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Andreyivanovite: A second new phosphide from the Kaidun meteorite

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Abstract

Andreyivanovite (ideally FeCrP) is another new phosphide species from the Kaidun meteorite, which fell in South Yemen in 1980. Kaidun is a unique breccia containing an unprecedented variety of fragments of different chondritic as well as achondritic lithologies. Andreyivanovite was found as individual grains and linear arrays of grains with a maximum dimension of 8 μm within two masses of Fe-rich serpentine. In one sample, it is associated with Fe-Ni-Cr sulfides and florenskyite (FeTiP). Andreyivanovite is creamy white in reflected light, and its luster is metallic. The average of nine electron microprobe analyses yielded the formula $Fe(Cr_{0.587}Fe_{0.150}V_{0.109}Ti_{0.081}Ni_{0.060}Co_{0.002})P$. Examination of single grains of andreyivanovite using Laue patterns collected by in situ synchrotron X-ray diffraction (XRD), and by electron-backscatter diffraction revealed it to be isostructural with florenskyite; we were unable to find single crystals of sufficient quality to perform a complete structure analysis. Andreyivanovite crystallizes in the space group *Pnma*, and has the anti-$PbCl_2$ structure. Previously determined cell constants of synthetic material [a = 5.833(1), b = 3.569(1), and c = 6.658(1) Å] were consistent with our XRD work. We used the XPOW program to calculate a powder-XRD pattern; the 5 most intense reflections are d = 2.247 (I = 100), 2.074 (81), 2.258 (46), 1.785 (43), and 1.885 Å (34). Andreyivanovite is the second new phosphide to be described from the Kaidun meteorite. Andreyivanovite could have formed as a result of cooling and crystallization of a melted precursor consisting mainly of Fe-Ni metal enriched in P, Ti, and Cr. Serpentine associated with andreyivanovite would then have formed during aqueous alteration on the parent asteroid. It is also possible that the andreyivanovite could have formed during aqueous alteration; however, artificial FeTiP has been synthesized only during melting experiments, at low oxygen fugacity, and there is no evidence that a hydrothermal genesis is reasonable.

Keywords: Andreyivanovite, electron diffraction, phosphide species, Kaidun meteorite