

ART. XXVII.—*On two hitherto undescribed Meteoric Stones*; by
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1. *Meteorite from Utah.*

IN the summer of 1869, the meteoric stone now described was found by Mr. Clarence King in Utah, on the open prairie between Salt Lake City and Echo. It was given by Mr. King

to Professor Brush and he presented it to the Yale College Collection. Nothing is known in regard to the circumstances or time of its fall; in that dry climate it may well have lain exposed on the surface of the ground for a long time without disintegration, especially as it was well protected by its crust.

The weight of this stone is 875 grams; it is oblong in shape, about 12^{cm} long, and 9^{cm} in its greatest width; one edge is sharp and wedge-like, and one end is relatively sharp, the other rounded. The surface is comparatively smooth and shows only a few broad and shallow pittings. A uniform crust, smooth except for minute angular elevations on certain portions and not very thick, covers it almost completely. The color of the crust is reddish black, in consequence of the partial rusting of the fused material. A small portion of the mass has been broken from one end to give material for study.

The interior of the stone is of a dark bluish gray color, distinctly mottled by its chondritic character, and showing a rather large proportion of iron irregularly distributed through it, with minute patches of troilite. The small portions of the interior of the stone which had been exposed are much stained by the oxidation of the iron, but this change has penetrated comparatively little into the mass, and the stone as a whole is exceptionally hard and firm. The nature of the mineral substances which, together with the metallic parts, make up the mass can be only imperfectly made out by mere macroscopic examination; thin sections, however, under the microscope show this very satisfactorily. The olivine is the most prominent constituent. This appears frequently in spherules or "chondrules" of the size of very small shot; these are made up of a multitude of individual grains having distinct rounded outline and each with its own optical orientation. These granular chondrules are sometimes enclosed by an iron border, and as the grains of olivine are fresh and clear and give brilliant polarization colors, they form very beautiful objects under the microscope. The separate grains in these cases are closely packed together, but sometimes show a little intermediate glassy matter. The olivine also appears in relatively large fragments, much fractured, but showing by the common optical orientation that all belongs to a single individual. Still again the olivine is seen in chondrules which have a distinct coarsely fibrous structure in consequence of the inclusions of dark-colored glass.

The bronzite (enstatite) appears in irregular crystal fragments scattered through the mass. Also in chondrules with fine fibrous structure usually eccentric; these have sharp angular outlines in many cases and appear to be but fragments of the original spherules—in this as in some other respects the stone has a

marked brecciated character. To the bronzite also are to be referred occasional large spherules having a coarsely fibrous or columnar structure, the fibers lying in several directions within the limits of the same individual.

Plagioclase feldspar seems to be sparingly present in crystalline fragments, showing distinct, though not sharp, twinning structure. Especial interest attaches to this constituent of the stone because it shows most clearly the brecciated character just alluded to. One piece for example has been broken transversely a number of times and then cemented by the ground-mass so that it still preserves in general its original outlines though made up of separate sections. This feldspar is rich in black inclusions lying parallel to the twinning lines. A number of patches of an isotropic mineral, which is probably to be referred to maskelynite, were also observed.

The specific gravity of this meteorite was found to be 3.66. A careful chemical analysis (Penfield), gave the following results. It was divided in the first place into the nickeliferous iron 17.16 per cent and the mineral part including the troilite and silicates 82.84 per cent.

The analysis of the iron yielded:

Fe	91.32
Ni	8.04
Co	0.60
Cu	0.04
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	100.00

The mineral portion was divided into:

Soluble in HCl	{ Troilite Fe (Ni) S	6.70 with NiS=0.62
	{ Silicates	48.85
Insoluble in HCl including chromite		43.97
Water		1.14
<hr/>		100.66

The analyses of the soluble and insoluble portions gave further:—

	Soluble in HCl.		Insoluble in HCl.	
SiO ₂	19.70	40.33	24.11	54.83
Al ₂ O ₃	0.25	0.51	2.12	4.82
FeO	10.42	21.33	3.80	8.64
MgO	17.17	35.15	10.80	24.56
CaO	0.81	1.66	1.47	3.34
Na ₂ O	0.16	0.33	0.87	1.98
K ₂ O	0.02	0.04	0.05	0.12
P ₂ O ₅	0.32	0.65	----	----
Chromite	----	----	0.75	1.71
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	48.85	100.00	43.97	100.00

The molecular ratio of the silica to bases in the soluble portion is 1:1.72, so that besides the olivine the glassy portion is probably here included. The composition of the insoluble part implies that it is made up largely of bronzite with a little plagioclase. Among the stones in the Yale College collection that from Chantonay seems to bear the closest resemblance to this new stone.

2. Meteorite from Cape Girardeau, Missouri.

This Missouri meteorite has waited just forty years for public description. It became the property of the Yale Museum several years ago, having been purchased from Dr. Otto Lugger of Baltimore, to whom we are indebted for the facts in regard to its history. The stone was obtained by Dr. Lugger when he was residing in St. Louis, about the year 1875, from an acquaintance, by the name of Padberg, whom he had employed to collect for him various objects in natural history, minerals and so on. According to Padberg's statement, the meteorite had formed part of his mineral collection since 1847. It was provided with a label which stated that it fell at 3 o'clock on the afternoon of August 14th, 1846, accompanied by a loud report, upon a small farm belonging to an Englishman by the name of William Free. This farm lay some $7\frac{1}{2}$ miles south of Cape Girardeau in southeastern Missouri. The meteorite was given to Padberg by Free in 1847. It was stated further that the meteorite broke upon its fall into three pieces, two of which form the mass here described, and the third was polished and presented by Dr. Lugger three years ago to Professor Uhlberg.

The account of the history of the stone, of which the above is an abstract, is so complete and circumstantial as to make it appear worthy of confidence, notwithstanding the many years which have passed since the stone fell.

The stone, when it became the property of the Museum here, consisted of two parts weighing together 2,058 grams. These two portions fitted closely together, and the fractured surface between them was fresh except for the oxidation of the iron. The general shape of the stone is roughly rectangular with dimensions of $12 \times 10 \times 10$ centimeters. The surface is smooth with no sharp edges nor angular projections. On one side, the crust, which is rather thick, shows with remarkable distinctness the lines of flow diverging from what was probably the projecting point in its flight through the air; on what was presumably the rear side the crust is thicker, rather rough and somewhat cellular or slag-like. One portion of the surface is simply blackened over without having a distinct crust, as if a part had been broken off shortly before it struck the ground. The general color of the fresh surface is light gray except as it

is stained by the rusting of the iron; this oxidation has proceeded rather far, as might have been anticipated, and indeed the appearance of some portions suggests that there may have been present also some deliquescent compound (e. g. iron chloride). The mass as a whole is somewhat porous and easily fractured.

The metallic particles, which have mostly a bluish tarnish, are scattered very uniformly through the whole mass. The chondritic character is distinct though not strongly marked, yellowish white spherules of olivine, and others of a dark gray (bronzite?) are sparingly scattered through it; for the most part it appears to be granular crystalline.

In the sections examined under the microscope the olivine is seen in granular form, not often distinctly grouped in chondrules; the bronzite also in longitudinal fragments. The dark gray chondrules have an indistinct fibrous eccentric structure and act rather feebly on polarized light—they may be also bronzite. The feldspar is not particularly distinct, although occasional patches of a dull gray in polarized light probably belong here. Glassy matter was not distinctly observed.

The specific gravity of a fragment of the stone was found to be 3.67. The chemical analysis (Penfield) showed a relation of native iron to troilite and silicates very near that of the Utah meteorite, namely, 17.90 to 82.10 per cent.

The analysis of the iron gave:

Fe.....	91.93
Ni.....	7.39
Co	0.63
Cu	0.05
	<hr/> 100.00

The analysis of the latter portion yielded:

Soluble in HCl { Troilite	6.95
{ Silicates.....	42.68
Insoluble in HCl, including chromite	50.19
Water	0.58
	<hr/> 100.40

The soluble and insoluble parts gave further:

	Soluble.		Insoluble.	
SiO ₂	15.50	36.32	28.00	55.79
Al ₂ O ₃	tr.	----	2.78	5.54
FeO	9.52	22.31	3.97	7.91
MgO	17.17	40.23	11.87	23.65
CaO	----	----	1.68	3.35
Na ₂ O	0.12	0.28	0.93	1.85
K ₂ O	0.02	0.04	0.12	0.24
P ₂ O ₅	0.35	0.82	----	----
Chromite	----	----	0.84	1.67
	<hr/> 42.68	<hr/> 100.00	<hr/> 50.19	<hr/> 100.00

The composition of the first portion corresponds very closely to a ferruginous olivine, the ratio of silica to bases being 1:2.17. The insoluble part is evidently for the most part bronzite with probably a little feldspar to which the alumina and soda and most of the lime belong. This stone belongs to rather a common type of meteorites, the light gray chondrites; there is, however, no stone in the Yale College collection from which it could not be at once distinguished.