METEORITES

[FROM THE AMERICAN JOURNAL OF SCIENCE, VOL. XXVI, JULY, 1883.]

The Bishopville and Waterville Meteorites; by M. E. WADSWORTH.

1. *The Bishopville Meteorite.*

THE meteorite which fell at Bishopville, South Carolina, March, 1843, has been regarded as an interesting and peculiar one. Professor C. U. Shepard in 1846 (this Journal, II, ii, 380–381), described from it, under the name of *chladnite*, a mineral which he regarded as a tersilicate of magnesia, and as forming over two-thirds of the stone. The color was snow-white, rarely tinged with gray. Luster pearly to vitreous, translucent. H. 6–6·5; sp. gr. 3·116. Fuses without difficulty before the blowpipe to a white enamel. He further describes as *apatoid* some very rare, small, yellow, semi-transparent grains, having a hardness of 5·5. A third mineral which he named *iodolite* was of a pale smalt-blue color, vitreous luster; brittle. Hardness 5·5–6. Fuses easily with boiling into a blebby, colorless glass. This was found only in a small quantity.

Later, Shepard gave a fuller account of this stone, holding that it contained chladnite ninety per cent, anorthite six per cent, nickeliferous iron two per cent, and two per cent of magnetic pyrites, schreibersite, sulphur, iodolite and apatoid. The chladnite was analyzed and the results will be given below. (Ibid., 1848, II, vi, 411–414).

The stone was next investigated by W. Sartorius von Waltershausen. He described it as chiefly made up of a white siliceous mineral forming a finely crystalline mass, with here and there little points showing metallic luster, also grains of magnetite and brown oxide of iron. The hardness of the white mineral was given as six, and the specific gravity as 3·039. His analysis is given below. His results indicated that the siliceous portion of the meteorite was composed of 95·011 per cent of chladnite and 4·985 per cent of labradorite. The former he found to be monoclinic and related to wollastonite in specific gravity, color, texture, hardness and crystalline form (Ann. Chem. Pharm., 1851, lxxix, 369–370). Later Professor J. Lawrence Smith stated that from some of his investigations "chladnite is likely to prove a pyroxene" (this Journal, 1855, II, xix, 163); and in time he published a further discussion giving an analysis which will be found below. As a conclusion from his results he said of chladnite: "It is identical in composition with *Enstatite* of Kenngott" (ibid., 1864, xxxviii, 225, 226). Earlier than Smith's last paper, some investigations were made upon this meteorite by Professors Carl Rammelsberg and Gustav Rose. The former held that the yellowish-brown and bluish-gray particles (the apatoid and iodolite of Shepard) arose from the oxidation of the nickeliferous iron or the alteration of the pyrrhotite.

The analysis of Rammelsberg is here given in connection with those of Shepard, Waltershausen, and Smith.

	Rammelsberg.	Smith.		Waltershausen.	Shepard.
SiO_2,	57·57	60·12	59·83	67·140	70·41
Al_2O_3,	2·72	----	----	1·478	----
Fe_2O_3,	1·25	0·30	·50	1·706	----
MgO,	34·80	39·45	39·22	27·115	28·25
CaO,	0·66	----	----	1·818	----
Na_2O,	1·14	0·74	0·74	----	1·39
K_2O,	0·70	trace	trace	----	----
Loss,	0·80	----	----	----	----
Li_2O,	----	trace	trace	----	----
H_2O,	----	----	----	0·671	----
MnO,	0·20	----	----	trace	----
Total,	99·79	100·61	100·29	99·928	100·05

Rose's examination showed that the chladnite fused before the blowpipe only on the edges to a white enamel (Abhandl. Berlin. Acad., 1863, pp. 117–122). Rammelsberg, in the continuation of his work, later declared that no feldspar was to be found in the stone (ibid., 1870, pp. 121–123).

Through the courtesy of Mr. John Cummings and the Curator of the Boston Society of Natural History, I have been permitted to make a microscopic examination of a small portion of this meteorite now deposited in the collection of that society.

The portion examined is a grayish-white mass resembling, as Shepard remarked, a grayish-white granite (albitic), with brown and black spots. Under the microscope it is seen to be composed of an entirely crystalline mass of enstatite, augite, feld spar, olivine, pyrrhotite and iron. The structure is essentially granitic, and it appears to belong to the gabbro (norite) variety of the basalts as defined by myself in "Science" for March 9th, 1883.

The enstatite is clear and transparent. It shows a longitudinal cleavage parallel to the line of extinction, and in some specimens this is crossed by a cleavage at right angles. It also has a cleavage which is often well marked and breaks the mineral into rhombic forms with angles, as approximately determined by several measurements, of 73° and 107°. The principal cleavage is parallel to the longer diagonal of these rhombs. It is this rhombic cleavage, probably, which has led observers to believe that chladnite crystallized in the monoclinic or triclinic systems.

The enstatite is found to contain many glass inclusions with polyhedral outlines, the planes being presumably, as is usual in such cases, the planes of the inclosing mineral. While many are arranged in the enstatite parallel to the cleavage planes, others are placed at every angle with those planes. The glass inclusions carry bubbles, microlites and rounded lenticular forms. The last are frequently at the end of the inclusion, and in some cases show the cherry-brown color of some chromite. This material, besides forming inclusions in the glass, is in lenticular and irregular rounded grains in the enstatite itself. It sometimes extends in a series of grains across the entire enstatite mass and at others is in isolated forms. These inclusions microscopically are seen to be composed of a center of nickeliferous iron or pyrrhotite, surrounded by a band of dark material, chromite or magnetite possibly. These ferruginous materials are in many cases surrounded by a yellowish-brown staining of iron which sometimes extends over a considerable portion of the mass and along the fissures. Along one plane in the enstatite numerous vacuum or vapor cavities were observed. The inclusions are seen to be crossed and cut by the cleavage and fissure planes of the enstatite, showing that they were of prior origin to the fissures.

The feldspar stands next in abundance to the enstatite and is in irregular masses held in its interspaces. It is water-clear, and almost invisible by common transmitted light. Much of it is seen to be plagioclastic; but the twinning bands are so exceedingly fine and the polarization colors so bright it does not as a rule show well this character, except with high powers and when the mineral is near the point of extinction. The feldspar contains numerous yellowish-brown, dark and almost colorless inclusions, sometimes irregularly scattered but more commonly arranged along planes like the fluid inclusions in quartz. These glass inclusions are of various dimensions and many contain a small bubble. Some microlites were also seen.

In the feldspar at one end of a section the enstatite was found in minute crystals extending outward from a center forming stellate or rosette-like forms. The structure is like that observed in terrestrial rocks in minerals formed from alteration or solution. This apparently might have been produced in this case, either by the rapid crystallization of enstatite material of a liquid feldspathic mass, or by secondary alteration through water action on the rock itself. The absence of any other signs of alteration, except in the ferruginous materials, seems to negative the latter supposition. The ferruginous alteration can probably be accounted for by the absorption of moisture by this friable fissured stone since it reached the earth. The bands of inclusions were seen in several instances to extend from the feldspar through the enstatite, and in one case pass into another feldspar on the opposite side. This indicates that the cause of these inclusions was a general one for the rock mass, and not limited to any one mineral. The enstatite was found in a few cases inclosed in the feldspar.

The monoclinic pyroxene or augite is less abundant, and its determination less sure than is the case with the enstatite and feldspar. It is crossed by fissures in a very irregular manner, but shows in some cases the approximately right angled cleavage of augite. In its optical characters it resembles that mineral; but its polarization is more brilliant than that of terrestrial augite and resembles that of olivine. All the transparent minerals of the section are clearer and lighter colored than their mundane representatives and hence tend to show in polarized light, clearer and more brilliant colors. The augite is not however so water-clear as the enstatite, but has a very faint tinge of yellowish-green. The ferruginous inclusions are the same in this as in the enstatite.

The determination of the olivine is more doubtful, since it only appears in small irregular grains and masses, which hold a similar relation to the other minerals that the olivine of terrestrial gabbros usually does. From this and the fact that optically these masses are like olivine, they are referred to that mineral.

This stone in its mineralogical composition, its structure, bubble-bearing glass-inclusions, and microlites is like terrestrial eruptive rocks and it is presumable that it had a similar origin. If the common methods of lithological nomenclature were followed by the writer it would be proper for him to give this rock a name as a rock species, but in accordance with the principles of his classification he prefers to regard it as belonging to the gabbro variety (norite) of basalt; for he holds to the essential unity of the universe and sees no necessity of employing different names according as the rock comes from above or below.

From the description of the mineral constituents of this meteorite it would seem that regarding the presence of the feldspar, Messrs. Shepard and Waltershausen were correct while Rammelsberg was not. This shows the inability of the ablest mineralogical chemists to draw correct conclusions regarding the mineral constituents even of an unaltered rock. The trouble appears to reside with the instrument employed—that is, with a defect in the method. Chladnite ought no longer to be regarded as enstatite of the purest kind as stated in most mineralogies but rather as a mineral aggregate of which enstatite, feldspar and augite are the principal constituents.

While these observations give an approximate solution of the Bishopville meteorite puzzle of twenty-seven years standing, it would be well if some one having larger amounts of this meteorite at their disposal could make a chemical analysis of it as a whole, and also analyze the minerals by the modern microscopic—specific gravity—chemical method.*

2. *The Waterville Meteorite.*†

At about midnight, sometime in Sept., 1826, a meteor was seen to pass over Waterville, Maine, by Captain Josiah Crosby of that town. It came from the southeast and passed in a curved line with a regular motion towards the earth. A moment after it disappeared from sight, a report like that of a small cannon was heard. A few days later Mr. Crosby picked up in a field about one-third of a mile from the place where he stood when he saw the meteor, a specimen which he regarded as a fragment of it. Bearing upon the question whether it could be a fragment of anything else or not, he stated that no glass works existed in that part of the State, but that common brown earthern-ware was formerly manufactured about one-third of a mile from the spot on which the meteorite (?) was found. "It was a solitary stone, the soil consisting entirely of sandy loam. There was no stone or accumulation of stones within two miles. The specimen, when picked up, appeared to be a newly detached mass. The grass upon which it lay was short and close to the ground, and was entirely unchanged in appearance."

* Read before the Boston Society of Natural History, April 4th, 1883; Science, 1883, i, 314.

† Briefly mentioned in Science, 1883, i, 377.

The stone was presented by Mr. Crosby to Virgil D. Parris, and by him to Professor G. W. Keely of Waterville College (now Colby University). A portion of the specimen was given by Professor Keely to Professor C. U. Shepard, who published an account of it in this Journal (1848, II, vi, 414, 415), from which account sufficient has been taken to render this paper intelligible to those who have not access to Professor Shepard's original publication. His analysis gave the following results:

SiO_2	Al_2O_3	FeO	MgO	CaO	Total.
70·00	18·50	8·00	2·59	1·90	=100·99

It was regarded by Shepard as a doubtful meteorite, and in his later catalogues has been omitted. My attention was especially called to it from the description and analysis indicating that it belonged, if a meteorite, to a group of which only one authentic specimen is known (Igast), although several doubtful ones exist. It was then a matter of importance to ascertain whether it was a meteorite or not; and if one to ascertain its microscopic characters. On inquiry of my friend and colleague Professor C. E. Hamlin, I learned that the main mass of the specimen was presented to the cabinet of Colby University by Professor Keely in 1871. Through the kind offices of Professor Hamlin, who is now a trustee of that college, the specimen was placed in my hands for microscopic examination.

It is a small triangular cinder-like mass, cellular, laminated, and on the fresh fracture of an ash gray color. The laminated appearance is produced by a series of flattened cells surrounded by a black vitreous mass. The original surfaces are coated with a gray, red-brown and bluish-black crust formed by fusion. The formerly upper portion of the mass, when examined under a lens, is seen to be worn and polished, as siliceous rocks are apt to be when exposed to rain, while the remaining parts of the surface are found to be coated to some extent by earthy material the same as rocks are when lying in a dry sandy soil. Its cavities contain in places a fine brown matted mass formed by the fibers of growing plants, and under the microscope their vegetable character can readily be distinguished.

The specimen then when picked up by Captain Crosby could not have been a newly detached mass, but had been for a long while partially buried in the soil, and of course could not have been a portion of the meteor which he saw. It remains then to consider the very improbable supposition: is it a fragment of a meteorite which fell at some former period?

Microscopically it is seen to be a cellular glassy mass which has begun to devitrify, and presents the appearance of a slag-like body, which has been long exposed to the action of atmospheric agencies. The sections were cut across the laminations, and showed a fluidal structure parallel to it. A few quartz grains which were cracked and fissured were seen. Near the fissures numerous ferruginous globulites had been developed and the quartz showed evident signs of having been exposed to strong heat. Adjacent to the flattened, as well as some other cells, is a black and brown ferruginous material.

The sections show not the slightest trace of characters belonging to any meteorite that has yet been examined microscopically either by myself or by others, so far as can be ascertained by their published descriptions. It is apparently a slag and most probably derived from the earthern-ware manufactory at some earlier date.

No blame attaches to Mr. Crosby, for he undoubtedly acted to the best of his knowledge in making his observations and statements; and it will be noticed that his remark, that it lay upon the surface while the grass was untouched, was opposed to its meteoric origin and in accord with the results of my examination.

Cambridge, Mass., April 14th, 1883.