mohs hardness of ~5 and a Vickers microhardness of 389–448 kg/mm^2 (VHN load in 100 g) and is brittle with a conchoidal fracture. The measured and calculated densities are 3.275(6) and 3.204 g/cm^3, respectively. In transmitted plane-polarized light, magnesio-ferri-hornblende is strongly pleochroic, X = pale yellow, Y = yellowish brown, Z = dark yellowish green. It is biaxial (–), $\alpha = 1.651(2)$, $\beta = 1.658(2)$, $\gamma = 1.662(2)$, $2V$ (meas) = 73 (1)° to 82 (1)°, and $2V$ (calc) = 73.9 (1)°, dispersion is $r > v$, medium to strong. The orientation is $Y||b$, $X\wedge a = 31.5°$ (β obtuse), $Z\wedge c = 16.5°$ (β acute).

Magnesio-ferri-hornblende is monoclinic, space group $C2/m$, $a = 9.8620(3)$, $b = 18.1060(5)$, $c = 5.30810(10)$ Å, $\beta = 104.8480(10)°$, $V = 916.17(4)$ Å^3, $Z = 2$. The seven strongest lines in the powder X-ray diffraction pattern are [d in Å(I)(hkl)]: 8.397(52)(110), 3.383(41)(150), 2.717(100)(151), 2.597(84)(061), 2.545(61)(20$\bar{2}$), 1.854(49)(1$\bar{7}\bar{2}$), and 1.519(62)(6$\bar{2}\bar{2}$). Analysis by a combination of electron microprobe and Mössbauer spectroscopy gave SiO_2 47.37, TiO_2 1.51, Al_2O_3 7.07, Fe_2O_3 3.86, FeO 11.62, MgO 12.77, CaO 11.22, SrO 0.15, MnO 0.39, Na_2O 1.54, K_2O 0.78, Cl 0.15, F 0, H_2O_{calc} 2.01, Cl≡O –0.03, sum 100.41 wt%. The empirical formula calculated on the basis of 24 (O+OH+F+Cl) with (OH+F+Cl) = 2 apfu is $^{A}(\square_{0.62}Na_{0.23}K_{0.15})_{\Sigma 1.00}{}^{B}(Ca_{1.76}Na_{0.21}Mn_{0.02}Sr_{0.01})_{\Sigma 2.00}{}^{C}(Mg_{2.79}Fe^{2+}_{1.42}Fe^{3+}_{0.43}Ti_{0.17}Al_{0.16}Mn_{0.03})_{\Sigma 5.00}{}^{T}(Si_{6.94}Al_{1.06})_{\Sigma 8.00}O_{22}{}^{W}(OH_{1.96}Cl_{0.04})_{\Sigma 2.00}$. The crystal structure of magnesio-ferri-hornblende was refined to an R_1 of 3.95% using 2185 data (>2σ) collected with Mo$K\alpha$ X-radiation. The A site is dominantly occupied by □ where $^{A}(Na+K+2Ca) \leq 0.5$. ^{T}Al is ordered at the $T(1)$ site. $M(1)$ and $M(3)$ are dominantly occupied by Mg^{2+}, and $M(2)$ is occupied by both Mg^{2+} and high-charged cations. The new mineral occurs most commonly in the porphyry-skarn Fe-Cu-Mo-Au- and hydrothermal Au-mineralized granitoids with high oxygen fugacity but is rare or absent in barren intrusions. Its finding has important significance for magma fertility discrimination and can potentially be used in regional exploration for porphyry-skarn ore systems.

Keywords: Magnesio-ferri-hornblende, amphibole, optical properties, electron-microprobe analysis, crystal-structure refinement, magma fertility, Western Tianshan, China