Modoc

Dupl.

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ON A NEW STONY METEORITE FROM MODOC, SCOTT COUNTY, KANSAS.

By George P. Merrill, with analyses by Wirt Tassin.

ART. XXXI.—*On a New Stony Meteorite from Modoc, Scott County, Kansas;* by GEORGE P. MERRILL, with analyses by WIRT TASSIN.

THE meteoric stone described below was received at the National Museum from Mr. J. K. Freed, to whom we are indebted for the facts given relative to its fall and the privilege of describing it.

The stone fell on the night of September 2, 1905, about 10 P. M., and seems to have come from the west or southwest. When about six miles due west of Scott City it exploded with what is described as a terrific roar, plainly heard for a distance of 25 miles, awakening those who had already gone to sleep and frightening people for miles around. Its appearance when exploding was variously described as like the "headlight of a locomotive," and a "white light as big as a haystack afire." Eighteen miles south of Scott City it is stated to have been light enough to "pick up a pin." Following the explosion, was a noise compared with the discharge of a heavy battery of artillery or of a heavy wagon running rapidly over the frozen ground, the noise gradually dying away like rolling thunder in the distance. Some claim to have heard the whistling of rocks through the air like bullets or heavy hail. Mr. Freed himself compares the sound to that of "a mighty swish-h-h, resembling the sound of a sky rocket."

After a search extending over a period of ~~more than a year~~ several months, fourteen pieces have been reported as found, scattered over an area some two miles by seven in the vicinity of Modoc, a small town on the Missouri Pacific Railroad. These were mostly complete individuals. Three and a fragment received at the National Museum weighed, respectively, 4640, 1170, 490, and 110 grams. Two others obtained by Dr. O. C. Farrington for the Field Columbian Museum are reported as weighing about 5400 grams. An individual of approximately 2000 grams weight is reported as in the hands of a collector in Kansas. This accounts for seven out of the fourteen reported finds. It seems safe to assume that the weight of the entire fall could not have been less than 15 kilograms.

The 4·64 kilo individual received at the Museum was the largest thus far reported. Its dimensions are: Height over all, 21^{cm}; maximum width, 15·5^{cm}; thickness, 10·65^{cm}. This was found several miles east of the others and was imbedded but four or five inches in the hard buffalo grass sod, inclining slightly to the west. It is a complete individual, with the exception of a small fragment of about an ounce weight, which

had been broken away to send to the Museum previously for examination.

This and the others examined are covered with a dull brown-black, slightly rough crust of approximately a millimeter in thickness, showing no traces of flow structure nor perceptible thickening in any part such as would indicate the position of the block in its flight through the air. The surfaces are, on the whole, rather free from pittings. Sundry darker streaks running parallel with the broader faces suggest a lack of homogeneity or a possible fissuring of the mass.

The broken surface shows the stone to be very indistinctly chondritic and of a color even lighter gray than the Möcs or Drake Creek, Tennessee stone, which it closely resembles. With a pocket lens abundant metallic points are visible.

Under the microscope the stone is found to consist essentially of olivine and enstatite in characteristic jumbled, granular crystalline forms, interspersed with larger irregular granules and indistinctly outlined chondrules of the same material, together with blebs of metallic iron and troilite. As already noted, the chondritic structure is quite inconspicuous on a broken surface, the individual chondrules consisting of irregularly rounded, oval and sometimes angular aggregates of olivines in granular and grate-like forms, or enstatites in eccentric radiating masses, in either instance the interstices being often occupied by a colorless mineral identified as feldspar. In a single instance a chondrule was noted consisting of a coal-black dust-like material interspersed with a few blebs of troilite, the whole being nearly surrounded by the colorless zone of feldspar (?), the appearance in an ordinary light being practically identical with the black chondrule from the meteorite of Chateau Renard, as figured by Tschermak.* The mineral identified as a plagioclase feldspar occurs in small, perfectly clear and colorless interstitial forms, so lacking in crystalline outline and cleavage as at first to suggest a residual glass. Extinction angles are quite unsatisfactory, the dark waves sweeping across the face of the crystals in a manner indicative of a condition of strain; and, were it not for an occasional particle with inconspicuous twin bands, the real nature of the mineral would be in doubt. It was, unquestionably, the last mineral to crystallize, is quite free from enclosures, and occupies the interstices of the olivines and enstatites, often partially enwrapping them, very like a glass, but between crossed nicols polarizing faintly in light and dark colors and breaking up into granular masses comparable with the secondary feldspars in the drusy cavities of metamorphic rocks. Aside from occurring between the bars and radiating columns of the chondrules, as already mentioned, it is scat-

* Die mikroskopische Beschaffenheit der Meteoriten, pl. 17, fig. 3.

tered throughout the ground in a manner closely identical with that of the Milena meteorite, as also figured by Tschermak.*

As noted above, the stone is traversed by fine, thread-like black veins, though how abundant such may be it is impossible to tell without breaking the specimen, and this the writer has not been able to obtain permission to do.

The fall adds one more—the twelfth—to the remarkable list for which Kansas has become noted.†

As will be seen from the description, the stone belongs to Brezina's group of veined chondritic meteorites (Cwa). It will be known as the Modoc, Scott County, meteorite.

Chemical analysis, by Wirt Tassin.

The native metal was determined in 2·0255 grams of the crust-free meteorite as follows: The finely pulverized material was treated in the cold with a solution of mercuric ammonium chloride, in an atmosphere of hydrogen. The results were:

Fe	6·56
Ni	0·68
Co	0·034

The sulphur was determined in 1·0300 grams of the meteorite, after fusion with $Na_2CO_3+KNO_3$. This yielded:

S	1·38

The phosphorus was estimated in 1·0450 grams, and the percentage found was:

P	0·051

The soluble silicates were determined by treatment with HCl, sp. 1·06. The action was allowed to take place on the water-bath and continued but two hours. The acid then decanted off and the operation twice repeated. This treatment gave:

SiO_2	17·38
FeO	10·95
Al_2O_3	0·20
CaO	0·14
MgO	17·73

The insoluble silicates were determined after fusion with Na_2CO_3. The alkalies were necessarily determined in a separate portion. Chromite was not present:

* Die mikroskopische Beschaffenheit der Meteoriten, pl. 16, fig. 3.

† For an enumeration of these see "A Newly Found Meteorite from Admire, Lyon County, Kansas," Proc. U. S. National Museum, vol. xxiv, 1902, pp. 907–913.

SiO_2	26·75
FeO	4·42
MnO	0·10 (?)
Al_2O_3	2·27
CaO	1·60
MgO	8·72
K_2O	present but not determinable
Na_2O	0·44

The general composition of the portions of the meteorite analyzed, as derived from the combination of the several determinations, is:

Fe	6·56
Ni	0·68
Co	0·034
S	1·38
P	0·051
SiO_2	44·13
FeO	15·37
MnO	0·10 (?)
CaO	1·74
MgO	26·45
Al_2O_3	2·47
K_2O	trace
Na_2O	0·44
	99·40

The mineralogical composition of the meteorite may be approximately calculated from the above summation. The amount of nickel-iron is determined directly; troilite and schreibersite are calculated from the amounts of sulphur and phosphorus found, assuming that schreibersite has the formula Fe_2NiP. The soluble silicate is olivine. The insoluble silicates are regarded as enstatite and the feldspathic mineral noted, the amount of alumina found furnishing the basis for the calculation:

Nickel iron	4·59
Troilite	3·79
Schreibersite	0·34
Olivine	46·40
Enstatite	29·94
Other insoluble silicates	14·36
	99·42

It must be confessed that the last item in the calculation is not wholly satisfactory, the 14·36 per cent of other insoluble silicates not being accounted for in the microscopic examination. It undoubtedly includes the feldspathic constituent and

presumably also a portion of the irresolvable matter of the chondrules. A like condition of affairs was noted by Borgström in his description of the Shelburne meteorite,* which, from a chemical standpoint, this closely resembles.

The specific gravity of the Modoc stone was determined on two complete individuals, weighing 1110 and 490 grams, respectively, by a large apparatus constructed on the plan of the beam balance recommended by Penfield in the latest edition of his Brush Determinative Mineralogy. No attempt was made to exhaust the air from the pores, the stone being immersed in water and, with frequent agitations, allowed to remain until no more bubbles were given off. The average of two determinations was 3·54.

Addenda.

Together with the samples of Modoc meteorite forwarded, Mr. Freed included two small pebble-like masses, which had been found by his boy and which it was thought might possibly be also of meteoric origin. One of these was of ferruginous quartzite. The other, some 40 by 60 millimeters in greatest diameter, and weighing 135 grams, proved to be meteoric. This, although weathered to a dull rusty brown on the surface, still showed distinctly the usual pittings, and on a polished surface presented a dull dark-gray ground thickly spotted with small points of metallic iron and occasional rounded areas recognized with the unaided eye as chondrules. Under the microscope this is found to consist of an extremely fine tufaceous ground carrying large clear olivines in single crystals and scattered aggregates and numerous chondrules of both olivine and enstatite. The olivine chondrules are in part polysomatic and in part of the common barred or grate-like character. The enstatite chondrules are most commonly in radiate forms. The entire structure and even the identity of some of the mineral constituents are much obscured by iron oxides which have stained the mass an ocherous red throughout. The metallic constituents are much more abundant than in the Modoc stone named above.

Although differing somewhat from Washington's description and my own studies on the meteorite of Jerome in the adjoining county of Gove, the differences are so slight as to be seemingly non-essential, and I am inclined to regard this as a straggler from the Jerome fall, which, it will be remembered, was found on April 10, 1894, on the Smoky Hill River and has been described in detail by Dr. Washington, in this Journal for June, 1898, vol. v, p. 447. There is, however, a chance for a difference of opinion on this subject.

* Trans. Royal Soc. of Canada, 1904.