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Meteorites Found in Pennsylvania

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METEORITES FOUND IN PENNSYLVANIA

By
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INTRODUCTION

A meteorite is defined in the Oxford Universal Dictionary as "a mass of stone or iron that has fallen from the sky upon the earth." A meteor, on the other hand, is "a small mass of matter from celestial space, rendered luminous by the heat engendered by collision with the earth's atmosphere." While in the sky, a particle is a meteor, but when it reaches the surface of the earth, it becomes a meteorite.

Most dwellers in the country have seen meteors flash across the sky at night and know, perhaps, that these shooting stars are most numerous in the fall of the year. A multitude of small bodies are always flying through space in different directions and at different rates of speed. Most of them revolve around the sun as if they were small planets, but others may not belong to our solar system. The shooting stars so commonly seen in the evening sky in August, September, and November are small bodies which diverge from the swarms of meteors that pursue fixed paths around the sun. These falling bodies are made luminous by friction with our atmosphere and most of them disappear in the sky by being consumed or burnt out. Many meteors are too small to be seen and, of course, those passing through the air in daylight are invisible. The number of meteors which enter our atmosphere daily has been estimated to be as high as 200 million. Their individual masses are so small, however, that their total addition to the earth is only a few tons. If this rate has held throughout the earth's past life of 4 or 5 billion years, the total addition to its mass has been less than one hundred-millionth.

Occasionally a meteorite has been seen or heard to strike the earth and has been found on or under the freshly disturbed surface. These bodies of known celestial origin have led to the identification of similar bodies found in the earth as also from the sky. Meteorites, almost without exception, have a definite family resemblance, which suggests that all came from one celestial body, or if they came from different bodies, or from another solar system (which is unlikely), the sources are much alike and not unlike the earth itself. Approximately 1300 meteorites or meteoric falls have been recorded throughout the world. Several museums may have slices or fragments from the same meteorite, for mineralogists customarily share in such a find by cutting it. From studying these collections it has been learned that some meteorites consist almost wholly of metal, chiefly iron alloyed with a small percent of nickel; some consist of metal and rock intimately mixed; and some are similar to plain rock. Although most appear to be of igneous origin, a few have a clastic character and may contain ancient preserved simple forms of life. They contain no elements not known on earth, but unique combinations of these elements produce minerals not found naturally. In a few cases, diamonds have been found in meteorites which were probably formed during the impact of the meteorite hitting the earth.

Eight meteorites have been found in Pennsylvania. The first five to be identified as meteorites were irons, the other three are stones. The first one was discovered near Pittsburgh in 1850 and the others at the following places: Bradford Woods, Allegheny County, 1886; Mount Joy Township, near Gettysburg, Adams County, 1887; Bald Eagle Mountain, near Williamsport, Lycoming County, 1891; Shrewsbury, York County, 1907; New Baltimore, Somerset County, 1922; Chicora, Butler County, 1938; and Black Moshannon State Park, Centre County, 1941 (Figure 1).

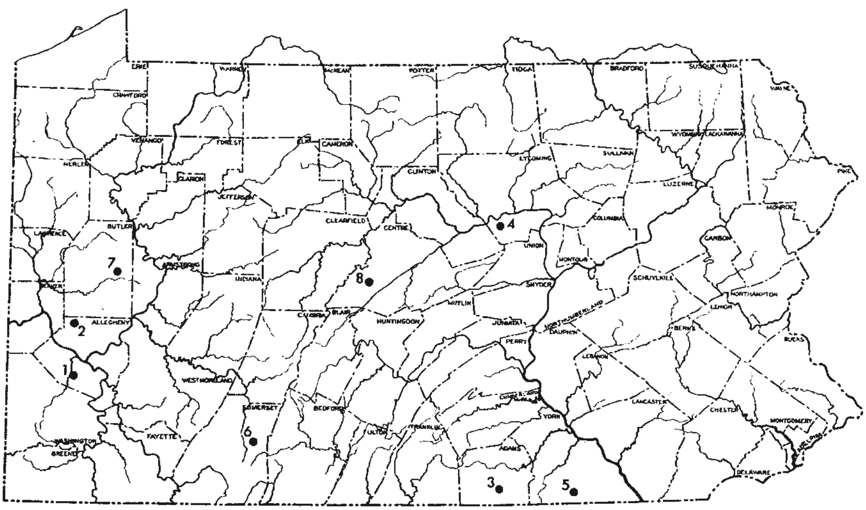


Figure 1. Map of Pennsylvania showing location where meteorites were found.

1. Pittsburgh, Allegheny County, 1850; 2. Bradford Woods, Allegheny County, 1886; 3. Mount Joy, Adams County, 1887; 4. Bald Eagle, Lycoming County, 1891; 5. Shrewsbury, York County, 1907; 6. New Baltimore, Somerset County, 1922; 7. Chicora, Butler County, 1938; 8. Black Moshannon, Centre County, 1941.

Four of these meteorites were found by farmers, one by a man digging a hole to plant a tree, one by laborers gathering rock for a stone crusher, and two were seen while falling. The smallest, found near Chicora, was about the size of a clenched fist and weighed less than a pound. The Bradford Woods meteorite weighed about 2 pounds and looked like a pan biscuit. The Black Moshannon was about the size of a hard ball and weighed 1 ½ pounds. The Bald Eagle was about the size and shape of an adult human foot and weighed 7 pounds. The Shrewsbury iron weighed 24 pounds, the New Baltimore about 40 pounds, and the Mt. Joy, one of the largest found east of the Mississippi River, weighed 847 pounds. The weight of the Pittsburgh meteorite, found in 1850, is not known because it was wrought into a bar and lost. It is reported as 292 pounds, but this does not agree with the statement that it was oval in shape and 6 or 7 inches in diameter. It may have weighed 29.2 pounds, an error being made in the original description of the meteorite.

Frequently nodules of pyrite and marcasite, sulphides of iron, are mistaken for meteorites. They are heavy and of peculiar appearance but can be readily distinguished from iron meteorites, however, by their crystalline faces and brass yellow color on a fresh fracture. Other materials often mistaken for meteorites include cast iron, lava, slag, and limonite, an iron ore.

CHEMICAL COMPOSITION OF METEORITES

Chemical Composition of the Iron Pennsylvania Meteorites

	Bald Eagle	Mt. Joy	New Balto.	Pitts-burgh	Pitts-burgh	Shrews-bury
Iron	91.36	93.80	93.256	92.809	93.38	90.84
Nickel	7.56	4.81	6.420	4.665	5.89	8.80
Cobalt	0.70	0.51	0.325	0.395	1.24	trace
Copper	....	0.005	none	0.034	0.05	....
Sulphur	0.06	0.01	none	0.037	0.07	0.01
Phosphorus	0.09	0.19	0.037	0.251	0.15	0.29
Manganese	....	....	none	0.141	0.00	....
Silicon	trace	....	0.010	....	....	....
Carbon	....	....	0.015	....	....	....
Chromium	....	....	....	....	0.02	....
Chromite	....	....	....	....	0.07	....
	99.77	99.325	100.63	98.332	100.87	99.94

The preponderance of iron, about 92 to 94 percent, the notable quantity of nickel, and the insignificant traces of other metals and minerals are clearly shown in this table.

The almost identical composition of the Mt. Joy, New Baltimore, and Pittsburgh meteorites and the fact that the three localities are practically in a straight line suggest that these may be parts of a larger body which was disrupted as it passed through the earth's atmosphere. The fact that the New Baltimore locality is 10 miles south of a line from the locality near Gettysburg to the site south of Pittsburgh and that these places are 150 miles apart does not seem incompatible with the idea of a single source when it is known that the average velocity of meteors passing through our atmosphere is computed to be between 20 and 30 miles a second and the height of passage above the earth may be several miles. Furthermore, as none of these was seen to fall, and the last was discovered 72 years after the first, all may have been buried in the soil for hundreds of years.

Only one of the stony meteorites, the Chicora, has been chemically analyzed. The results are shown below:

	Fine-grained material (Percent)	Coarse material (Percent)
Insoluble	32.74	39.50
SiO_2	21.56	19.47
Fe	18.14	16.71
Ni	.49	.81
CaO	.69	.49
MgO	20.07	17.89
P	.11	.06
S	2.46	2.06
Co	.19	.33
	96.32	97.32

ORIGINAL DESCRIPTIONS OF METEORITES

A search for information about Pennsylvania's meteorites has disclosed no one source for all the data. Farrington's catalogue of North American meteorites published in 1913 contains references to the Pittsburgh, the Mt. Joy, and the Bald Eagle meteorites. The original descriptions are in various periodicals, complete files of which are to be found only rarely. For the convenience of those who are interested in further details than the bare facts given above, the leading papers are reprinted here, by date of discovery.

Mineral terms used in these descriptions are defined as follows:

Daubreelite. Native chromium sesquisulphid, a rare mineral known to occur in certain iron and stony meteorites. It has a black color, metallic luster, and is associated with troilite.

Kamacite. A nickel-iron alloy occurring as tin-white blades or grains in iron meteorites.

Neumann's Lines. A system of fine parallel lines revealing the complex lamellar twinning of kamacite in some meteoric irons.

Plessite. A mineral consisting of an intimate intergrowth of kamacite and taenite and generally a darker color than the other irons found only in meteorites.

Rhabalite. A rodlike or accicular variety of Schreibersite.

Schreibersite. A phosphide of iron and nickel, occurring in steel-gray folia and grains in many meteoric irons. It is known to occur as a terrestrial mineral.

Taenite. A nickeliferous iron found in meteorites and commonly occurring in narrow, bronze-yellow blades.

Troilite. A native iron sulphide often occurring in meteorites, and especially meteoric irons, as embedded nodules or generally disseminated. It is granular, bronze-yellow, and has a dull luster.

Widmanstatten figures. Intersecting bands seen on the polished surfaces of many meteoric irons when these have been etched by an acid.

PITTSBURGH METEORITE

The first notice of a meteorite found in Pennsylvania was given by Prof. B. Silliman, Jr. at the fourth meeting of the American Association for the Advancement of Science, held at New Haven, Conn., August 1850. The minutes of the meeting contain the following statement: (Silliman, 1851)

"The second mass of iron noticed by Prof. Silliman was found in the State of Pennsylvania, near the city of Pittsburgh. The attention of Prof. Silliman was called to this mass by Mr. George Weyman, a student in the Analytical Laboratory of Yale College, and through him all the details of its history have been obtained, which can now be hoped for, from Mr. John H. Bailey, of Pittsburgh. Prof. Silliman then read extracts from a letter from Mr. Bailey, dated June, 1850, from which it appears that this mass of meteoric iron was found in a field upon Miller's Run, in Allegheny County, Pennsylvania, near Pittsburgh. A farmer was ploughing in the field, where, seeing a snake, he seized a stone, as he supposed, to destroy the animal, but, finding it remarkably heavy, he was attracted, after accomplishing his purpose, to examine the body which possessed such a remarkable weight. It was carried to Pittsburgh, where it was found to be very malleable, and unfortunately wrought into a bar, which has since been lost sight of. The mass was of an orvidal (ovoidal) figure, almost six or seven inches in diameter, and weighed nearly 292 pounds. It is greatly to be regretted that only a very small portion of this large mass has been preserved. A qualitative examination of it has shown that it is rich in nickel, and possesses only a very inconsiderable portion of insoluble acids."

If this iron was comparatively symmetrical, a spheroid measuring 6 or 7 inches, the volume was approximately 130 cubic inches and the weight may have been 29.2 pounds, not 292 pounds as reported (Figure 2). Miller's Run is a branch of Chartiers Creek on the southwest boundary of Allegheny County, and about 8 miles from Pittsburgh. According to Shepard (1851), the specific gravity was 7.380.

Genth (1875, p. 207-208), repeated Silliman's description in his *Mineralogy of Pennsylvania,* and in the appendix of that book gave the following additional information:

"The small portion of the meteoric iron from Pittsburgh, referred to in my report B, of 1875, has been preserved in the Yale College cabinet. Mr. Edward S. Dana, the curator of this collection, presented me with a small fragment, which I submitted to a fuller investigation.

"Its specific gravity, which Shepard gave as 7.380, was found to be 7.741, the average of three closely corresponding determinations by Dr. Koenig, Dr. Headden, and myself. After polishing and etching with dilute nitric acid, it presents Widmannstatten's figures which are produced by inclosed schreibersite. In the section which has been made, it happens that most of the exceedingly minute schreibersite crystals are cut across, and are seen as small dots on a frosted surface; some appear as minute needles, arranged in parallel lines, like the trees in an orchard. A few elongated patches of a whiter iron-nickel alloy are also visible.

"The analysis of a somewhat oxidized piece, gave the following composition.

Iron	92.809
Copper	0.034
Cobalt	0.395
Nickel	4.665
Manganese	0.141
Sulphur	0.037
Phosphorus	0.251
Total	98.332

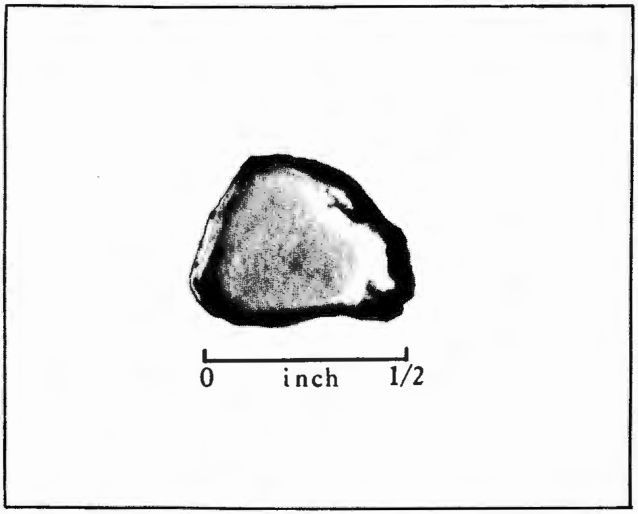
0.251 percent of phosphorus are equal to about 1.8 percent of schreibersite."

A 99-gram piece of the Pittsburgh meteorite acquired by Gottingen University was studied by E. Cohen (1903, p. 1-4), who described is as follows:

"It was a very irregular piece with ragged edges, and had evidently been cut with a chisel from the mass and from the peripheral portion of the latter, since there seemed to be small flat parts of the border of the original surface of the meteorite. By cutting, a surface of 4 sq. cm. was obtained.

"Etching proved that Millers Run is actually, as Reichenbach stated, an octahedrite. The coarse lamellae are for the most part of an irregular lumpy form, sometimes elongated and regularly bounded. Some of the bands lie immediately upon one another, others are divided by a minute cleft; between many of them, however, a distinct taenite band is found, which at the point where several lamellae cluster together broadens out into somewhat large, triangular portions. That no schreibersite is present is easily proven by testing the ductility with a fine needle. As usual in coarse octahedrites, plessite is very inconspicuous; the tiny little portions are rich in combs.

"The kamacite bands act differently. At some distance from the original surface of the mass it is coarse-grained, shows distinct hatching marks and numerous uniformly



Photograph by Pennsylvania Historical and Museum Commission, Harrisburg, Pennsylvania.

Figure 2. Polished fragment of the Pittsburgh meteorite.

distributed etching pits; the more granular it is the less prominent are the hatchings, while the etching pits remain about the same in amount. In a few bands numerous small, brightly glistening rods are found, which appear to be schreibersite.

"An outer zone of from 1 to nearly 1.5 cm. in breadth, whose border runs in a wavy or serrated outline, but which was partially cut off and does not coincide with the boundaries of the lamellae, appears much altered. It is duller and darker than the interior of the meteorite, and the kamacite is spotted, while very irregular particles as much as 0.5 mm. in size are distinctly differentiated from one another by a lively oriented luster, though not sharply separated. The coarse granulation of the bands is obscured or entirely disappears.

"This is undoubtedly a zone of alteration; whether it is original or not, or whether the piece under investigation was partially heated in the working up of the main mass and then cut off, must remain uncertain. The latter may be more probable, since in the case of so large a mass (132.5 kg.) a considerably narrower zone of alteration is usually met with, unless, indeed, this should be a tonguelike projection.

"The only accessory material observed was a few small particles of schreibersite.

"The analysis of Hildebrand gives the following figures:

Fe	93.38
Ni	5.89
Co	1.24
Cu	0.05
Mn	0.00
Cr	0.02
S	0.07
P	0.15
Chromite	0.07
Total	100.87

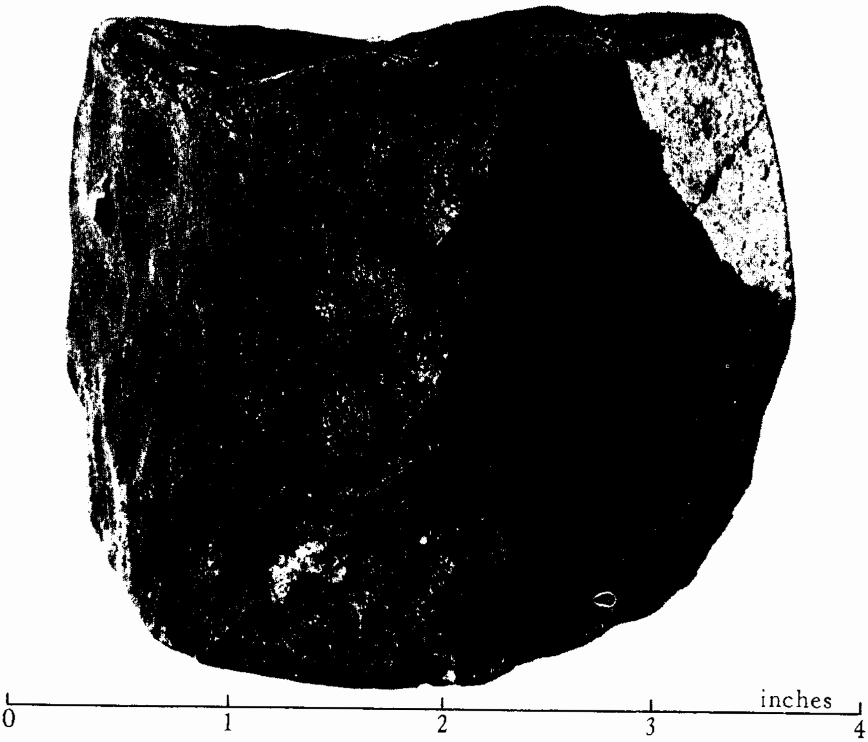
This gives the following mineralogical composition:

Nickel iron	98.78
Schreibersite	0.96
Troilite	0.14
Daubreelite	0.05
Chromite	0.07
Total	100.00 "

The above description by Cohen is copied from Farrington (1915, p. 354). The largest specimens of this meteorite can be found in the British Museum and at Yale University.

BRADFORD WOODS METEORITE

In 1946 an aerolite or stony meteorite, the Bradford Woods Meteorite, was uncovered. A student, C. R. Bruce, brought to Henry Leighton of the Department of Geology at the University of Pittsburgh, a specimen (Figure 3) for identification which had been lying in family cupboards for 61 years. The specimen proved to be a meteorite.



Photograph by Pennsylvania Historical and Museum Commission, Harrisburg, Pennsylvania.

Figure 3. External appearance of the Bradford Woods meteorite.

In 1956, William Lytle of the Pittsburgh office of the Topographic and Geologic Survey visited Ralph Hillman, the son of the farmer who originally discovered the meteorite in Allegheny County. According to Mr. Lytle, the son gave the following account of the find (personal communication).

"The former George Hillman, father of Ralph Hillman, was husking corn at a farm directly west of the impact point. The impact point can be located in Section E of the 15′ Sewickley Quad. 9000′ from the East line and 14,600′ from the North line. The entrance to the lane leading back to the farm can be seen on the map about 1300 feet southwest along the road from the impact point. It was almost noon on a day in September, 1886, and George had left his work to go to lunch at a farmhouse about 300 feet north of the impact point on the east side of the road. The path he traveled led from the farm to a point near the impact point. As George approached the road he heard a loud explosion, a hissing sound and a thud nearby as if something hit the ground. The order in which he heard these sounds is not known. George continued along the path to the road and kept looking to see what it was that hit the earth. He came out on the road and turned north along the road to go to the farmhouse for his meal. He had gone just a short distance along this road when he saw a depression in the road in the wheel tracks. Since nothing was in the hole, he kicked the weeds in the ditch along the road and found the meteorite. He didn't realize it was a meteorite but it was heavy and had made the hole in the road, so he took it home. Later he found out from the local paper that a meteor had passed through the sky on that same day. The road on which the meteorite was found is no longer open to the public for the land in this area is now State Game Land #203."

Dr. Leighton (1946) of the Department of Geology, University of Pittsburgh examined the meteorite and wrote the following:

"The meteorite measures 55 × 65 × 85 mm. and weighs 762 grams. It is shaped somewhat like an old fashioned pan biscuit with one smooth, curved surface like the biscuit top and three more square faces like the broken faces of a biscuit. The surface has the glazed, varnishlike, pitted surface characteristic of meteorites and is nearly black. It would seem that it is a part of a smooth, pebblelike, elliptic body which, as it reached the earth's atmosphere, exploded, the broken surfaces becoming fused and pitted in the rush through the atmosphere.

"A freshly broken corner of the mass made it possible to examine its mineral composition. It is made up of fine-grained, greenish silicate material which is highly birefringent and has a high index of refraction and an obscure cleavage. This is probably olivine. Accompanying the silicate is a small amount (possibly 2 or 3 percent) of metallic iron, which is also visible on the unbroken surfaces. The specific gravity of the whole specimen is approximately 3.4.

"From this preliminary examination it is evident that the meteorite is an aerolite with a small amount of metallic iron and may possibly be classed as an olivine achondrite."

The specimen has not been examined further and is owned intact by Ralph Hillman of Baden, Pennsylvania.

"Professor Clarke has kindly furnished me with the following analysis, made by Mr. L. G. Eakins in the laboratory of the United States Geological Survey.

"Professor Clarke did not succeed in developing the Widmanstatten figures satisfactorily, and the small amount of nickel shown by the analysis would indicate a poor etching iron; when larger surfaces are available, we shall doubtless obtain better results.

Fe	93.80
Ni	4.81
Co	0.51
Cu	0.005
P	0.19
S	0.01
	99.325

"No idea can be formed of the length of time the meteorite had lain in the ground and very little of the amount of surface decomposition, it has undergone—sufficient, however, to remove all the finer pittings, leaving a comparatively smooth surface.

"Having been much interested in Mr. Davison's examination of the magnetic properties of the Welland meteorite, and thinking that this line of investigation in other meteorites might lead to interesting results, I requested Mr. Marcus Baker of the U. S. Geological Survey, to make an examination of the meteorite, which he kindly consented to do.

"The result of this examination is to show that the meteorite, as a whole, acts as a mass of soft iron, gaining polarity under the inductive action of the earth. The lower portion on the north side became a north-seeking pole, while the upper part became a south-seeking pole; a pretty distinct neutral line was shown, inclined to the horizon at an angle (20°-25°) which is approximately the complement of the local inclination of the dipping needle. This induced polarity shifted with each change in the position of the whole mass, and in general this shifting of the poles took place promptly though not always at once. Mr. Baker also states that his observations suggested the probable existence of an unequal distribution of permanent magnetism, but this matter requires further investigation."

Brezina (1895, p. 293), observed as follows regarding the Mount Joy meteorite:

"A lumpy grain of the size of a nut which fell out during the cutting shows the imprint of the neighboring grains. Upon the section surface are to be seen bent Neumann lines with somewhat brighter yellow-colored porous crystals of troilite."

After acquisition of the principal part of the mass by the Vienna Museum the structure was studied by Berwerth (1897, p. 56-57), with the following results:

"The analysis by Eakins led Linck to class Mount Joy as a hexahedrite, and when later Brezina, on a piece broken from the surface, observed Neumann lines the meteorite was classed as a breccia-like hexahedrite. For the purpose of investigation and material for exchange the mass at the Vienna Museum was sawed in two parts in the direction of its principal section, and the smaller part cut into corresponding smaller plates parallel with this section. The faces obtained were so large and their character so remarkable that a complete investigation of the iron is in preparation; here the only endeavor will be to correct the error regarding its structure which has crept into literature. The preparation of the faces for exhibition showed without question that Mount Joy belongs to the octahedral irons, and by its very coarse structure should be placed among the last of the octahedral irons classed as having coarsest

MOUNT JOY METEORITE

The following description is by Mr. Edwin E. Howell (1892) of Washington, D. C., who was associated with the Wheeler and Powell Surveys in the early days of Federal geological exploration. Later he was proprietor of Howell's Microcosm, a shop in Washington dealing in minerals, fossils, and other natural history specimens, and making relief models of geographic and geologic features.

Professor F. M. Clarke of whom Howell speaks in this paper was for many years chief chemist of the U. S. Geological Survey.

The Mount Joy meteorite (Figure 4), according to G. P. Merrill, resembles the New Baltimore meteorite in its irregularly granular character.

Howell's (1892, p. 415-416) description follows:

"The accompanying cut gives a good idea of the form of the third largest meteorite found in the United States, and the largest east of the Mississippi River.

"It was found in November, 1887, on or about the 16th of the month, by Jacob Snyder, about a foot below the surface while digging to plant an apple tree near his house, five miles to the southeast of Gettysburg, in the township of Mount Joy, Adams County, Penna. It was supposed by the finder and his friends to indicate the near presence of an iron mine, and considerable prospecting was done to locate it. The meteorite was placed on some timbers in the open air where it remained until the summer of 1891, before it was seen by any one who surmised its true character.

"Professor F. W. Clarke induced Mr. Snyder to send it to the National Museum for inspection, but was finally unable to secure it, as Mr. Snyder was unwilling to part with it for a price, which the museum felt justified in paying. I, therefore purchased it from Mr. Snyder on the 15th of August, 1891. The three largest dimensions of the meteorite are 11, 24, and 33 ½ inches and it weighed on the museum scales 847 pounds. Professor Clarke had a few ounces taken off for examination; with this exception and the scaling of decomposed crust, from the outside, the mass still remains as it was found.

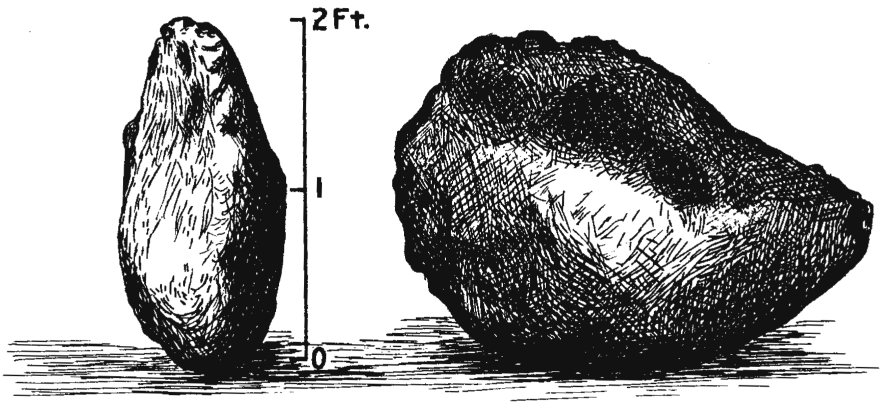


Figure 4. Sketch of the Mount Joy meteorite.

lamellae. The general structure of Mount Joy is that of a coarse-grained mass, the coarse grains of which are intergrown and so elongated with a certain regularity in one direction that the grains have a relatively short rodlike shape. From this shape and the position of the grains arises an appearance of Widmanstatten figures that is plain to the eye on a large section. The fine crystalline structure of the single grains makes the figures more distinct, since the grains show a similar course of Neumann lines, luster, and sheen. Contrary to the usual structure of octahedral irons with more compact band systems, Mount Joy shows by reason of the more granular than lamellar formation a disconnected network of figures. A regular inclusion of fine rhabdite is common to the grains. As regards the appearance of the etched surface the grains show two characters. Along the section the course of the Neumann lines is shown plainly. In another part of the mass the Neumann lines show only weakly. This disguised appearance of the lines comes from the fact that the mass of the grains has a composition of two fields, one of which is depressed and the other appears swollen on the etched surface. This gives a spongy or shagreened appearance. In certain sections the etching of the fields is oriented. The two fields show parallel striae and resemble the perthitic structure seen in twin feldspars. Of other components which occur in the meteorite, troilite is present only in relatively small quantity in scattered nodules of medium size. Single nodules contain white and lustrous crystalline inclusions. The troilite is regularly surrounded by a coating of schreibersite. Schreibersite appears in larger skeleton-like crystals in the iron grains, also inclosing the troilite and interspersed between the grains. Where the spaces between the grains are open wide and are cleft a dark oxidation product of iron taking a good polish accompanies the schreibersite. These fillings are commonly regarded graphitic. Graphite seems, however, to be everywhere lacking. Where these oxidized interspersions are extensive there may also be seen an earthy yellow silicate. To the above may be added the statement that the manner of the octahedral structure of Mount Joy, showing its composition of great crystalloids, requires a change in the present classification of iron meteorites. Probably a revision of the so-called brecci-like hexahedrites will be required and its members put into the octahedrite division. * * * Further, it is indicated that all iron meteorites possess an octahedral structure and that the meteorites of hexahedral structure which have fallen to our earth are simply fragments of octahedral irons of very coarse structure."

In 1941 a new analysis of the Mount Joy meteorite was made by E. P. Henderson (1943, p. 407) at the Smithsonian Institution. His work is described below:

"Mount Joy, Pennsylvania, meteorite was first studied in 1892 and apparently has never been re-analyzed. Its nickel content was also below the value consistent with its structure and therefore a redetermination of its nickel content was thought desirable.

Mount Joy, Pennsylvania meteorite.

	1	2
Fe	92.93	93.80
Ni	5.79	4.81
Co	.61	.51
Cu		.005
P		.19
S		.01
	99.33	99.325"

1—New analysis. Analyst, E. P. Henderson.
2—Ibid. Analyst, L. G. Eakins.

Mount Joy has been classified as a hexahedrite, a brecciated hexahedrite, and as a coarsest octahedrite. If there is any relationship between the nickel content and structure, a restudy of Mount Joy would certainly aid in more properly classifying this meteorite. The old value of 4.81 percent is below the nickel content consistent with that of other hexahedrites. The new and higher value of 5.79 percent places it above the range of normal hexahedrites and very close to the boundary between coarsest octahedrites and hexahedrites.

Mr. E. E. Howell, the original purchaser of this meteorite, was a dealer in minerals and presumably supervised the breaking up and selling of the specimen (Figure 5). The largest specimens of the Mount Joy meteorite are located in the Museum of Natural History in Wien, Austria, the Field Museum in Chicago, and Arizona State University, Tempe, Arizona.

Unfortunately, the majority of the specimens of this meteorite are decomposing. According to Dr. Gero Kurat (personal communication) at the Museum of Natural History in Wien, Austria, "the condition of the pieces ranges, depending upon locality, storage and care, from very good to bad. Spot rusting evidently cannot be avoided on the Mount Joy Meteorite due to its low content of Lawrencite ($FeCl_2$)."

BALD EAGLE METEORITE

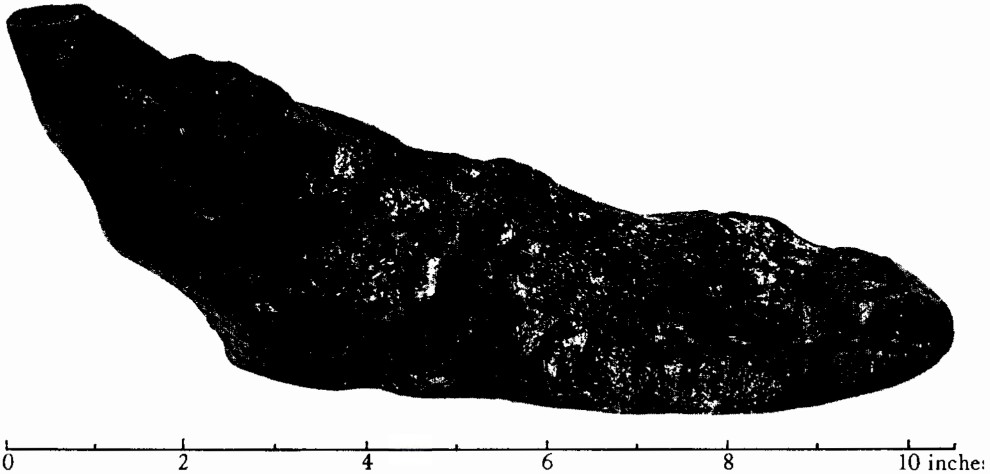
A meteorite found on Bald Eagle Mountain near Williamsport was described by Prof. W. G. Owens in a paper read before the Chemical Society of Bucknell University, Lewisburg, Pa. and published in 1892 (Owens, 1892, p. 423-424). At this time it was the third meteorite discovered in the State (Figures 6, 7, and 8). He wrote as follows:

"The meteorite which I wish to describe at this time was found on or about the 25th of September, 1891, upon the east side of Bald Eagle Mountain, seven miles south of the Park Hotel, Williamsport, Pa. At this point the mountain comes down to the edge of Susquehanna River, a road bed for the Philadelphia-Erie Railway having been cut in the mountain side. Numerous transverse depressions occur in the mountain side and some of these are filled with loose sandstone, varying in size from a few cubic inches to several cubic feet in volume.

"It was in one of these depressions, several hundred feet from the railroad track, that some Italians, while getting out stones for a stone-crusher, found in a bed of loose stones about 2 meters (6 2/3 feet) deep, something which resembled a stone in appearance; it was covered with fungus growth as were the stones, but when picked up attracted the laborer's attention on account of its weight. He showed it to the superintendent who tried to break it and failing attempted to cut it with a cold chisel, when it proved to be soft iron. After this it was again lost but soon after found. When, several weeks later, the owner of the crusher, Mr. Geo. S. Matlack, class of 1870, came to the works it was given to him and he, realizing its value, presented it to this University. It weighs 3.3 kilos (7 lbs., 1 oz.). In shape it resembles in general outline a human foot. The flat face, corresponding to the sole, measures 16.6 cm. (6 1/2 inches) long and 8 cm. (3 1/8 inches) wide at the broadest place. From the extremity of the

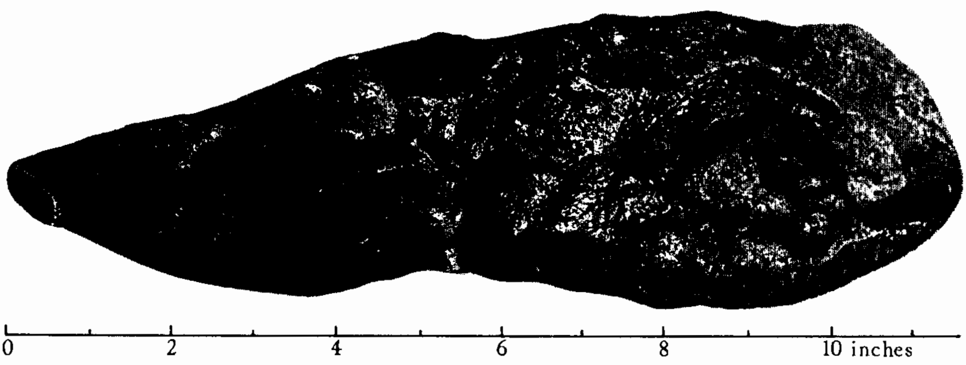
Photograph by Pennsylvania Historical and Museum Commission, Harrisburg, Pennsylvania.

Figure 5. Fragments of the Mount Joy meteorite.



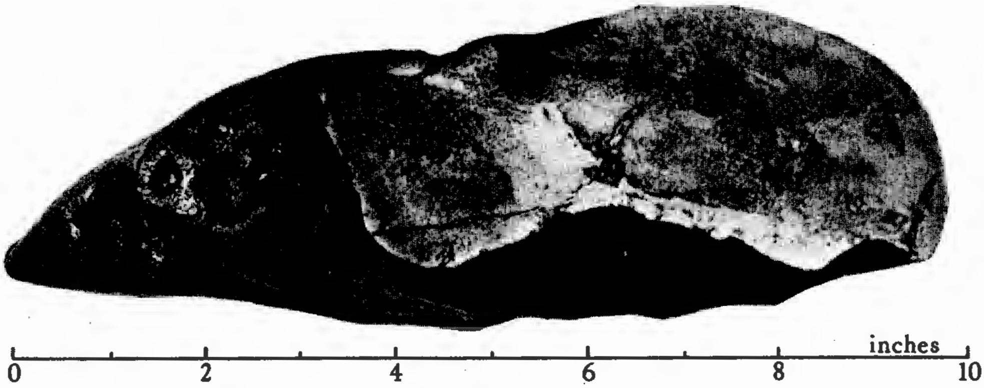
Photograph by Pennsylvania Historical and Museum Commission, Harrisburg, Pennsylvania.

Figure 6. Side view of the Bald Eagle meteorite.



Photograph by Pennsylvania Historical and Museum Commission, Harrisburg, Pennsylvania.

Figure 7. Top view of the Bald Eagle meteorite.



Photograph by Pennsylvania Historical and Museum Commission, Harrisburg, Pennsylvania.

Figure 8. Bottom view of the Bald Eagle meteorite showing sliced area.

heel it projects upward 14 cm. (5 ½ inches) ending in a point. The surface is covered with a reddish brown rust. This easily scales off in many places, and at several points this covering is so thin that the bright metals shine through. It is pitted quite deeply in some places, and very irregular in outline. On the projection above the heel there is a cavity about 1.5 cm. (⅝ inches) deep entirely burned out and almost opposite a core which has been only partially consumed.

"There are several surfaces which would seem to indicate that the objects which it struck were flat. So even was the surface corresponding to the sole of the foot that when it was cut for etching not more than 2 mm. (2/25 in.) had to be removed to get a surface of 32 sq. cm. (5 sq. in.). At the front there is also a surface of much smaller extent, which is perfectly flat and from it there projects a tip or point. Its specific gravity is 7.06. It is quite soft compared with iron. Most of the surface is covered with a very thin coating of rust. When polished and etched with dilute acid the Widmannstatten lines appeared very distinctly and beautifully. Chemical analysis gave: Fe 91.36; Ni 7.56; Co 0.70; P 0.09; S 0.06; Si, trace = 99.77.

"Nothing is known as to the time of its fall, though as it was found covered by several feet of stones which have not moved sensibly since the Susquehanna Valley has been inhabited by white men it could not have been recent. As far as can be learned, this is the only specimen of the fall which has been found."

The Bald Eagle iron was loaned by Prof. Owens to H. A. Ward, of Rochester, N. Y. for examination and cutting. Ward (1902, p. 79-81) published the following details:

"It has seemed to be desirable to add to this description by Professor Owens a view of this most interesting iron. The picture is a half-tone taken from a photograph of the mass before cutting. Its resemblance to a human foot is very striking, despite the many rough notches and depressions which cover the surface. But few of these depressions are well defined pittings, seeming rather to be fractuosities, caused by the violent tearing of the iron from a parent mass, and the sharpness of the angles and crests reduced by the attrition to which the whole mass has been subjected. A portion only of the surface, all the upper part of the ankle, has a well smoothed surface, with a fine granulation akin to a skin or crust. On the back, above the heel, are two sharp depressions, one round and 3/8 of an inch in depth and in diameter, the other, half as deep, a parallelogram 3/4 of an inch long and 1/3 inch wide. Both of these have vertical walls, and show clearly as cavities which have once been filled with softer matter, probably troilite nodules, which have since been eroded or decomposed away. On the top of the front part of the foot is a deep cavity, due to the folds in the iron, which passes nearly through to the sole. The sole itself is very flat, which has allowed a thin slice, 1/4 of an inch thick and weighing 300 grammes, to be cut off, of same width from toe to heel, and like thickness throughout, like the sole of a shoe. The polished section is quickly etched by the use of dilute nitric acid, and the Widmannstatten figures produced are both sharp and peculiar. The iron is typically octahedral. The etched surface is composed mainly of short kamacite blades, with an average thickness of about 1 mm. and from 5 to 10 mm. in length. These depart from the ordinary rule defining the usual angular figures by being largely curved or snake-like in form, giving a pattern like that of floss or tangled yarn. Many of these kamacite blades are club-shaped (rounded on both ends) as in the August Co., Va., iron. The patches of plessite are minute, sometimes showing clearly the alternate layers of taenite and kamacite. The taenite plates lying between the kamacite blades are very narrow, but stand out in prominent relief on the etched surface, and are faintly distinguishable by their bronze-yellow color from the tin-white kamacite.

"Two fissures, each about 25 mm. in length and averaging from 1 to 2 mm. in width, cross the sole diagonally, and are filled with troilite. No rounded nodules of this mineral were to be seen in the section made. Several patches of schreibersite, rudely representing cuneiform characters, are scattered throughout the etched surface. These are brighter and with denser surfaces than the troilite, the latter being granular and less lustrous. But the main peculiarity of this iron is the extremely winding, vermiform assembling of the kamacite plates, to which we have already referred. In this respect the Bald Eagle iron is quite unique."

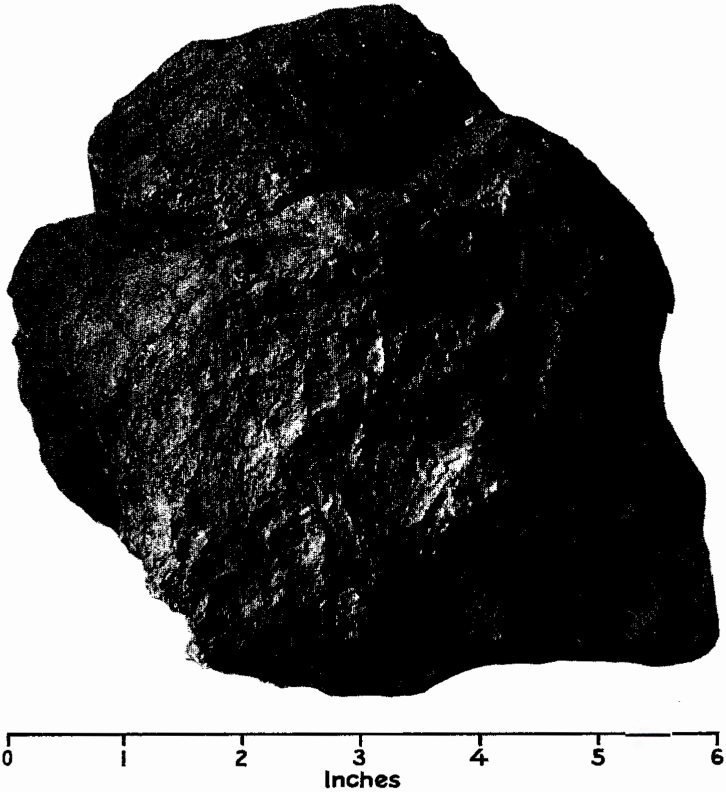
Upon examination by Dr. Stone in 1931 and Mrs. Starr in 1966 the resemblance of this meteorite to a small deformed or club foot is striking (Figure 6).

This meteorite was feared lost in the August 27, 1932, Bucknell Museum fire but was recovered intact. The meteorite has remained intact at Bucknell University except for the 1/4 inch slice removed from the sole by H. A. Ward as mentioned in his description. This slice is now owned by the Field Museum in Chicago. The difference between the original weight and the current weight may be due to the evaporation of water from the specimen or by some damage from the fire. It is unlikely that the original weight was incorrect.

SHREWSBURY METEORITE

The fourth Pennsylvania meteorite (Figure 9) was described by O. C. Farrington (1910, p. 350-352) as follows:

"To the iron meteorites known from Pennsylvania, Bald Eagle, Pittsburgh, and Mount Joy, a fourth is now added. This last cosmic accession was found in 1907 on a farm about seven miles north of Shrewsbury, York County, Pennsylvania. It was discovered by being struck by a plow while plowing and attracted attention on account



Photograph published by courtesy of Field Museum of Natural History, Chicago, Illinois.

Figure 9. External appearance of the Shrewsbury meteorite.

of its unusual weight. As the region is one in which more or less brown limonitic iron ore occurs, the meteorite was supposed by its finder to be an unusually heavy specimen of such ore and as such was shown to Mr. F. Justice Grugan of Philadelphia when in the vicinity in June, 1909. Mr. Grugan, in whose possession the meteorite now is and to whom the writer is indebted for the history here given, at once recognized the meteoric nature of the mass, and took steps for its preservation. He also instituted a search for any associated specimens that might be in the vicinity. In this he was successful to the extent of finding several fragments that had been distributed as curiosities, but no important additional individuals were found. The smaller pieces obtained were reported to have been found about three-quarters of a mile northwest of the main mass. If this distribution was a natural one, a southeasterly course of the meteor is indicated. The fragments and mass placed in the hands of the writer for examination had evidently all belonged to a single individual. The main mass as received weighed 24 pounds and the fragments 3 pounds more, giving a total weight to the meteorite as now known of 27 pounds (12.2 kgs.). The forms of the meteorite as restored by adding the fragments is roughly rhombohedral, with dimensions of about 6 inches (15 cm.) on a side. At the same time there is much rounding of the solid angles and there are many depressions and irregularities which make the above characterization of the form only an approximate one.

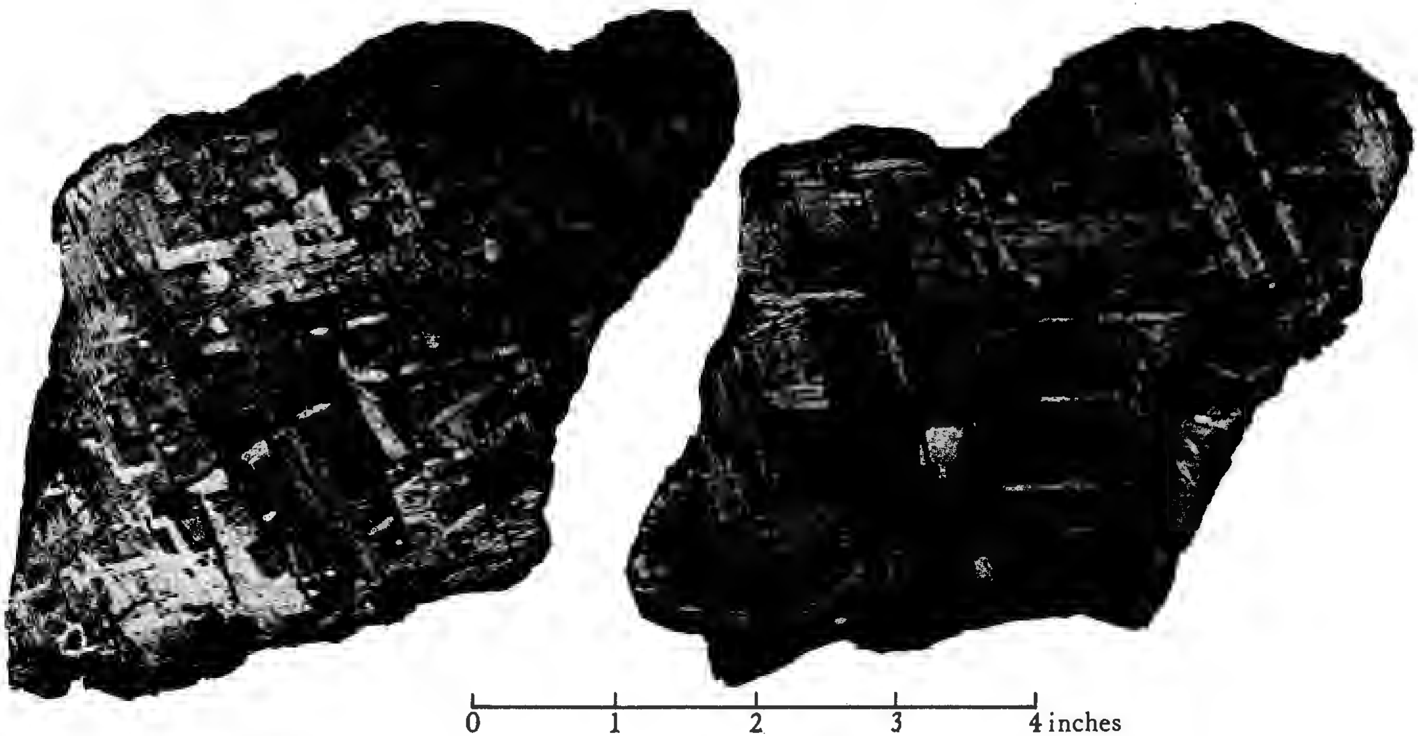
"Owing partly to decomposition from lying in the soil and partly probably in rough handling, the appearance of the original surface of the meteorite remains over less than half the mass. Where seen it shows the usual rounded and smooth exterior of iron meteorites with broad, shallow pits, the broadest being about 3 inches (7 cm.) in diameter. There has been considerable alteration of this surface through weathering, so that its substance has become more or less friable and limonitic in character. This alteration appears to extend in places to a depth of about half an inch (1 cm.). Where the original surface is not present the meteorite shows a jagged fractured appearance and exhibits typical octahedral structure. It is probable that over such portions the original surface has disintegrated and fallen away, though the appearance at one point would indicate a rounding of the mass in the air like that shown by one of the Glorieta Mountain (N. M.) individuals.

"On account of oxidation the mass as a whole presents a generally rusty-brown color with spots of a green incrustation, due doubtless to the formation of some nickel salt. The undecomposed nickel-iron is easily cut by a file, but is not malleable owing to a well-developed laminated structure. Under the hammer, therefore, it is inclined to crumble. Plates of bronze-yellow, flexible, magnetic taenite can be easily separated both from the decomposed and undecomposed nickel-iron.

"Analysis of the meteorite by Dickman and Mackenzie of Chicago gave the following result:

Fe	90.84
Ni	8.80
Co	tr.
S	0.01
P	0.29
Total	99.94

"Sections of the meteorite show a firm, homogeneous interior with little or no disintegration. Broad, straight lamellae almost entirely prevail. These lamellae average a little over one millimeter in width, thus placing the meteorite in the group of medium octahedrites. For the most part the lamellae show simple, broad bands of kamacite, but some of these are seen on closer examination to be made of smaller lamellae grouped together. The kamacite shows considerable hatching, generally in a single direction. Where fields occur they appear to be mainly of two kinds: 1, those made up of numbers of minute taenite foliae with parallel arrangement and parallel to the adjoining bands, and 2, those made up of kamacite grains bordered by taenite and showing a more or less divergent arrangement. Accessory constituents are comparatively abundant and scattered irregularly over the section though somewhat more numerous toward the periphery. They include troilite and schreibersite, the troilite occurring in spheroidal and the schreibersite in hieroglyphic forms. The troilite is characterized by a bronze-yellow color and dull luster, the schreibersite by a tin-white color and shining luster. One troilite nodule in the section especially studied by the writer is more nearly circular in form, 2 cm. in diameter and has an irregular border of schreibersite. In other places the troilite has a more nearly vein-like distribution and is more or less mixed with schreibersite. Hieroglyphic schreibersite occurs at several points, usually in groups of three. The grains are from 4 to 8 millimeters in length. Swathing kamacite from 2 to 4 millimeters in width surrounds the schreibersite inclusions, but there is none about the troilite."



Photograph by Pennsylvania Historical and Museum Commission, Harrisburg, Pennsylvania.

Figure 10. Etched section of the Shrewsbury meteorite.

Mr. Grugan, who first recognized its character and was for a time possessor of this meteorite, appreciated the value of such material to science and kindly allowed it to be sliced into museum specimens that it might be widely distributed among museums and students of meteorites (Figure 10). The British Museum in London, England, and the Academy of Natural Sciences in Philadelphia, Pennsylvania, now own the largest slices of this meteorite.

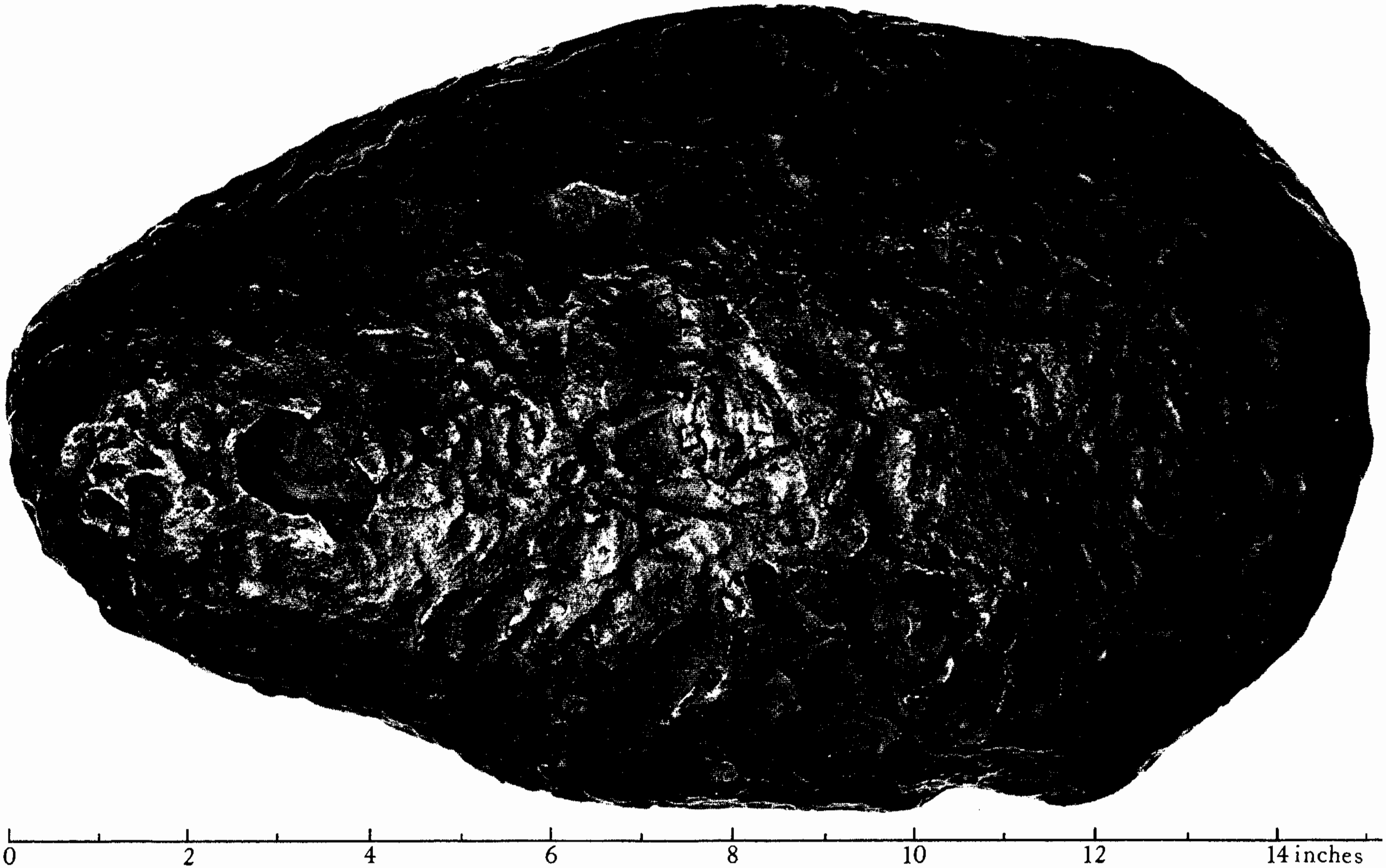
NEW BALTIMORE METEORITE

In September 1922 the Pennsylvania Geological Survey received a 2-ounce mineral specimen for identification from Mr. W. C. Keyser, Schellsburg, Bedford County. It was at once recognized by Dr. George H. Ashley, State Geologist, as meteoric iron and on October 12, 1922 Dr. Stone called at Mr. Keyser's home and saw a lump of meteoric iron 23 pounds in weight from which the small piece had been detached (Figures 11-15). This lump was said to be one-half of the original find, the other half being on the farm where found. Dr. Stone accompanied Mr. Keyser to this farm on the crest of Allegheny Mountain 2 ½ miles south of the Lincoln Highway and 3 miles northwest of New Baltimore, Somerset County, and we brought the other half back to Schellsburg.

According to Mr. Keyser, in the summer of 1922 Mr. Jefferson Long, while plowing in a corn field, unearthed a cobble so heavy that it attracted his attention. It was about the size and shape of a small ham but weighed nearly 40 pounds. Mr. Long broke it in two pieces with a sledge, a feat made possible by the coarsely granular character of the iron. He took part of it to Mr. Keyser as a curiosity and, as related above, it thus came to public notice.

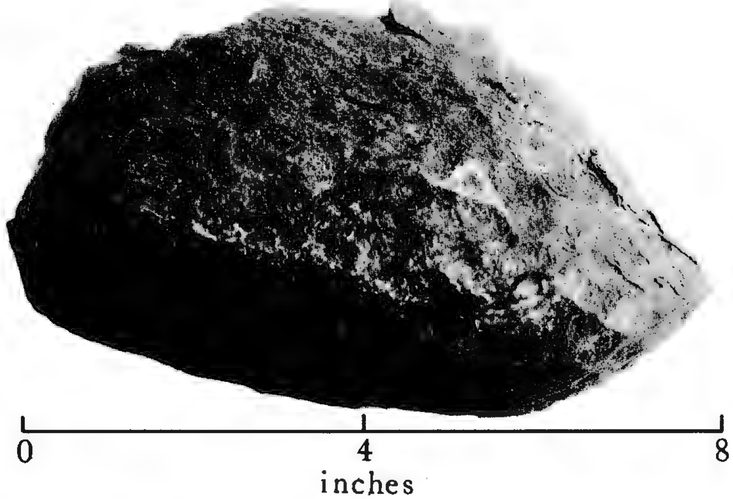
Dr. Stone succeeded in nearly fitting the parts together and concluded that the iron as originally found measured about 14 ¾ inches long and 8 inches at its greatest width. The circumference on the long axis was about 29 inches and crossways about 21 ½ inches. The mass was elliptical in cross section with a greatest thickness of 3 ½ inches. One of the main pieces approximated the half of an ellipse in outline, measured 7 inches in diameter, 17 inches in circumference, and 3 inches thick. The other piece was roughly triangular, approximately 6 ½ by 8 inches across and 3 ½ inches thick.

The exterior surface of the original mass was considerably oxidized and slightly scaly. A light tan colored shell concealed a rusty red inner skin. Freshly fractured surfaces were iron black. A coarsely granular texture was recognizable in the broken faces (Figure 14). The individual granules, ranging up to 1 inch in size, have irregular shapes, with sharp, narrow ridges outlining slightly concave faces. These granules are closely interlocked. Only by repeated heavy blows with a



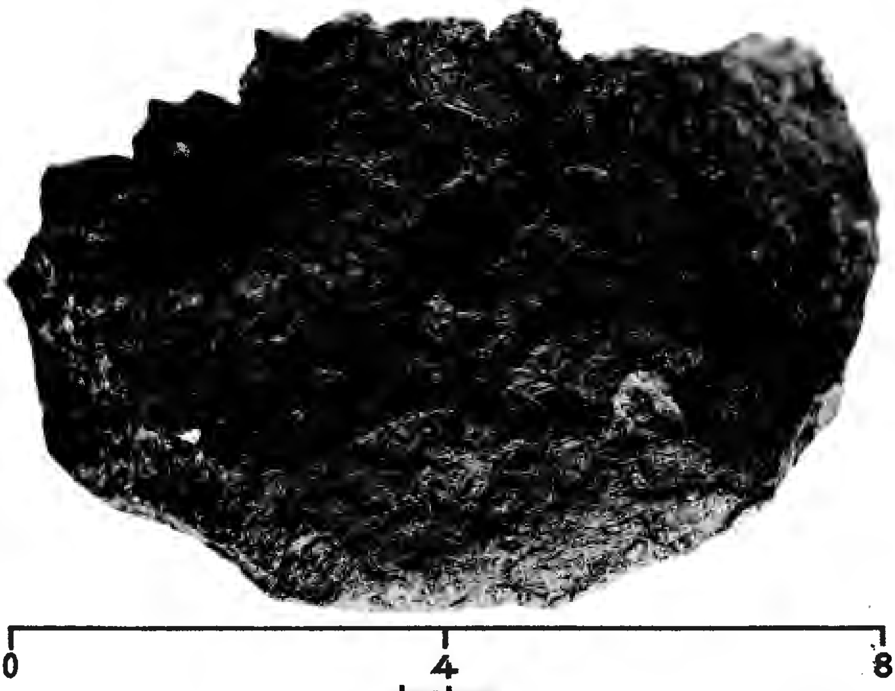
Photograph by Pennsylvania Historical and Museum Commission, Harrisburg, Pennsylvania.

Figure 11. Plaster cast of the New Baltimore meteorite.



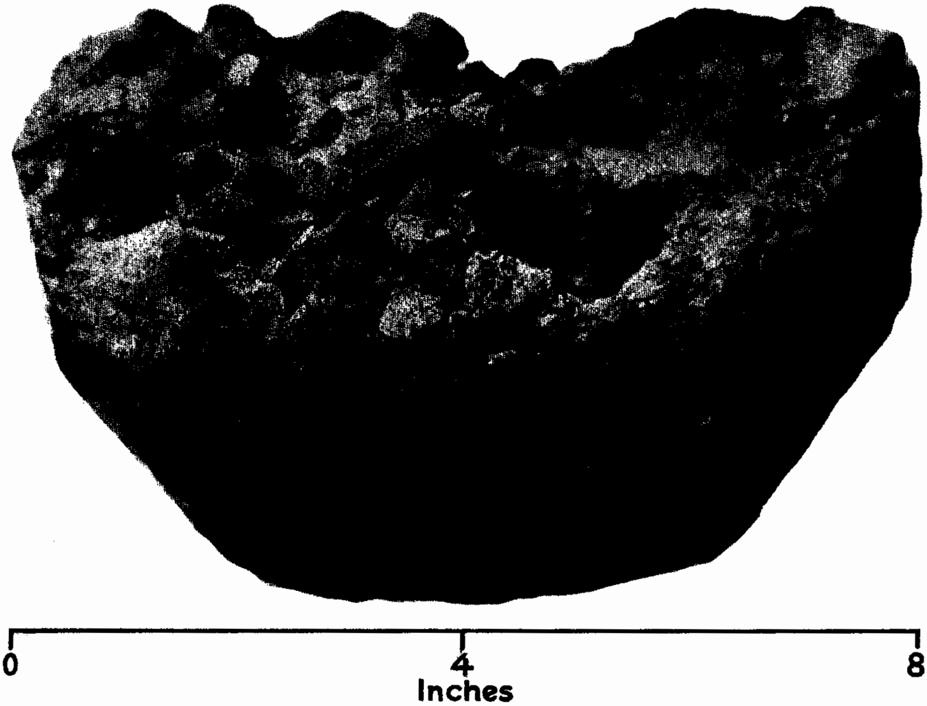
Photograph by Pennsylvania Historical and Museum Commission, Harrisburg, Pennsylvania.

Figure 12. End view of the New Baltimore meteorite.



Photograph by Pennsylvania Historical and Museum Commission, Harrisburg, Pennsylvania.

Figure 13. View of the New Baltimore meteorite showing jagged break.



Photograph by Pennsylvania Historical and Museum Commission, Harrisburg, Pennsylvania.

Figure 14. View of the New Baltimore meteorite showing coarsely granular character of break.

sledge was part of the meteorite broken off. The irregular granules clung tenaciously but tended to break down to coarse, rough fragments.

The field in which this meteorite was found is within a few rods of the crest of Allegheny Mountain and underlain by Pottsville sandstone. A search over this field and adjacent pastures did not disclose other pieces of meteoric iron, and inquiry of residents in the neighborhood, which is sparsely settled, was fruitless of recollections of a conspicuous falling star.

Mr. Keyser kindly permitted Dr. Stone to send a few fragments of the meteorite to G. P. Merrill, curator of geology, U. S. National Museum, for examination and analysis.

The first published notice of the New Baltimore meteorite was by Merrill (1923, p. 175-176). In accordance with the usual custom of designating by a nearby geographic feature, Merrill named it the New Baltimore and wrote as follows:

"A single glance at the iron suggested at once the possibility of its being a portion of the Mount Joy, Adams County, fall, and also explained how the mass could become so readily broken into fragments. Like the Mount Joy iron, it is an irregularly granular mass, the individual granules of which vary in size up to 40 mm. or more. These, while closely interlocking in the fresh iron, on weathering, separate and fall away as a coarse metallic gravel. Those who have had to do with the last named iron will recall a similar characteristic which made it almost impossible to preserve it intact. When polished and etched the individual granules are essentially structureless, a feature of the Mount Joy iron that caused it to be first classed as a brecciated hexahedrite (Hb), and it was not until a large surface was exposed to etching that its true coarsely octahedral nature was disclosed.

"A granule of 100 grams weight was submitted to Dr. J. E. Whitfield for analysis with results as in column I below. In column II is given the composition of the Mount Joy iron as determined by Mr. L. G. Eakins in 1892 (Howell).

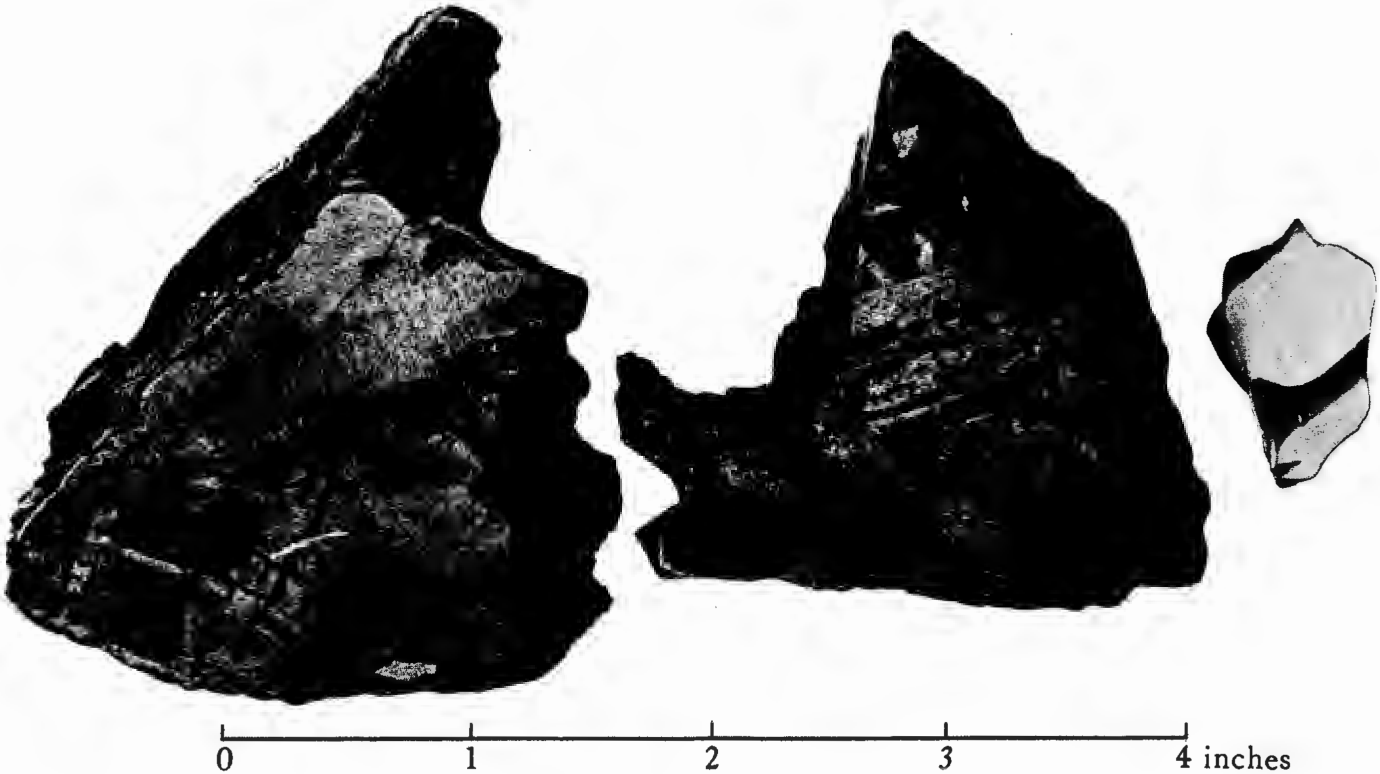
	I	II
Iron	93.256	93.80
Nickel	6.420	4.81
Cobalt	0.325	0.51
Copper	none	0.005
Phosphorus	0.037	0.19
Sulphur	none	0.01
Manganese	none	
Silicon	0.010	
Carbon	0.015	
Total	100.063	99.325

"The only marked difference in these results, it will be noted, is in the percentage amount of nickel. Just how much weight is to be attached to this the writer is not at present prepared to state. Further analyses of the Mount Joy iron are needed to settle the point. The absence of sulphur, manganese and copper, and low content of phosphorus are features worthy of note.

"The distance between Allegheny Mountain in Somerset County and Mount Joy in Adams County, as measured in a straight line on the map, would be approximately 90 miles. On the assumption that the meteorite was traveling in either an easterly or westerly direction, this distance is not considered too great for them to be relegated to one and the same fall, as above suggested, though I do not know that we have any definite record upon which to base such an opinion. * * * "

Subsequent to the preliminary description further laboratory work disclosed several noteworthy features. These were described by Merrill (1923a, p. 262-264) as follows:

"As stated in the first paper, the iron, like that of Mount Joy (also Ainsworth), has a coarse irregularly granular structure, the individual granules varying in sizes up to 40 or more millimeters. These while closely interlocking show a tendency to separate and on weathering to fall away to a coarse metallic gravel. Even where there are no distinct evidences of weathering—as oxidation—the granules by hammering can be separated, breaking out in peculiarly irregular forms with smooth, black, somewhat lustrous surfaces. A considerable number of these were polished and etched on various faces and invariably showed the characteristic hexahedral structure and Neumann lines. It was surmised, however, that larger polished surfaces might show the iron to be a very coarse octahedrite as was the case with the Mount Joy iron and hence the sample was cut and polished in a way to give the roughly triangular



Photograph by Pennsylvania Historical and Museum Commission, Harrisburg, Pennsylvania.

Figure 15. Etched section of the New Baltimore meteorite.

surface 11.5 cm. × 8.5 cm. shown in the plate. The structure as thus brought out is wholly unlike anything I have before met with or seen described, the coarsely granular portion on either side being bordered by somewhat undulating kamacite plates so arranged as to suggest an octahedral structure but with no intervening taenite or plessite fields. The large kamacite granules are sharply differentiated and, as stated, can often be broken entirely free from one another but seem less sharply differential, more closely welded as it were, to the octahedral portions. With considerable difficulty a piece of the iron was cleaved off and after polishing and etching on all sides to insure its uniform structure, was submitted to Dr. Whitfield for partial analysis. The result is given in column I below, while in column II is that of one of the hexahedrite nodules as given in my first paper. The two portions are then chemically identical and typical of kamacite.

	I	II
Fe	93.02	93.256
Ni	6.38	6.42
Co	0.43	0.325
P	not. det.	0.037
Si	not. det.	0.01
C	not. det.	0.015
Total	99.83	100.063

"The structure, so far as my experience goes, is quite unique and but for the analyses would suggest an admixture of two different irons rather than local enlargements of kamacite bands in a very irregular coarse octahedrite as seems probably the case. In this respect it differs from the Mount Joy and Ainsworth irons with which I have compared it.

"A second and equally interesting feature shown by the section is a small fault with a throw of about one centimeter which is visible in the plate as a sharp curved line extending from the lower left, upward to the right margin. At the left this seems to have been slightly enlarged by oxidation but for the remainder of the distance is as sharp as though scratched with a diamond. The amount of displacement is most plainly evident in the large kamacite granule in the lower right center and less distinctly in other portions. It is to be noted that though the iron is soft and malleable at ordinary temperature there is not the slightest indication of any drag between the walls of the fault. To account for this, one seems justified in concluding that the fracturing, or faulting, was the result of some sudden shock, like a collision, occurring when the iron was rendered brittle by intense cold.

"It is difficult to classify this iron by any of the prevailing systems, but I have placed it provisionally in Berwerth's kamacite octahedrites group KO. This is the fifth meteorite reported from Pennsylvania; all are iron and none of them seen to fall."

The main mass of the New Baltimore meteorite was bought by the Mineralogical Museum of Harvard University, through Dr. G. P. Merrill of the U. S. National Museum. According to Prof. Charles Palache, curator, it was received at the Mineralogical Museum in two pieces one weighing 23 pounds (10.4 kilograms) and the other 17 pounds, 10 ounces. The smaller piece was sent to the Smithsonian Institution in 1925 and cut into several slices.

Harvard University still owns the one large specimen while the Field Museum in Chicago, Illinois, and the Smithsonian Institution in Washington, D. C. have the largest specimens from the sliced second specimen.

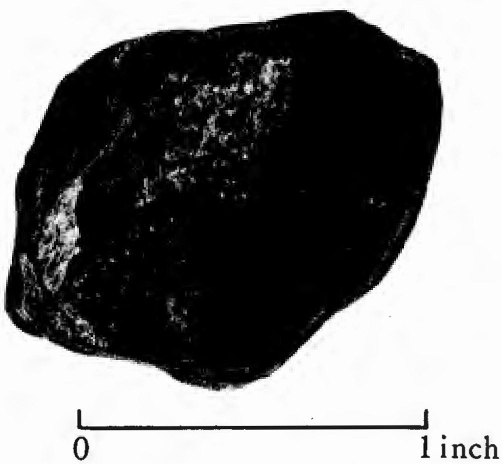
CHICORA METEORITE

On June 24, 1938, at approximately 6 o'clock P.M. EST a large fireball was seen to pass from southwest to northeast over western Pennsylvania. Its passage was well documented by a number of observers in Pennsylvania and eastern Ohio, who observed the smoke trail that lasted up to twenty minutes after the fireball had disappeared. The shock wave from the compressed air in front of the fireball was heard from the northern part of Pittsburgh to Petrolia, Pennsylvania, although the noise in most cases was mistaken for lightning or an explosion.

From the apparent trajectory surmised from witnesses who saw the fireball, the point of impact should have been in northern Butler County on the west side of the Allegheny River at lat. 41° 1'N. and long. 79° 40'W. Although the rugged area was searched, nothing was located.

Along the trajectory of the meteor, two small rock fragments left the major mass and dropped vertically into a chicken paddock owned by Adam Gering of Chicora, Pennsylvania (Figure 16). According to Preston (1941):

"A farmer was sitting on his porch when there came a sound like an approaching airplane, and a great gust of wind. The chickens in a nearby paddock were wildly excited and objected to something in their midst, but a search failed to disclose what it was all about. Next day, hearing of the meteorite, the farmer searched again and discovered two pieces of it, the larger about half the size of a man's clenched fist, the



Photograph by Pennsylvania Historical and Museum Commission, Harrisburg, Pennsylvania.

Figure 16. External appearance of the Chicora meteorite.

smaller, half that size. They were stony meteorites, the outer skin melted, resolidified, and slightly cracked, and they were buried 2 or 3 inches in the grass roots. The impression fitted the stones well and the stone appeared to have fallen vertically. The farmer reported no flash of light or roar of thunder, but only a noise like an airplane and a great gust of wind. In a neighboring field a cow was discovered to have its hide torn downward as if struck a glancing blow by a falling stone, and it was necessary to have a veterinarian tend to it."

One specimen, weighing 45.79 grams, is owned by the finder's son, Mr. Adam Gering of Chicora, Pennsylvania, another specimen weighing 242 grams is owned by the Smithsonian Institution. It has been estimated that the original mass of the meteor before entering the earth's atmosphere was 628 tons (Preston and others, 1941, p. 406). The slow speed and slanted path of the meteor caused most of the mass to disintegrate before impact giving rise to the smoke trail.

Both specimens that were located at Chicora, Pennsylvania, were analyzed by the National Museum in Washington, D. C. According to Henderson (Preston and others, 1941, p. 407):

"Both individuals were covered with a thin film of black fused crust, and neither shows any evidence of being oriented through much of its flight. Shallow and irregular depressions (thumb marks) are noticeable on each, but no unusual physical features are present.

"When the crust was removed a fine-grained texture was found exhibiting a rather uniform gray color. All the component minerals are so small that none could be recognized by the unaided eye, unless it be an occasional inclusion of bronze-colored troilite. On the freshly broken surface no conspicuous evidence was observed of the chrondritic nature of this meteorite, and not until a thin section was prepared could positive proof be given. From the smooth surface, made by cutting away a portion for the thin section, a dappled-gray pattern is noticeable. The darker gray material is in rounded, as well as slightly elongated, chondrules or portions of chondrules, each being separated by a thin zone of lighter gray material. The texture is just firm enough to make it slightly difficult to break apart by use of a steel tool."

Randolph (Preston and others, 1941, p. 410-411) used material taken from the smaller specimen for study. The material, selected from the central portion of the meteorite, was partially crushed and sized by screening through two sieves, one 140 mesh, the other 80 mesh. Chemical analyses were run independently on the coarse and fine grained material. The finely divided material contained 57.22 percent olivine, while in the coarser samples 51.89 percent was found. According to Randolph (Preston and others, 1941):

"The olivine in this meteorite has two different modes of occurrence:

(a) They are fragments of a banded chondrulitic olivine structure but no complete chondrules. The banded or barred olivine is made up of alternating zones of olivine and a granular, fine-grained crystalline aggregate. The olivine bands in a given chondrule fragment will extinguish under crossed nicols as a crystallographical unit. The origin of this banded structure of the olivine must have taken place when the original chondrules were formed. These were broken up and their fragments added to this mineral aggregate.

(b) There are a number of subhedral olivines present, and their outer areas have been badly granulated, while the central portion, although fractured, is not nearly so badly broken up or shattered. It appears that this shattering of the outer zones of the olivine has taken place after the consolidation of this mineral aggregate * * *."

Oligoclase feldspar was found to make up 7.20 percent of the total meteorite. Pyroxenes made up 28.24 percent, the majority of which is hypersthene. Metallic iron made up 2.65 percent of the total. The fine-grained material contained 1.65 percent Iron, 0.49 percent Nickel and 0.19 percent Cobalt. The coarse grained material contained 1.83 percent Iron, 0.81 percent Nickel and 0.33 percent Cobalt. Why the coarse material contains more iron than the fine-grained material cannot be explained.

The Chicora meteorite is classified as an olivine-hypersthene chondrite of the Soka Banja type which it resembles chemically although the Chicora meteorite is far less chondritic in texture than the Soka Banja meteorite.

On the texture of the Chicora meteorite Randolph (Preston and others, 1941, p. 414-415) says:

"Olivine and hypersthene are present in sizeable masses distributed through a fine-grained crystalline ground mass. The hypersthene has a fiberous habit and is present as fragments of chondrules. The olivine is also present in fragments of chondrules, but some of it is encountered in subhedral inclusions.

"'The structure of this meteorite seems to indicate a clastic origin, and very little can be interpreted from the structure. Some evidence of adjustment or movement is noticed since the mass was consolidated, as shown by the granular zones around some of the olivine as well as a portion of the texture of the fragments of hypersthene chondrule."

In 1940 Mr. Gering found two more fragments of the Chicora meteorite in a field about 400 feet and a little north of due east from where the first two fragments were found. These fragments are now owned by the Smithsonian Institution.

BLACK MOSHANNON METEORITE

On July 10, 1941, the Black Moshannon meteorite (Figures 17 and 18) landed in Black Moshannon State Park, Centre County, Pennsylvania. It was found by Robert H. Reed of Philadelphia who was camped, with his wife and son in the state park.

According to Mr. Reed (1941):

"Shortly after 6 A.M., I slipped out of the tent to see what the weather would be like for the day. As I stood there, looking over the lake, I heard a strange whirring noise as if a million bumble bees had been disturbed. In mere seconds the noise increased in intensity, suddenly ending with a dull thud behind me that shook the platform and tent. This was followed by the fluttering of leaves as twigs floated down from an oak tree.

Mrs. Reed, awakened from her sleep, called out:

'What in the world was that?'

'I don't know,' I said, 'maybe someone is blasting. It sounded like a rock falling.'

"But there had been no explosion. This increased our curiosity, and I went to the back of the tent where the twigs from the oak lay, freshly broken, upon the ground. There I noticed a hole at the base of the tree, and I dug out an iron-like, rocky mass a little larger than a man's fist.

'It looks like a meteorite,' I remarked to my wife, 'only it is quite cold.' I thought then, as most people do, that a meteorite is hot when it bits the earth.

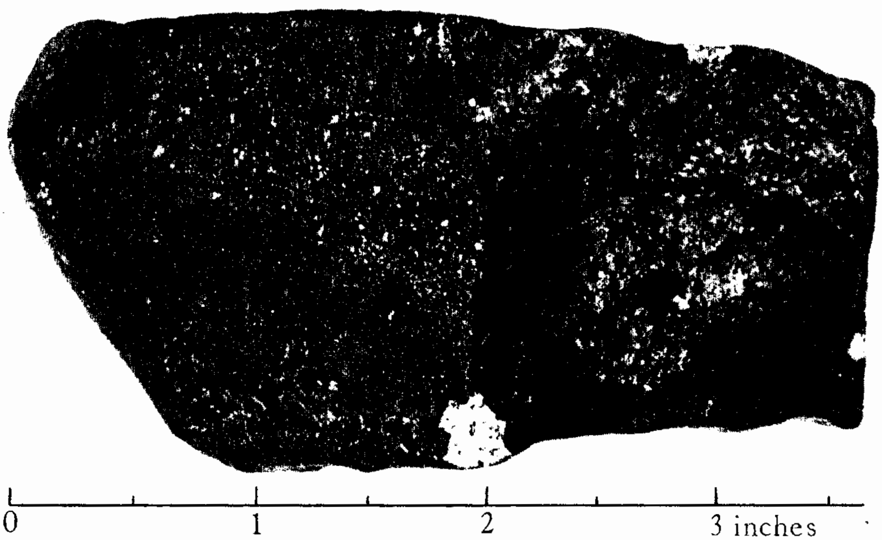
"The little brownish-black mass showed pock marks as if it had at one time been intensely heated. It is heavy for its size—it weighs 1 pound 2½ ounces—brownish black with one side, where it appears to have been broken off, showing silver-like streaks.

'Did that little thing make all that noise?' asked Mrs. Reed. And Robert said that he had been having a dream about an office, and believed that he had been awakened by a typewriter falling off a desk.

"Later I measured the distance from our tent to the hole punched in the earth by the falling fragment. It had buried itself in the ground just four feet from my son's head.

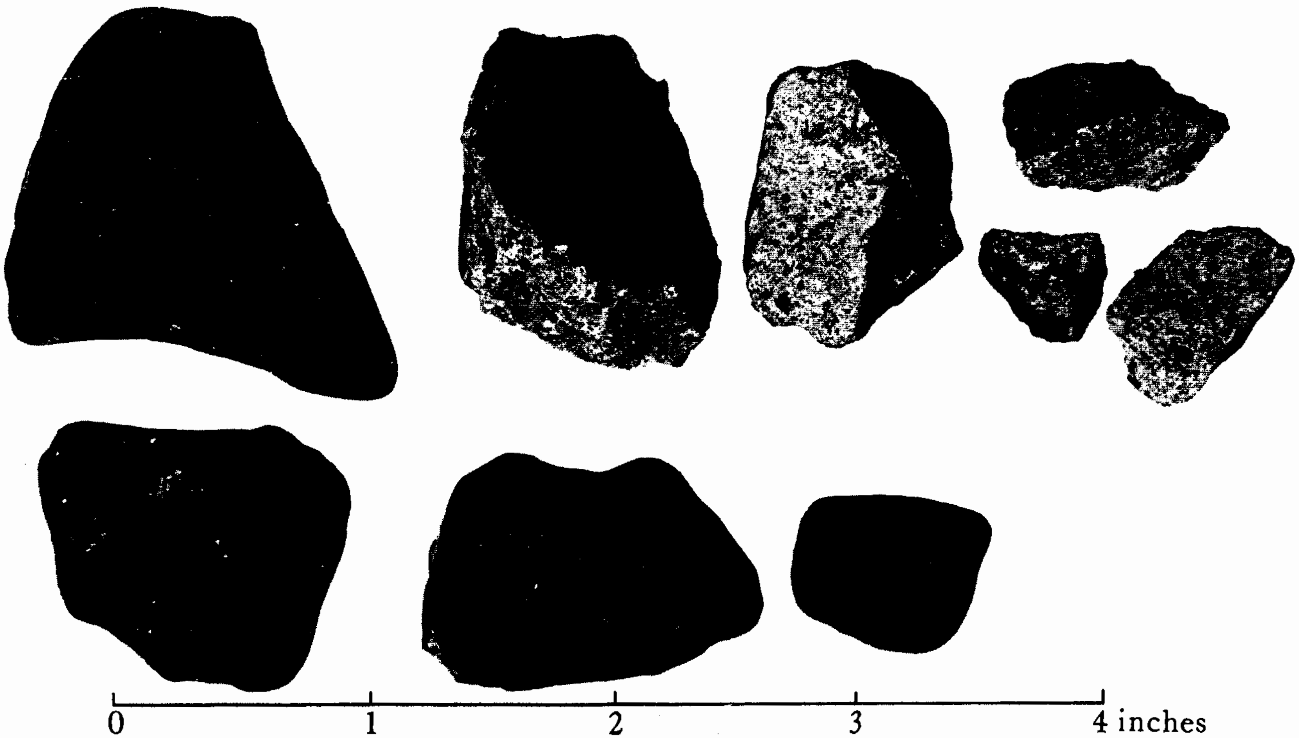
"Returning to Philadelphia, I took the chunky little mass to the Academy of Natural Sciences where Samuel G. Gordon, assistant curator of minerals, pronounced it 'the real thing.' His keen interest, as he examined it under the microscope, emphasized our find. Subsequently, he got in touch with other officials, and an interested member purchased our meteorite and presented it to the Academy of Natural Sciences where it is now on display."

Eleven specimens of this meteorite were found, the largest of which is described above. The Academy of Natural Sciences owns the one large and nine smaller specimens. Three of the small specimens can be fitted together to form one large one. The Smithsonian Institution owns the other small piece.



Photograph by Pennsylvania Historical and Museum Commission, Harrisburg, Pennsylvania.

Figure 17. Largest chunk of the Black Moshannon meteorite.



Photograph by Pennsylvania Historical and Museum Commission, Harrisburg, Pennsylvania.

Figure 18. External appearance of smaller chunks of the Black Moshannon meteorite.

PRESENT LOCATIONS OF METEORITE SPECIMENS

Pittsburgh Meteorite

British Museum, London, England 171 g., 28½ g.
Yale University, New Haven, Connecticut 158 g.
Field Museum, Chicago, Illinois 49 g.
University of Gottingen, Gottingen, Germany 43.6 g., 37.6 g.
Harvard University, Cambridge, Massachusetts 33 g.
American Museum of Natural History, New York, New York 4.4 g.
Smithsonian Institution, Washington, D. C. residue from studies.

Bradford Woods Meteorite

Ralph Hillman, Baden, Pennsylvania 730.34 g.
Mellon Institute, Pittsburgh, Pennsylvania 1.63 g. thin section.

Mount Joy Meteorite

Museum of Natural History, Wien, Austria 175 Kg. now in 40 pieces largest of which is 141 Kg.
Field Museum, Chicago, Illinois 20,712 g.
Arizona State University, Tempe, Arizona 8,580 g.
Smithsonian Institution, Washington, D. C. 1,228 g., 945 g., 265 g., 129 g., 48.2 g., 47 g.
Academy of Natural Sciences, Philadelphia, Pennsylvania 949 g.
Hungarian Natural History Museum, Budapest, Hungary 880 g., 671 g.
American Museum of Natural History, New York, New York 773 g., 47 g., 15 smaller pieces
British Museum, London, England 713 g., 46½ g., 18¾ g., 1½ g.
Yale University, New Haven, Connecticut 595 grams.
Harvard University, Cambridge, Massachusetts 553 g., 12 g.

Bald Eagle Meteorite

Bucknell University, Lewisburg, Pennsylvania 2,639.3 g.
Field Museum, Chicago, Illinois 300 g.
British Museum, London, England 15 g. filings.

Shrewsbury Meteorite

British Museum, London, England 925½ g., 9½ g.
Academy of Natural Sciences, Philadelphia, Pennsylvania 850 g.
American Museum of Natural History, New York, New York 563 g.
Harvard University, Cambridge, Massachusetts 507 g.
Smithsonian Institution, Washington, D. C. 337 g.
Carnegie Museum, Pittsburgh, Pennsylvania 303.5 g.
Field Museum, Chicago, Illinois 103 g.
Yale University, New Haven, Connecticut 90 g.
Arizona State University, Tempe, Arizona 24 g.

New Baltimore Meteorite

Harvard University, Cambridge, Massachusetts 10,400 g.
Field Museum, Chicago, Illinois 1,613 g.
Smithsonian Institution, Washington, D. C. 1,470 g., 1,060 g., 637 g.
British Museum, London, England 513 g., 24½ g.
American Museum of Natural History, New York, New York 430 g.
Academy of Natural Sciences, Philadelphia, Pennsylvania 106 g.
Arizona State University, Tempe, Arizona 62.2 g.
William Penn Memorial Museum, Harrisburg, Pennsylvania 17 g.

Chicora Meteorite

Smithsonian Institution, Washington, D. C. 242 g., 28.7 g., 4.5 g., residue from studies.
Adam Garing, Chicora, Pennsylvania 45.79 g.
Mellon Institute, Pittsburgh, Pennsylvania 8.09 g.

Black Moshannon Meteorite

Academy of Natural Sciences, Philadelphia, Pennsylvania 458.3 g., 56.6 g., 23.9 g., 20.9 g., 19.3 g., 16.4 g., 5.9 g., 4.3 g., 3.4 g., 1.3 g.

Smithsonian Institution, Washington, D. C. 29.5 g.

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