Florenskyte, FeTiP, a new phosphide from the Kaidun meteorite

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Abstract

Florenskyte is a new phosphide species from the Kaidun chondritic meteorite, which fell in South Yemen in 1980. Kaidun is a unique chondritic breccia containing a huge variety of fragments of different chondritic types. Florenskyte was found as four dispersed grains with a maximum dimension of 14 μm within a single mass of Fe-rich serpentine within one Kaidun clast. Florenskyte is associated with submicrometer-sized grains of pentlandite and small (up to 1.5 μm in width) laths of a still uncharacterized Fe-Cr phosphide. Florenskyte is creamy white in reflected light, and its luster is metallic. The average of three electron microprobe analyses gave (wt%) Fe 40.52, Ti 30.08, Ni 5.47, Cr 0.93, V 0.91, Co 0.60, P 21.69, Si 0.59, sum 100.79, corresponding to Fe6(Ti0.34Ni0.66)O1.75(Cr0.04V0.02Co0.01)O0.5(P0.64Si0.36). Single-crystal structure analysis was performed on florenskyte using a Laue pattern collected from a multiple crystal by in-situ synchrotron X-ray diffraction. Florenskyte crystallizes in the space group Pnma, and has the anti-PbCl2 structure. Previously determined cell constants of synthetic material [a = 6.007(1), b = 3.602(1), c = 6.897(1) Å] were used in the single-crystal data reduction. We used the POWD12 program to calculate a powder XRD pattern; the 5 most intense reflections are d = 2.301 (I = 100), 2.188 (88), 2.307 (47), 1.938 (45), and 1.801 Å (45). Florenskyte is only the fourth phosphide to be described from nature. Its paragenesis may be unique, and may be due to melting of a mineral assemblage including Fe-Ni metal, schreibersite, daubreelite, osbornite, or heideite and subsequent crystallization of phosphides from the melt.

Introduction

The Kaidun meteorite is a highly heterogeneous meteoritic breccia containing an unprecedented variety of fragments of different chondritic types (CR, CM, CI, CH, EH, EL; these are classes of carbonaceous, Rumaruti, and enstatite chondrites) as well as other clasts which show unique mineralogical features (Brandstaetter et al. 1996; Clayton et al. 1994; Ivanov 1989; Ivanov et al. 1986; Zolensky et al. 1996). Kaidun is the Franklin Furnace of the meteorite world. This meteorite (842 g total mass) was recovered immediately after its observed fall in South Yemen in 1980; therefore formation of terrestrial minerals within the meteorite (due to hydration, oxidation, hydrolysis, etc.) is basically precluded. The new mineral florenskyte was found in a single polished section of Kaidun (section no. 53.10) among the twenty examined; we do not know how common it may be within the meteorite; it may well be unique.

Three natural, well-defined phosphides are known today as minerals. Schreibersite, (Fe,Ni)3P, is a typical accessory mineral in most iron and many stony meteorites. Barringerite, (Fe,Ni)3P, was found at first in the Ollague pallasite (Buseck 1969) and later in the Y-793274 lunar meteorite (Brandstaetter et al. 1991). Both minerals are also found on Earth, and both are characterized by high variations in Fe/Ni ratio and usually by low trace element contents. Perryite, (Ni,Fe)3(Si,P)3, contains essential P substituting for Si in tetrahedral coordination. One more Fe-Cr rich phosphide phase (Fe,Cr)3P was reported in the ALH85085 meteorite (Kimura and El Goresy 1989; Zanda 1992), but has not received detailed examination. Thus, florenskyite is the fourth well-defined phosphide to be described from nature.

The mineral is named for Cyrill P. Florensky (1915–1982), Russian geochemist, who is one of founders of planetology (Colleagues in the Laboratory of Comparative Planetology, 1985). The new mineral and the name have been approved by the Commission on New Minerals and Mineral Names of the IMA. The type (and sole) polished section containing florenskyte is deposited at the Meteorite Curation Facility, NASA Johnson Space Center, Houston, Texas, U.S.A.

Occurrence

The Kaidun clast (no. 53.10) containing florenskyte measures approximately 4 mm × 3 mm, and consists of extremely brecciated carbonaceous and enstatite chondrite material, showing various degrees of asteroidal alteration (Fig. 1). Among these fragments are two rounded phyllosilicate masses of similar