American Mineralogist, Volume 106, pages 1828–1834, 2021

Carletonmooreite, Ni_3Si, a new silicide from the Norton County aubrite meteorite

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Abstract

Carletonmooreite (IMA 2018-68), Ni_3Si, is a new nickel silicide mineral that occurs in metal nodules from the Norton County aubrite meteorite. These nodules are dominated by low-Ni iron (kamacite), with accessory schreibersite, nickelphosphide, perryite, and minor daubréelite, tetrataenite, taenite, and graphite. The chemical composition of the holotype carletonmooreite determined by wavelength-dispersive electron-microprobe analysis is (wt%) Ni 82.8 ± 0.4, Fe 4.92 ± 0.09, and Si 13.08 ± 0.08 (n = 6, total = 100.81) giving an empirical formula of $(Ni_{2.87}Fe_{0.18})_{\Sigma 3.05}Si_{0.95}$, with an end-member formula of Ni_3Si. Further grains discovered in the specimen after the new mineral submission extend the composition, i.e., (wt%) Ni 81.44 ± 0.82, Fe 5.92 ± 0.93, Cu 0.13 ± 0.02, and Si 13.01 ± 0.1 (n = 11, total = 100.51 ± 0.41), giving an empirical formula $(Ni_{2.83}Fe_{0.22}Cu_{0.004})_{\Sigma 3.05}Si_{0.95}$. The backscattered electron-diffraction patterns were indexed by the $Pm\overline{3}m$ auricupride ($AuCu_3$)-type structure and give a best fit to synthetic Ni_3Si, with $a = 3.51(1)$ Å, $V = 43.2(4)$ Å^3, $Z = 1$, and calculated density of 7.89 g/cm^3. Carletonmooreite is silver colored with an orange tinge, isotropic, with a metallic luster and occurs as euhedral to subhedral crystals 1 × 5 μm to 5 × 14 μm growing on tetrataenite into kamacite. The dominant silicide in the Norton County aubrite metal nodules is perryite $(Ni,Fe)_8(Si,P)_3$, with carletonmooreite restricted to localized growth on rare plessite fields. The isolated nature of small euhedral carletonmooreite single crystals suggests low-temperature growth via solid-state diffusion from the surrounding kamacite and epitaxial growth on the tetrataenite. This new mineral is named in honor of Carleton B. Moore, chemist and geologist, and founding director of the Center for Meteorite Studies at Arizona State University, for his many contributions to cosmochemistry and meteoritics.

Keywords: Carletonmooreite, silicide, meteorite, aubrite