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A METEORIC IRON FROM OWENS VALLEY, CALIFORNIA.

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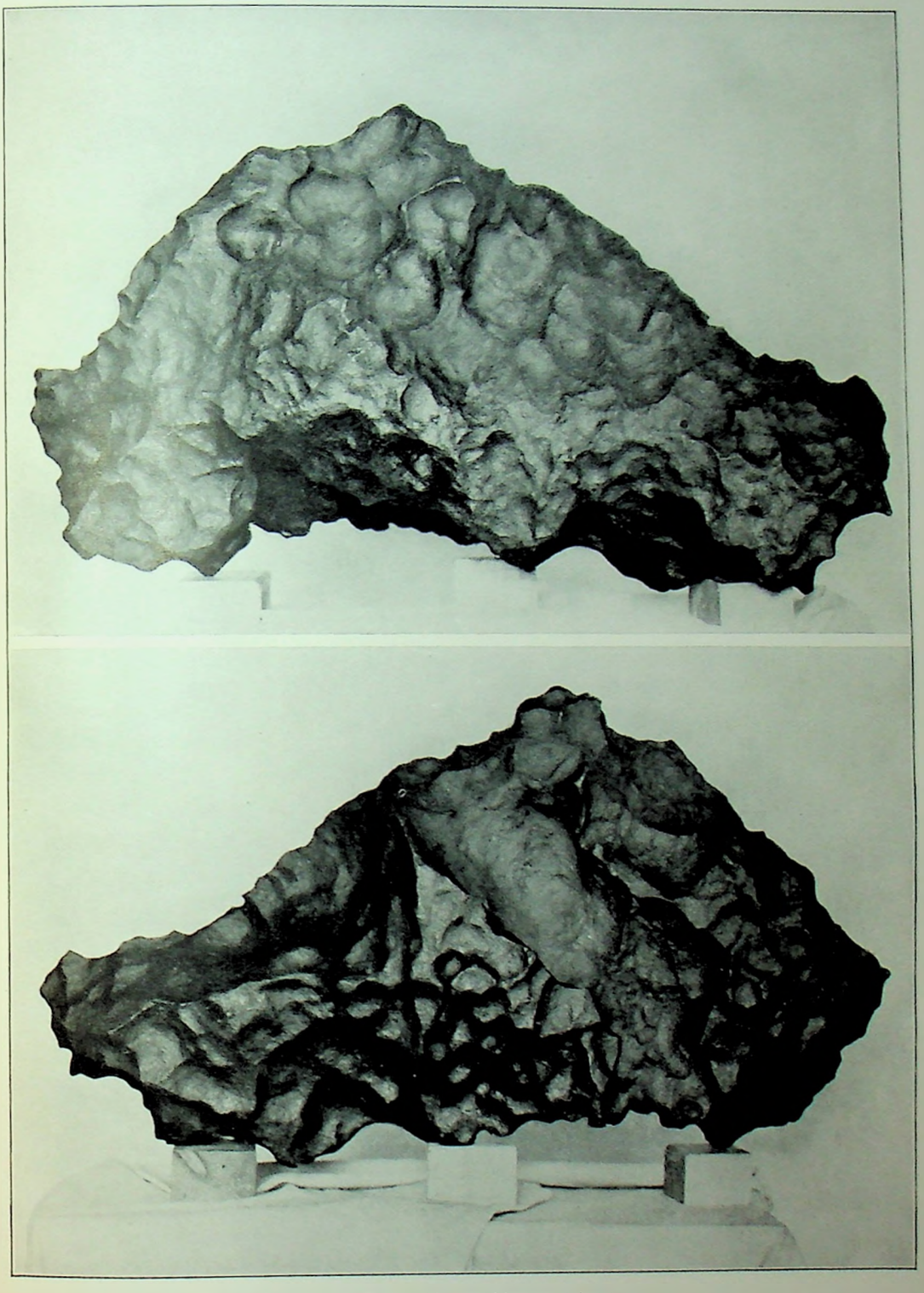
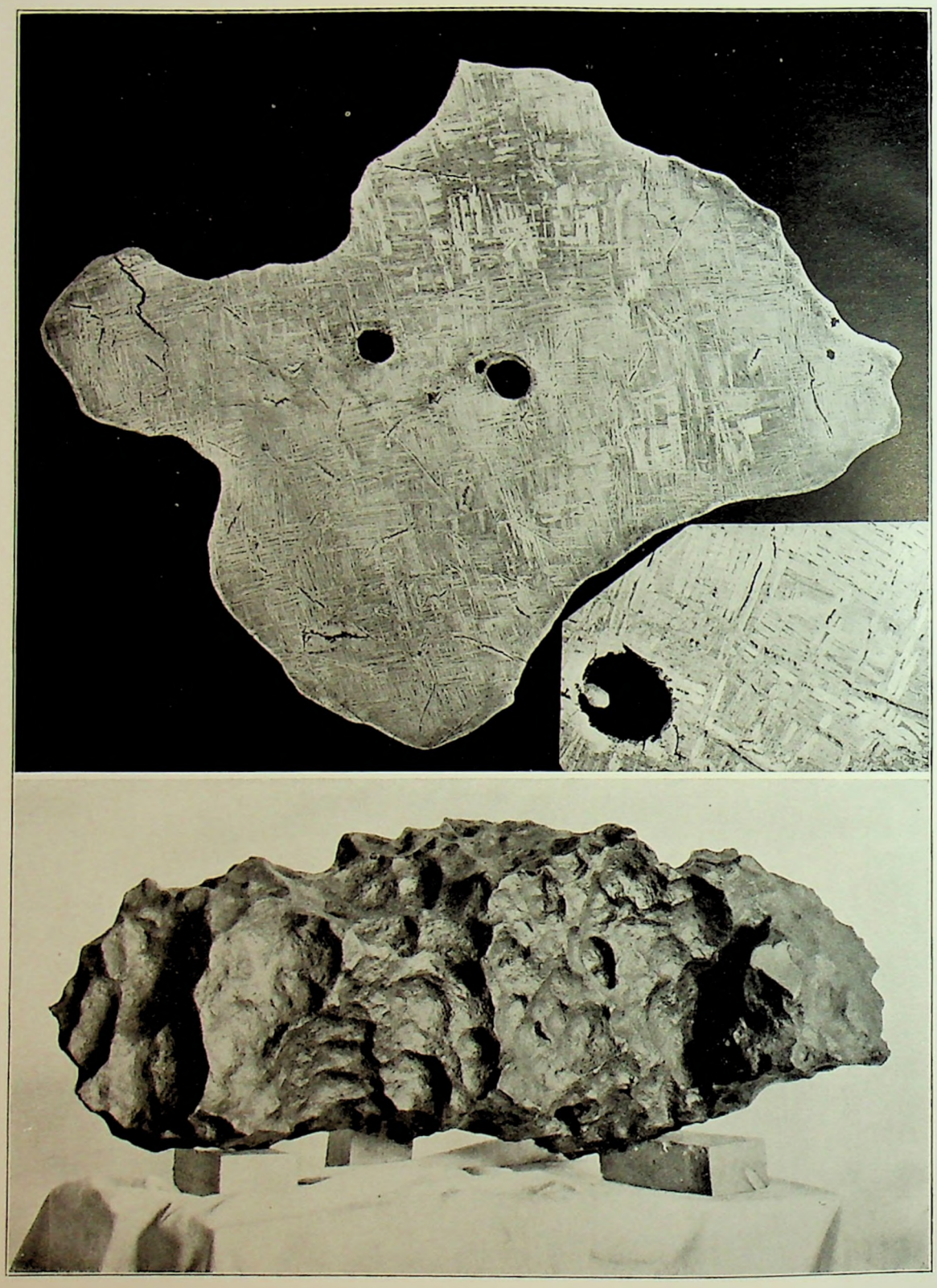


OWENS VALLEY METEORIC IRON.

Upper: Side view. Lower: Same in reversed position.



OWENS VALLEY METEORIC IRON.

Upper left: Complete cross section about two-thirds natural size. Upper right: Portion of same natural size. At bottom: Lower surface of mass.

A METEORIC IRON FROM OWENS VALLEY, CALIFORNIA.

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The iron meteorite here described and figured (Pls. I and II) was found by a sheep herder in 1913, some 22 miles northeast of Big Pine, Owens Valley, Inyo County, California. It passed immediately into the hands of Mr. Lincoln Ellsworth of New York City, in whose possession it has remained undescribed until the present. Except for a very uniform oxidation over the entire surface, the iron is in an excellent state of preservation, measuring 65 centimeters in length and weighing 193.17 kilograms (425 pounds). The outlines of the mass are well shown in the plates. The pittings, it will be observed, are quite uniformly distributed over the entire surface, and a striking feature is the absence of a nose or *brustseite* to indicate what may have been its orientation during flight. Whether this is due to weathering or a too frequent reversal of position to allow the formation of this feature, cannot be told definitely, though evidently the latter assumption is correct. Oxidation has obscured any flow lines that may possibly have existed.

Although taking great pride in the possession of the iron, Mr. Ellsworth has yielded to the interests of science and allowed the mass to be sawn so as to yield the surface shown in Figures 1 and 2, Plate II. The iron etches easily but not deeply, the surfaces soon becoming dull and the figures having little relief. The kamacite bands are sometimes slightly swollen and undulating with numerous enclosures of sulphide and phosphide which show up as black dots and dashes in the plate. Several of these are of a character to be classed as Reichenbach lamellae, but that they seemingly have no constant orientation. The taenite plates are very thin and inconspicuous, and, as shown by the analysis, there is but little schreibersite. Two rounded masses of troilite some 10 mm. in diameter, each partially bordered by the phosphide, are shown in the section. At the left, and in other parts of the section, are shown irregular fracture lines filled with a black unidentified material, probably carbon. The maximum width of the widmanstätten figures is 1 mm. and the iron therefore classed as a medium octahedrite. In comparison with other irons in the collection, it resembles closely that of Cleveland, East Tennessee, with which also it agrees quite closely in chemical composition, so far as the main constituents are concerned. It does not, however, etch so strongly and gives a dull, rather than a bright lustrous surface, as does the last named.

For the investigation of the chemical constitution of the iron I was fortunate in securing the services of Prof. Stuart R. Brinkley of the Kent Chemical Laboratory of Yale University, whose care and skill as an analyst need no commendation, as the results show for themselves. The following is from Professor Brinkley's report:

For the qualitative and preliminary work 50 grams of the sample submitted were digested with HCl of constant boiling strength until there was no further action. Tests were made on the acid soluble part and on the residue separately. In the HCl solution there were found to be present: Iron, nickel, cobalt, sulphur, phosphorus, and a trace of copper. Very careful tests were made for the following with negative results: The platinum metals, arsenic, antimony, tin, gold, silver, lead, mercury, cadmium, bismuth, selenium, tellurium, molybdenum, aluminum, zirconium, titanium, zinc, manganese, chromium, vanadium, uranium, tungsten, the alkali-earths, and the alkali metals.

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For the HCl insoluble residue the remaining 25 grams of the material furnished were digested similarly with HCl and the residues combined, giving a sample amounting to the residue from 75 grams of the original material. Iron, nickel, cobalt, phosphorus, carbon, and silica were found. There was obtained a very slight precipitate of ammonium chloro-platinate showing a trace of platinum to be present. Moreover, this precipitate was somewhat brownish in color indicating a trace of iridium. Tests showed no palladium, osmium, ruthenium, nor rhodium in amounts sufficient for detection by wet method. Further negative results were obtained on making tests for all the other metals mentioned as being found absent in the HCl solution.

In the quantitative work 25 gram samples were used for the metals, 10 grams for each sulphur and total phosphorus, and 5 grams each for the combined and graphitic carbon. The following results were obtained:

	Per cent.		Per cent.
Iron	55.15	Silica	0.15
Nickel	30.09	Platinum	Trace.
Cobalt	0.67	Iridium	Trace.
Phosphorus	13.06	Total	99.12

It is evident that this is largely one of the variable compounds to which the name schreibersite is commonly applied.[1]

Carbon determinations run on the original sample showed:

	Per cent.
Combined carbon	0.019
Graphitic carbon	0.013

All the graphitic carbon would be in the acid insoluble part and probably most of the combined as cohenite.

The material soluble in HCl showed the following composition:

	Per cent.		Per cent.
Iron	91.65	Sulphur	0.13
Nickel	7.80	Copper	[2] Trace.
Cobalt	0.46		
Phosphorus	0.007	Total	100.047

From the accumulated residues from the HCl treatment a sample corresponding to 75 grams was obtained and this was found to contain 0.0008 gram platinum, the brown color of the ammonium chloro-platinate precipitate indicating iridium, though attempts to effect a separation were unsuccessful.

[1] A study of the phosphide question as so admirably summed up by Cohen (Meteoritenkunde, B. 1, S 124), coupled with experience gained in my own work as mentioned in a previous paper (Mem. Nat. Acad. Sci., vol. 14, 1916, p. 10) has led me to the conclusion that the rhabdite alone has a definite crystallographic form and a chemical composition that can be expressed accurately by the formula $(FeNiCo)_3P$. The forms commonly described under the name schreibersite are but solid solutions of rhabdite in varying amounts of iron as in artificial iron and steel (see Sauveur, The Metallurgy and Heat Treatment of Iron and Steel, p. 144). In this way only, as it seems to me, can we account for the imperfect development of crystal faces and the continual variation in the proportional amounts of iron and phosphorus shown in the large series of analyses now available. I hope soon to be able to say more upon this subject. I can not wholly agree with Cohen in ascribing the discrepancies shown to impure material or poor analyses.

[2] Less than 0.001 per cent.

These values, recalculated on the basis of the original sample, show the following:

	Per cent.	Per cent
HCl soluble part:		
Iron	89.89	
Nickel	7.65	
Cobalt	0.45	
Sulphur	0.122	
Phosphorus	0.007	
Copper	Trace.	
Total		98.119
Residue from HCl treatment:		
Iron	1.05	
Nickel	0.572	
Cobalt	0.012	
Phosphorus	0.248	
Silica	0.003	
Platinum	Trace.	
Iridium	Trace.	
Total		1.885
Separated material:		
Combined carbon	0.019	
Graphitic carbon	0.013	
Total		0.032
Total		100.036

The results given above need little discussion other than to say that they corroborate fully what I have previously written with particular reference to the minor constituents in meteorites,[3] and incidentally substantiate the work of Doctor Whitfield. It may be well to note that platinum was found only in the insoluble portion, and that it showed traces of iridium as did that found by Mingaye in the iron of Mount Dyrring, Australia. No traces of palladium, osmium, rhodium, or ruthenium were detected, however, nor of gold or tin. It is well to state here that having still in mind Derby's determination of tin in the Canon Diablo meteorite, and my failure to corroborate him, as noted in a recent paper,[4] I took advantage of the present opportunity to make still another separation of the insoluble constituent of this much discussed iron, 20 grams of which were referred to Professor Brinkley who reported: "The Canon Diablo sample to be tested gave no evidence at all of the presence of tin."

It is with a feeling of no little satisfaction that the careful work of so efficient an analyst as Professor Brinkley is found to corroborate that of Whitfield and others as published in my previous papers.

[3] Amer. Journ. Sci., vol. 35, 1913, pp. 509–525; Mem. Nat. Acad. Sci., vol. 14, 1916, pp. 7–29; Proc. Nat. Acad. Sci., vol. 418, 19, pp. 175–180.
[4] Proc. Nat. Acad. Sci., vol. 4, 1918, p. 177.