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Brenham, Kansas

Forest City → Winnebago, Iowa
Ferguson, N. C.
Bridgewater, N. C.
Summit, AL

ON FIVE NEW AMERICAN METEORITES.

By George F. Kunz.

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ART. XLII.—*On five new American Meteorites;* by GEORGE F. KUNZ.

1. *On the group of Meteorites recently discovered in Brenham Township, Kiowa County, Kansas.*

ABOUT four years ago, the farmers of Brenham Township ploughed up a number of heavy objects, which they used to weight down haystacks and for other like purposes, as they would have used boulders. It was discovered in March last that these were not common "rocks," but an interesting group of meteorites, numbering over twenty in all, weighing together about 2,000 pounds, and individually from 466 pounds down to one ounce. They were found imbedded at a slight depth in the soil, which here, for about one hundred feet deep is formed of Pleistocene marl, originally the bottom of an ancient lake; they occurred scattered over a surface more than a mile in length, principally, however, in a square of about sixty acres.

What is now Kiowa County, Kansas, five years ago formed parts of Edwards and Comanche counties, and was occupied by large ranges and cattle ranches. Brenham Township, or Township 27, as it was then called, is in the northwestern part of Kiowa County, consists of high prairie with some areas of sand-hills, and has an altitude of about 220 feet above sea-level. Some drains of the head-waters of the Medicine River and its tributaries, farther south, become ravines and valleys; and there a gravel occurs, the debris of Miocene "Loup Fork" conglomerates. But on the high prairie not a stone of any kind is to be found; hence the ranchmen and settlers were greatly surprised at finding heavy "rocks" or stones projecting through the prairie sod.

Several years ago, Mr. Davis, a lawyer at Greensburg, identified these as meteorites; and although the farmers had thus

known the fact for a long time, yet, strange to say, no importance was attached to them until Mrs. Kimberly applied to Professor F. W. Cragin, of Washburn University, in the early part of last spring. It was not until the 13th of March that Professor Cragin secured four of these masses. They were nearly all found by being struck by mowing-machines, ploughshares, corn-cultivators, or other farm implements. Over twenty distinct masses have been reported; but it is very evident, from the weight and other facts, that some have been noted several times over. The townships are reckoned from the base-line, the 40th parallel; and the ranges, from the 6th principal meridian, which crosses Kansas about longitude 97° 30′ west of Greenwich. Brenham Township [27] is made up of thirty-six sections, each one mile square, numbering from No. 1 to No. 36. The meteorites seem to have covered an area over one mile in length. Some of them fell on the east half of the northwest quarter, Section 27, Township 28, Range 17, west of the 6th principal meridian.

The history of some of the pieces is remarkable. The 35·72-pound piece, found on the Evans place, was lost, and again found in a hole made by hogs under a barbed-wire fence. The 75-pound mass was used by Mrs. Kimberly to hold down a cellar door or the cover to a rain-barrel. Mass No. 3 was used to keep down a stable-roof. The 466-pound mass [called by the farmers the "moon meteorite"] was covered by only three inches of soil, and broke a ploughshare when first struck. Apparently none of the masses were buried to a greater depth than five or six inches.

The 101·5-pound, the 71·5 pound, and the 55-pound masses were found four years ago by a cow-boy, when the ranch had not yet been occupied by settlers, being simply used as a cattle-range. He was unable to move them to the "Green's Stage Station," now Greensburg, eight miles distant, and so buried them in the gulch a mile northwest of the Kimberly farm on the "Francisco Claim." About a year afterward he became ill, and died; but before his death he communicated the burial of the "three strange rocks," as he called them, to two of the settlers, who succeeded in finding them and bringing them to the new town of Greensburg about a year later. The 55-pound mass was carried over by a neighbor, who used it to weight down his haystack.

Professor Snow, of Lawrence, Kansas, visited Kiowa County several times, and the last time obtained the 101·5-pound mass in the streets of Greensburg, the county seat, where it had lain for several years in front of a lawyer's real estate office.

The exterior of all the masses shows the characteristic pitting. The surfaces have all been more or less oxidized by

exposure to the elements, showing that the fall is not recent, and that the original mass was made of crystalline iron as well as of iron filled with crystals of olivine; in other words, the masses show two distinct groups. Of these, the 345-pound and the 75-pound ones are nickeliferous iron of highly octahedral structure and cleavage, and are caillites, while the others are meteoric iron containing olivine, and belong to the group known as pallasites.

The largest mass, a pallasite, weighs 466 pounds, or 211·818 kilos. It is thick, slightly flattened, triangular in form, somewhat heart-shaped, and measures through the longest part 61 centimeters, or 24⅛ inches; across the widest part 48 centimeters, or 19 inches; and in the thickest part, 37 centimeters, or 14½ inches. It is covered with large indentations measuring 10x6x3 centimeters. The coating is more or less oxidized, but the olivine is perceptible in all parts of the mass. The dimensions of the 345 pound mass [158·818 kilos] are 60x37x29 centimeters, or 23¾x14½x11⅛ inches. It is slightly arch-shaped, is an iron with many pittings, and shows the characteristic magnetic oxide of iron crust. The 219-pound mass [99·535 kilos] measures 51x41x26 centimeters [20½x16½x10⅛ inches; in form like a three-sided pyramid. The 211-pound mass [95·909 kilos] is somewhat rounded, with a circular depression on one side.

There are two masses weighing 125 pounds [58·863 kilos] and 54·96 pounds [25·084 kilos] respectively. The 101·5-pound mass [46·136 kilos] is almost round, measuring 35x26x27 centimeters [13¾x10¼x10¾ inches]. The exterior is evenly pitted, and the center of each pitting is occupied by an olivine crystal. The 75-pound one [34·09 kilos] is an iron, and measures 32x22½x15 centimetres [12½x8½x5⅞ inches], in shape like a pear or ham covered with pittings. The crust has been changed somewhat by weathering. The 71·5 pound mass [32·485 kilos] measures 27x23x22 centimeters [10½x9x8⅝ inches]. It is a jagged, irregular square, and shows olivine crystals all over the exterior. The 60-pound mass [27·272 kilos] measures 36x21x17 centimeters [14⅛x8x6⅝ inches]. It is an elongated, rounded piece, with one large flat side showing large spaces filled with olivine. The 40-pound [18·181 kilos] measures 22x21x13 centimeters [8⅝x8⅛x5⅛ inches], of irregular shape, with one large projecting point. The 36-pound mass [16·363 kilos] measures 22x22x16 centimeters [8⅛x8½x6¼ inches. It is a flattened spheroid, containing some olivine, but almost entirely iron, showing large pittings like the 75-pound or the 345-pound masses.

There are seventeen or eighteen small masses weighing 18, 12, 7, 6, 5, 3 and 1 pounds respectively, and a few weighing only one ounce each. The 211 and 6 pound masses belong to

the University of Minnesota; the 125-pound mass, to Harvard University; the 101·5 to Yale University; the 218½ and the 54·96-pound masses, to the University of Kansas; the others are in the collection of the writer.

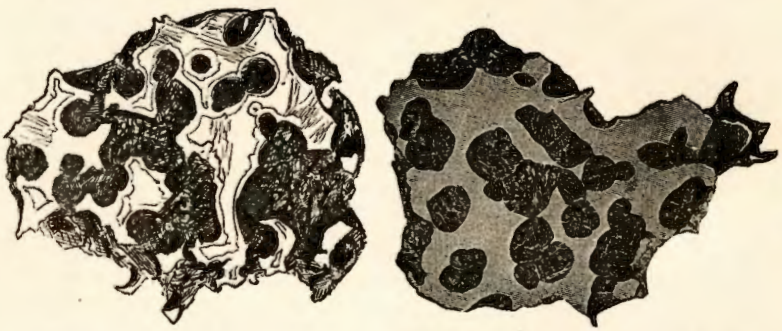
The specific gravity of the pieces is very variable, and was found to be as follows:—of the 6-pound mass, 5·17; 40-pound mass, 6·41; 71·5-pound mass, 5·22; 75-pound mass, 7·27; 345-pound mass, about the same density as the last; 466-pound mass, about the same density as the 71·5-pound mass. The following analyses of the Kiowa meteorites were made by Mr. L. G. Eakins in the laboratory of the United States Geological Survey:

Iron.		Olivine.		Dark Outer Zone of Olivine.	
Fe	88·49	SiO_2	40·70	SiO_2	34·14
Ni	10·35	Al_2O_3	tr	FeO	23·20
Co	·57	Fe_2O_3	·18	NiO	tr
Cu	·03	FeO	10.79	CoO	·03
P	·14	NiO	·02	MnO	·09
S	·08	MnO	·14	MgO	40·19
C	tr	MgO	48·02	S	5·42
Si	tr		99·85		103·07
	99·66			Less O for S	2·71
					100·36

The specific gravity of the iron freed from olivine was found to be 7·93 at 23·4° Celsius; of the olivine, 3·376 at 23·2°. The iron is brilliant white, enclosing the troilite, and surrounding the olivine crystals. Occasionally small etched surfaces show delicate figures like that of the Linnville Mountain meteorite. Troilite exists plentifully, in rounded grains from one to five millimeters in diameter, and in thin folia mixed with and surrounding the olivine crystals, as well as running into and filling small spaces in the body of the iron, either as flat plates or rounded masses. Several flat circular plates [crystals?] of graphite, two millimeters in diameter, were observed.

The olivine crystals are very brilliant, and break out entire, the faces on many of them being distinct enough to allow of measurement of the angles. The spaces from which they break are highly polished, showing every crystal face with a mirror-like luster; and in the center there is a coating of a shining mineral that is jet-black in color, and crushes into a jet-black powder. Many of the olivine crystals are in two distinct zones,—the inner half a bright transparent yellow, the outer a dark-brown iron-olivine. In reality this dark zone is an intimate mixture of troilite and olivine, as the analysis of

Mr. Eakins and a microscopical examination of the crystals by Mr. J. S. Diller, of the United States Geological Survey, fully prove.



This group of meteorites, which has recently come to me for description, possesses more than ordinary interest, on account both of the peculiar composition and structure and also of the undoubted ethnological relation, especially because of its probable connection with the meteoric iron found in the Turner mounds.

In the spring of 1883, Professor F. W. Putnam found on the altar of mound No. 3 of the Turner group of mounds, in the Little Miami Valley, Ohio, several ear-ornaments made of iron, and several others overlaid with iron. With these were also found a number of separate pieces that were thought to be iron. They were covered with cinders, charcoal, pearls [two bushels were found in this group of mounds], and other material, cemented by an oxide of iron, showing that the whole had been subjected to a high temperature. On removing the scale, Dr. Kennicutt found that they were made of iron of meteoric origin.* One of the pieces weighed 28 and the other 52 grains.

In the autumn of 1883, a mass was found on the altar of mound No. 4 of this same group, which weighed 767·5 grams [27·25 ounces]. Dr. Kennicutt suggested that these were all parts of some larger meteoric mass. The results of the investigation were published in connection with the description of the Atacama meteorites, because in structure they approach more closely to the latter than to those of any other occurrence known at that time. In the Liberty group of mounds in the same valley, Professor Putnam found a celt five inches long, and in another of the Turner mounds an ornament five inches long and three inches wide, made also of the same meteoric iron.

* Sixteenth and seventeenth reports of the Peabody Museum of Archæology, p. 382.

The Carroll County meteorite was found in 1880, about three-quarters of a mile from Eagle Station, Carroll County, Kentucky, ten miles from the mouth of the Kentucky River, and about seven miles in a direct line from both the Kentucky and the Ohio Rivers. The distance to the Turner mounds, where Professor Putnam found the meteoric iron and the ornaments made of it, is about sixty miles. The mass, which weighed about eighty pounds, or 36·5 kilos, was rusted on the surface to a depth, in some places, of 10 to 12 millimeters; and deep pits, some two centimeters across, are observed in the spots where grains of olivine have probably dropped out. The meteorite was largely made up of fine yellow transparent olivine resembling that of the famous Pallas iron, with a specific gravity of 4·72.

Taking the specific gravity of the iron at 7 6, and that of the olivine at 3·3, we find that the Turner mound meteorites consist of about three parts of olivine to one of iron. Several of the Kiowa masses have about the same constitution. For comparison, see the analyses of the Kiowa meteorites, given above, and of the olivine and iron from the Turner mound,* here inserted, as follows:

Olivine.		Iron.	
SiO_2	40·02	Fe	89·00
FeO	14.06	Ni	10·65
MnO	0·10	Co	0·45
MgO	45·60	Cu	tr
	99·78		100·10

When the Carroll County iron was described by the author in this Journal (vol. xxxiii, March, 1887), it was suggested that the pieces found by Professor Putnam in the Miami mounds had probably been taken from that mass, since no other olivine meteorite had up to that time been found in North America; while that of Carroll County contained a large percentage of olivine, even greater than the mound specimens. Very little cutting had been done on the Carroll County mass; and it proved on being cut, not to be a pallasite, but a brahinite variety of meteorite. In the Little Miami valley meteorite are embedded circular grains or crystals of olivine; whereas that of the Carroll County consists of a mass of olivine in which the iron serves as a filling between the crystals. When a section was cut from the Kiowa County material, however, there appeared no doubt as to the identity of this fall with that from which the ear-rings were made that were found in the mound. In both the Kiowa County and

* Kennicutt; 16th and 17th Reports of the Peabody Museum of Archæology, p. 382.

the mound specimens the body of the meteorite is iron, in which are imbedded circular masses or crystals of olivine. The fact that in connection with the large Kiowa masses a number of small portions, weighing from half a pound to six pounds each, were found, makes it very probable that a small mass, of perhaps three or four pounds, had been conveyed by the Indians to the Ohio valley. Probably the two ear-rings in the collection of Mr. Warren K. Moorhead, recently found by him at Fort Ancient, Ohio, may have been made from a part of the mass weighing 767·5 grams, which is now in the Harvard University collection.

I must here express my indebtedness to Professor F. H. Snow for information, and particularly to Professor Robert Hay for aiding me in procuring many of the meteorites and assisting greatly to obtain exact data by visiting the place of discovery, and to secure the illustrations; as also to Mr. L. G. Eakins for making the analyses, and to Professor F. W. Clarke, of the U. S. Geological Survey, for his courtesy in having them made at the Survey Laboratory.

2. *On the Winnebago County, Iowa, Meteorite.**

On Friday, May 2, 1890, at 5.15 P. M., standard Western time, a meteor was observed over a good part of the State of Iowa. It is described as a bright ball of fire, moving from west to east, leaving a trail of smoke which was visible for from ten to fifteen minutes; it was accompanied by a noise, likened to that of heavy cannonading or of thunder, and many people rushed to their doors, thinking it was the rumbling of an earthquake. Substantiated reports have been received from DesMoines, Mason City, Fort Dodge, Emmetsburg, Algonia, Ruthven, Humboldt, Britt, Garnet, Grinnell, Sioux City and Forest City; the noise was also heard at Chamberlain, South Dakota. Some of these places were distant more than a hundred miles from the point where the meteor fell. It exploded about eleven miles northwest of Forest City, at Leland, Winnebago County, in the center of the northern part of Iowa, latitude 43° 15′, longitude 93° 45′ west of Greenwich, near the Minnesota State line, and the fragments were scattered over an area one mile wide and nearly two miles long. Up to the present time, there have been found masses weighing respectively eighty pounds, sixty-six pounds and ten pounds, two of four pounds and about five hundred fragments weighing from one-twentieth of an ounce to twenty ounces each, while a part of the mass is believed to have passed over into Minnesota. The pieces are all angular, with rounded edges.

* Read before the New York Academy of Sciences, May 12, 1890.

The meteorite is a typical chondrite, apparently of the type of the Parnallite group of Meunier, which fell February 28, 1857, at Parnallee, India. The stone is porous, and when it is placed in water to ascertain its specific gravity, there is a considerable ebullition of air. The specific gravity, on a fifteen-gram piece, was found to be 3·638. The crust is rather thin, opaque black, not shining, and, under the microscope, is very scorious, resembling the Knyahinya, Hungary, and the West Liberty, Iowa, meteoric stones. A broken surface shows the interior color to be gray, spotted with brown, black and white, containing small specks of meteoric iron, from one to two millimeters across. Troilite is also present in small rounded masses of about the same size. On one broken surface was a very thin scum of black substance, evidently graphite, soft enough to mark white paper; a feldspar (anorthite) was likewise observed, and enstatite was also present.

Results and analyses furnished by L. G. Eakins.

Approximate composition of the mass.		Analysis of the Nickeliferous Iron.	
Nickeliferous iron	19·40	Fe	92·65
Troilite	6·19	Ni	6·11
Silicates soluble in HCl	36·04	Co	·65
Silicates insoluble in HCl	38·37	P	tr
			99·41

Specific gravity of the mass, 3·804 at 28·5° Celsius.

Analysis of the siliceous portion, with the magnetic extracted.

Soluble in HCl.	(1.)		(2.)	(3)	Insoluble in HCl.	(4.)	(5.)
SiO_2	17·82		17·82	39·74	SiO_2	26·49	55·51
					Al_2O_3	2·59	5·43
FeO	14·27	6·01 FeO, equiv. to 4·67 Fe, required by S to form FeS	8·26	18·42	Cr_2O_3	·12	·25
					FeO	4·49	9·45
NiO	·17		·17	·38	NiO	tr	
MnO	tr		tr		CaO	1·45	3·00
CaO	·31		·31	·69	MgO	11·50	24.09
MgO	18·28		18·28	40·77	K_2O	·07	·15
Alkalies	tr		tr		Na_2O	1·01	2.12
S	2·67	[2·678 to form FeS]					
P_2O_5	tr		tr			47·72	100·00
	53·52		44·84	100·00			
O for S	1·34						
	52·18						

The approximate composition of the mass was got by extracting everything possible by an electro-magnet, which took out all the nickel iron and a little troilite, leaving the siliceous part and most of the troilite. Then the amount of S present in the magnetic portion, and that in the siliceous portion, was calculated as FeS; the silicates were split into two portions by

HCl, and by the weights found in each case, the given approximate composition was calculated. Under the head of analysis of nickeliferous iron is given the analysis of the metallic portion after allowing for a very slight amount of attached silicates and troilite.

The analyses numbered from 1 to 5 are the residue left after removing all the magnetic material. Column 1 is the part soluble in HCl, column 4 that insoluble in HCl; these two added together would give the analysis as a whole of the non-magnetic portion. Column 2 is the same analysis as 1, after removing the 2·67 per cent S and an amount [6·01 per cent] of FeO equivalent to the Fe necessary to form troilite with the S. Column 3 is the same as 2 calculated to 100 per cent. Column 4, as stated, is the analysis of the insoluble portion, and 5 is the same to 100 per cent. It is of course probable that the Cr_2O_3 represents chromite, and possible that the alkalies and alumina with a little lime represent a soda-lime feldspar.

The thanks of the author are due to Mr. L. G. Eakins for the analysis and results furnished, and to Professor F. W. Clarke for his courtesy and assistance by having the analyses made in the U. S. Geological Survey Laboratory.

3. *On the Meteoric Stone from Ferguson, Haywood County, North Carolina.*

Mr. W. A. Harrison, of Ferguson, Haywood County, North Carolina, says: that about six o'clock on the evening of July 18, 1889, he noticed a remarkable noise west of him, and that fifteen minutes later he saw something strike the earth, which, on examination, proved to be a meteoric stone, so hot that he could scarcely hold it in his hand five minutes after it fell. Two-thirds of its bulk was buried in the earth when found. This stone was sent to the writer and was unfortunately lost in New York city during the month of December. The stone was slightly oblong, covered with a deep, black crust, which had been broken at one end, showing a great chondritic structure with occasional specks of iron. Its weight was about eight ounces: and it very closely resembled the meteoric stone from Mocs, Transylvania. It remained in the writer's possession so short a time that it was not properly investigated, but still the mere mention of a fall which had been so carefully observed is thought to be well worthy of publication.

4. *Meteoric Iron from Bridgewater, Burke County, North Carolina.*

The Bridgewater, Burke County, meteorite was found by a negro plowman, two miles from Bridgewater Station, in the

western part of Burke County, near the McDowell County line in North Carolina, latitude 35° 41′, longitude 81° 45′ west of Greenwich. The negro thought that it must be either gold or silver, from its weight, and took it to some railroad laborers, who broke it in two pieces, one of which weighs ten and a half pounds, and the other eighteen and a half pounds, together 30 pounds, equal to 13·63 kilos. It measures 22½x15 x10 cm. [9x6x4 inches.] [See fig. 1].

Traces of black crust very much oxidized are still visible on the surface. The iron is highly octahedral in structure, and the mass was readily broken by the laborers who found it. Between the cleavage plates schreibersite is visible. On etching a polished surface of this iron with dilute nitric acid, the characteristic Widmanstätten figures were shown, (see fig. 2). The iron belongs to the caillite group and resembles those of the Cabin Creek and Glorietta Mountain in structure. The specific gravity of a fragment was found to be 6·617. The following analysis was kindly furnished by Professor F. P. Venable of the University of North Carolina.

Fe	88·90
Ni	9·94
Co	·76
P	·35
Cl	·02
	99·97

The nickel is the mean of two determinations, 9·74 and 10·14, on different parts of the sample; the cobalt also of two determinations, ·85 and ·67. The iron is the mean of four determinations, some of which were not very closely agreeing, as the crust could not be entirely removed from the samples taken. The phosphorus and chlorine are single determinations. The author takes great pleasure in thanking Mr. T. K. Brunner for his courtesy in obtaining the information and the iron for him, and also Professor F. P. Venable for furnishing the analysis.

5. *Meteoric Iron from Summit, Blount County, Alabama.**

This mass of meteoric iron was found near Summit, Blount County, Alabama, latitude 33° 41′, longitude 86° 25′ west of Greenwich, in Fraction A, Section 2, Township 10, Range 1, east, by a six-year-old negro girl who used it to crack hickory nuts. Its great weight excited some curiosity, and her brother sent it to Mr. St. John, of Summit, and through the courtesy of Professor Eugene A. Smith it passed into the possession of the writer. It measures 12·5x5x7·5 centimeters [5x2x3 inches] and weighs one kilogram [2 2 pounds].

This meteorite contains a large quantity of free chloride of iron [Lawrencite] which from time to time has formed in beads on the surface. It showed only a slight trace of the original crust and was almost completely oxidized; and on etching a polished surface of this iron with nitric acid no Widmanstätten figures were developed, but instead a fine marking similar to that of the Linnville Mountain, N. C., meteorite. The specific gravity of a fragment was 6·949. The following analysis was kindly given by Professor F. P. Venable of the University of North Carolina:

* Trans. N. Y. Acad. Sciences, Jan. 27, 1890.

Fe	93·39
Ni	5·62
Co	·58
P	·31
	99·90

The iron is the mean of three fairly agreeing determinations, the nickel of two determinations, 5·61 and 5·63, the cobalt of two determinations, and the phosphorus is a single determination.

We take great pleasure in thanking Professor Eugene A. Smith for his assistance in obtaining the iron, and Professor F. P. Venable for furnishing the analysis.