REEXAMINATION OF THE SOPER, OKLAHOMA METEORITE*

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This iron meteorite was found 6 miles northwest of Hugo, Oklahoma, and was first described by E. C. Wood and C. A. Merrith.[1] It was correctly identified as belonging to the ataxite group with an unusually high schreibersite content. The U. S. National Museum acquired a 1317 gram sample of this iron from the authors shortly after the description appeared. This meteorite was restudied because the analysis first reported did not agree with the series of accepted analyses now being compiled for other low nickel ataxites.

The following table gives the only two analyses of Soper that have so far been made.

Soper, Oklahoma Meteorite

	1	2
Fe	90.89	91.71
Ni	6.21	5.66
Co	.70	.54
P	2.23	2.08
C	.02	N.D.
S	.03	none
Al	.10	none
Cl	trace	N.D.
	100.18	99.99
Sp.G.	7.387	7.644

No. 1. S. G. English, *Am. Mineral.*, **24,** 59–61 (1939).
No. 2. E. P. Henderson.

The second analysis reports a slightly lower nickel content and a higher iron value but confirms the unusually high percentage of phosphorus. The 5.66 value for nickel, brings this meteorite into consistent agreement with other analyses of nickel-poor ataxites.

A thin slice of the material to be analyzed was polished and etched to determine if the structure was the average for the entire meteorite and to make certain that no large inclusions of any accessory minerals were

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[1] *Am. Mineral.*, **24,** 59–61 (1939), The Soper, Oklahoma meteorite.

included. The slice was then dissolved in dilute hydrochloric acid and the gas liberated was passed through a solution of dilute lead acetate. Since no black precipitate of lead sulfide formed, there was no troilite in the specimen analyzed.

Schreibersite is practically insoluble in dilute hydrochloric acid and hence it remains behind as a residue. To make certain that all the kamacitic iron was removed, the hydrochloric acid solution stood in contact with the residue for 12 hours before filtering.

The schreibersite portion was then dissolved in mixed hydrochloric and nitric acid; after several repeated boilings only a very small quantity of the dark material remained as an insoluble residue and this may be the carbon reported in the first analysis. It was not determined.

Analyses of Kamacite and Schreibersite in Soper, Meteorite
E. P. Henderson, analyst

	Kamacite	ratios		Schreibersite	ratios	
Fe	95.35	1.707	21.85	68.22	1.2218	
Ni	4.11	.070	1.0	15.61	.2660	3.02
Co	.51	.008		.77	.0130	
P	none			15.38	.4958	1.0

The results give a kamacite with an unusually low percentage of nickel. The alpha iron, or kamacite, could have any nickel content from 0 up to about 5.5 percentage; the higher value seems to be the limit of solubility for nickel in alpha iron. The strange fact is that in hexahedrite meteorites, which consist entirely of alpha iron, the nickel contents of the reliable analyses are remarkably constant. The average nickel content for hexahedrites[2] was found to lie between 5.519 and 5.60. In all of the old published analyses, of less than 5 per cent nickel, which have been reinvestigated, those low values have been found to be erroneous, generally indicating that in the analytical work the nickel was not completely separated from iron. This low value of 4.11 for the kamacite is reported with confidence as it was carefully checked.

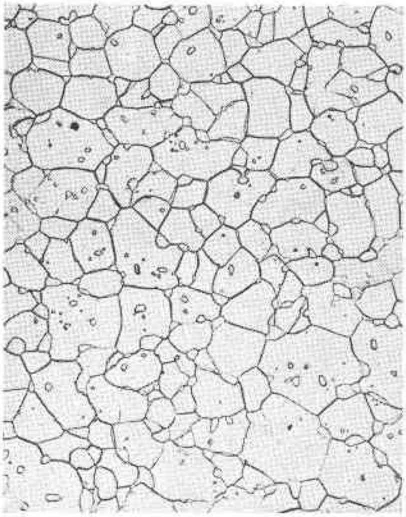
Farrington[3] lists 24 analyses of schreibersite of which all but six are higher in nickel than the Soper schreibersite. Since the phosphide particles are so uniformily dispersed in the Soper meteorite it is suggested that during the interval when this iron was reheated and modified into an ataxite, the temperature was raised high enough and retained long enough to permit some nickel to migrate from the kamacite and combine with the phosphide to form schreibersite.

[2] Henderson, E. P., Chilean hexahedrites and the composition of all hexahedrites: *Am. Mineral.*, **26**, 546–550 (1941).

[3] Meteorites, Privately published by O. C. Farrington (**1913**).

If the nickel is not taken from the alpha iron or kamacite, as suggested above, the iron must be quite low in nickel, which has been found rejected as small drops[4] in the Fe-Ni-P eutectic structures and has migrated and combined with the kamacite. Either process will result in a kamacite which is lower in its nickel content than the normal kamacite from hexahedrites.

A study is now being made of the low nickel ataxites by these authors and a general descriptive paper will soon appear.



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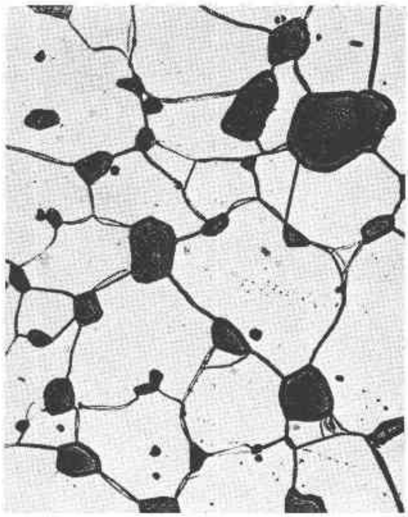

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Explanation for illustrations.

1. The schreibersite particles are developed along the boundaries of the kamacite. Some minute particles of phosphide are found within the kamacite grains, but otherwise the kamacite is clear and structureless.

2. The phosphide bodies are shown to have a mottled structure probably indicating an Fe-P-Ni eutectic.

[4] Stuart H. Perry, The Metallography of Meteoric Iron: *U. S. National Museum.*, *Bull.* **184.**