NEASPILOTA DOLOSA Benjamin

1934. *Neaspilota dolosa* BENJAMIN, U. S. Dept. Agr. Techn. Bull. 401, p. 39.

The type materials were restricted by the describer to specimens reared from *Heterotheca subaxillaris* of which there are besides the holotype male and allotype 150 paratypes. There are many other specimens in the collection, all from Florida localities.

Type, U.S.N.M. No. 54403.

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THE FREDA, N. DAK., METEORITE: A NICKEL-RICH ATAXITE

By E. P. Henderson and Stuart H. Perry

While plowing sod in May 1919, Henry G. Meyer, of Shields, N. Dak., found a unique little meteorite, weighing 268 grams, 2 miles southwest of Freda, N. Dak. (lat. 46°23′ N., long. 101°14′ W.). Although not a witnessed fall, it must be a fairly recent one, as the external surface is fresh and has some of the fused crust still attached.

It is a beautifully oriented individual (see pl. 1), exhibiting the flight markings as perfectly as in any iron meteorite with which the authors are familiar. In front of it the air was heated sufficiently to soften the metal and cause it to flow. The rounded end was the forward face, and some of the delicately carved furrows curve upward toward the crown, while others run down the sloping sides from the front face. The concave side, assumed to be the under side in the flight, is also marked by similar features.

The metal at the edge is rolled over and down on the concave side as if it had been hammered down, and perhaps it was—driven down by the resistance of the air. Since this overhanging metal fringe is covered with the delicate flight markings, it gives positive evidence that this feature is a phenomenon of the flight and not of its striking the earth.

From the color of the metal one might suspect that it has a high nickel content. A thin slice was removed from the rear of the sample and polished for study. After completion of the metallurgical study, this slice was analyzed. Table 1 gives the chemical composition of

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the Freda meteorite and also, for comparative purposes, that of other known nickel-rich ataxites.

The general structure of the Freda meteorite is that of an ataxite. It consists of a fine, acicular groundmass in which are scattered abundant spindles and particles of kamacite. In appearance this acicular structure is similar to martensite in artificial irons and probably had an analogous origin, for owing to the high nickel content the gamma-alpha transformation was greatly depressed. After the initial transformation, when the kamacite had separated, the remaining gamma solid solution underwent only a partial transformation and the kamacite was very sparingly precipitated on octahedral planes, producing an acicular structure similar to that observed in many octahedrites.

Plate 1 shows in natural size the flight markings of this meteorite.

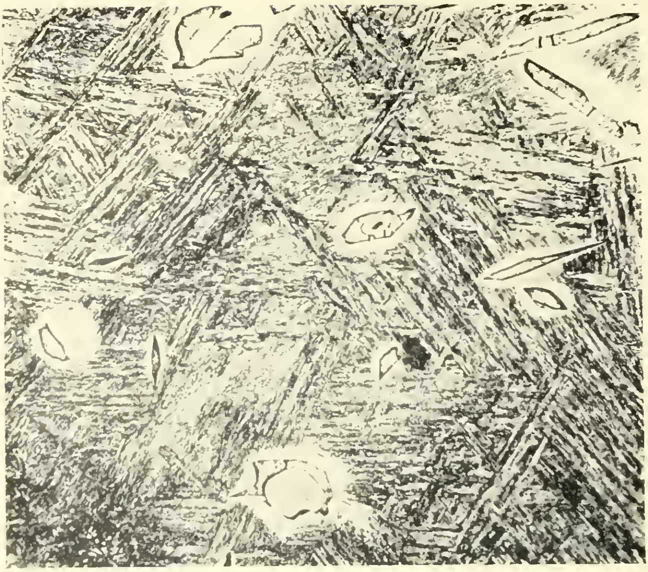
Plate 2, figure 1, illustrates the general structure at low magnification. The kamacite inclusions are surrounded by clear (white) zones, which are areas of taenite from which the kamacite has been attracted to the larger masses. In other words, there has been an impoverishment of the kamacite in these areas and an accumulation of it into masses. Many of these kamacite areas contain inclusions of a rounded iron-phosphide eutectic. The general acicular groundmass exhibits the martensite structure.

TABLE 1.—*Chemical analysis (in percentages) of the Freda meteorite and other nickel-rich ataxites*

Substance	Freda	Limestone Creek		San Cristobal		Santa Catharina	Oktibbeha	
	(E. P. Henderson, analyst)	*(R. Knauer, analyst)* [1]	*(C. T. Jackson, analyst)* [2]	*(O. Sjostrom, analyst)* [3]	*(E. Cohen, analyst)* [4]	*(A. A. Damour, analyst)* [5]	*(W. J. Taylor, analyst)* [6]	*(E. Cohen, analyst)* [7]
Fe	75.86	65.03	66.56	73.72	73.56	63.69	37.69	37.24
Ni	[8]23.49	29.99	24.70	25.60	25.44	33.97	59.69	62.01
Co	.66	1.48	------	1.00	1.00	1.48	.40	.72
P	.15	.19	------	.18	------	.05	.10	.15
S	Trace	------	4.00	------	------	.16	------	------
Insoluble	.07	.20	------	------	------	.01	------	------
Cl	------	------	1.48	------	------	------	------	------
Cr and Mn	------	------	3.24	------	------	------	------	------
C	------	------	------	------	------	.20	------	------

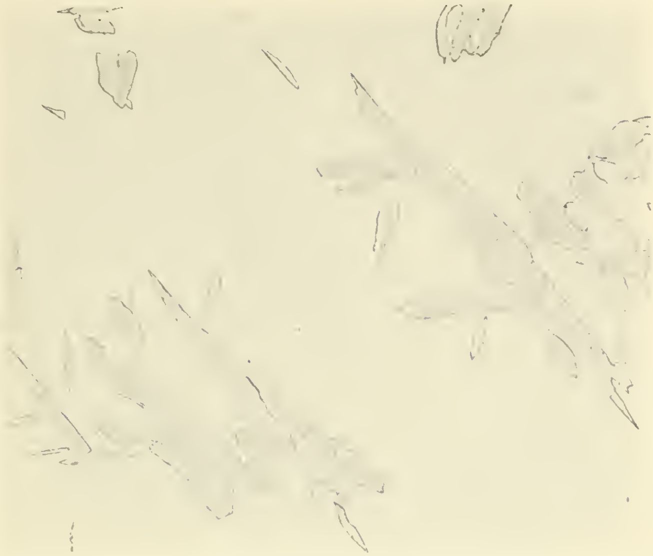
[1] Meteoritenkunde, 1905, No. 3, p. 131.
[2] Amer. Journ. Sci., vol. 34, p. 335, 1838.
[3] Sitz. Akad. Wiss. Berlin, 1898, p. 607.
[4] Meteoritenkunde, 1905, No. 3, p. 135.
[5] Compt. Rend. Acad. Sci. Paris, vol. 84, p. 48, 1877.
[6] Amer. Journ. Sci., ser. 2, vol. 24, p. 293, 1857.
[7] Ann. Naturh. Hofmus. Wien, vol. 7, p. 146, 1892.
[8] J. G. Fairchild, U. S. Geological Survey, determined by methods different from those used by the author the nickel content of the same sample and reports 23.27 percent.

Two views of the Freda, N. Dak., meteorite. Natural size.

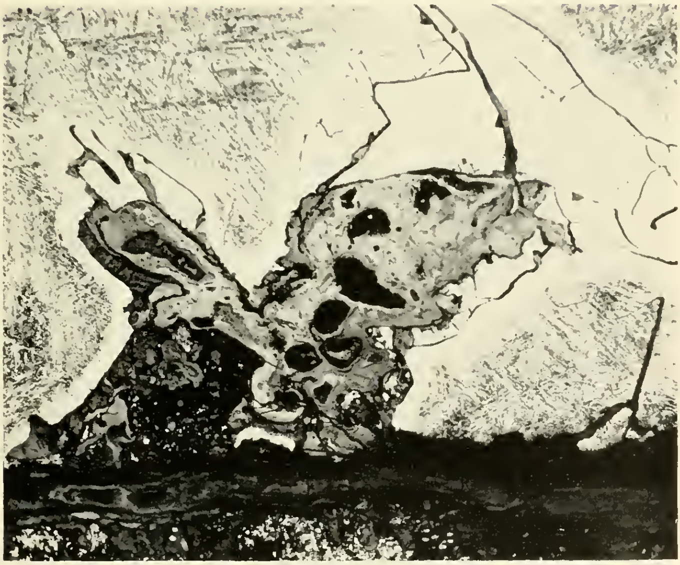


1. Groundmass of Freda meteorite, showing martensite structure and kamacite inclusions surrounded by white areas of taenite. Picral etching. × 100.

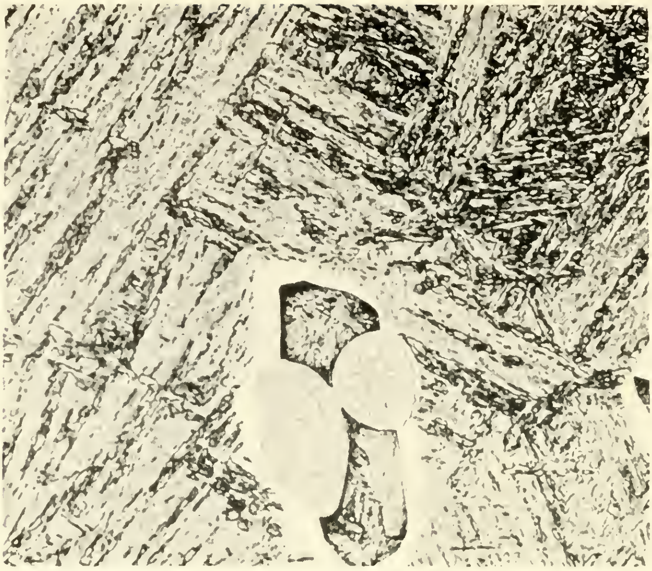
2. Invasion of fusion into the meteorite. Picral etching. × 100.



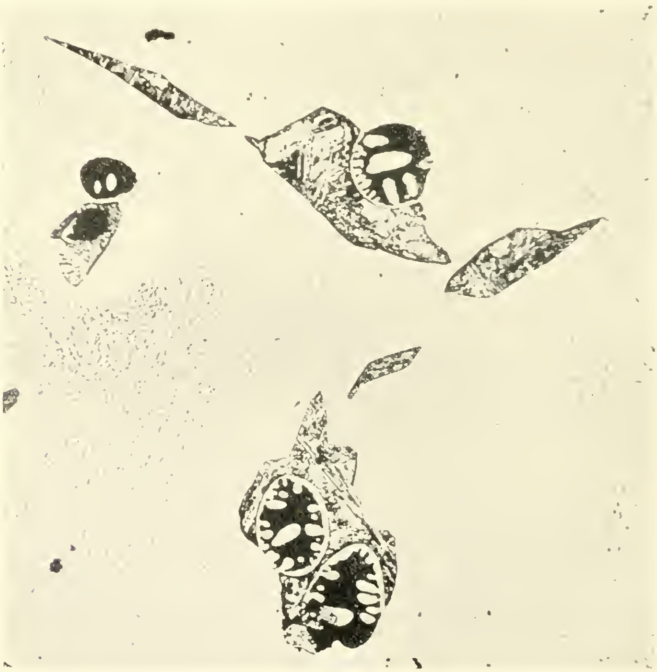
1. Freda meteorite: Kamacite arranged in octahedral pattern. Picral etching. × 100.



2. Invasion of oxide into the kamacite. Picral etching. × 100.



1. Freda meteorite: Kamacite with inclusions of phosphide eutectic. Picral etching. × 500.



2. Eutectic inclusions. Sodium picrate darkens the phosphide inclusions. Clear areas are rejected iron droplets. × 250.

Plate 2, figure 2, displays the fusion crust and its invasion into the meteorite.

Plate 3, figure 1, shows the kamacite bodies at moderate magnification and very lightly etched. There is a trace of octahedral orientation, and in place of the narrow taenite borders usually seen around needles of kamacite in nickel-rich ataxites there is a wider zone.

Plate 3, figure 2, illustrates the invasion of oxide into particles of kamacite, which contains phosphide inclusions.

Plate 4, figure 1, shows martensiticlike structures with a kamacite body containing two rounded inclusions of iron-phosphide eutectic. The eutectic contains minute clear droplets of rejected iron.

Plate 4, figure 2, is lightly etched with picral solution and then sodium picrate, which blackens the phosphide inclusions. These inclusions, formed by absorption of iron from the surrounding mass, on cooling rejected the excess of iron above the iron-phosphide eutectic ratio, which formed minute clear droplets. Some phosphide also appears distributed in the kamacite.

Classification.—The Freda meteorite belongs to the nickel-rich ataxite group, there being only four meteorites now known with higher nickel percentages. In table 1 these end members of the nickel-rich ataxite group are arranged in order of their increasing nickel content. There are reasons to suspect that the nickel contents of the four meteorites richer in nickel than the Freda specimen may not be accurately determined. The old analyses are given for qualitative comparison. However, there is sufficient unpublished metallographic evidence on file to show that the Freda has a metallographic structure similar to the four meteorites that probably have higher nickel contents.

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