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AËROLITE FROM ROSE CITY, MICHIGAN

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At about eleven o'clock in the evening of October 17, 1921, a meteor was seen to pass through the sky from N.N.W. to S.S.E. over the northeastern portion of the Lower Peninsula of Michigan. Near Rose City, Ogemaw County, it exploded with the usual accompaniment of several loud reports, and three of the fragments into which it burst have been recovered on the premises of Mr. George Hall about nine miles northeast of this little hamlet, which gives its name to the fall. These portions are stated to have weighed about 3¼ pounds (1.47 kg.), 7 pounds (3.18 kg.) and 14 pounds (6.36 kg.) when obtained. They are now the property of Mr. P. W. A. Fitzsimmons of Detroit, Michigan, to whom I am indebted for the opportunity of describing the largest mass. The weight was not checked up on receipt of the specimen, but after sectioning and removal of a fragment for chemical analysis the material weighs twelve pounds (5443 gm.) and it is supposed that the original weight of this mass was not more than about twelve pounds ten ounces (5726 gm.).

The fragment in hand is roughly ovoid in shape and is about 225 mm. by 167 mm. by 136 mm. in dimensions. The color of the exterior is black and that of the interior as shown in section is also black. A side view is given in Fig. 1 and an end view in Fig. 2. On all sides the surface is deeply pitted. The skin due to superficial melting while passing through the earth's atmosphere is well developed but does not possess a brilliant luster. This skin extends into the pits or depressions but is less in evidence or is wanting on the knobs which also characterize the exterior of the mass. These knobs are the protruding parts of small masses, like the pebbles in a conglomerate, which are cemented together to form the main mass. The fragment here described is reported to have fallen about forty feet south of Mr. Hall's house and to have buried itself about two feet in soft, sod-covered earth. It was found the day after it fell. When first examined by the writer, many of the pits in its surface contained grass, grass roots, and soil firmly wedged into them. The grass was not burned or even charred, and therefore it is evident that the temperature of the mass when it struck the ground was not elevated.

The second largest piece (3.18 kg.) was found later in the same day about 150 feet from the house, near a highway and not so deeply imbedded in the ground as the previous mass.

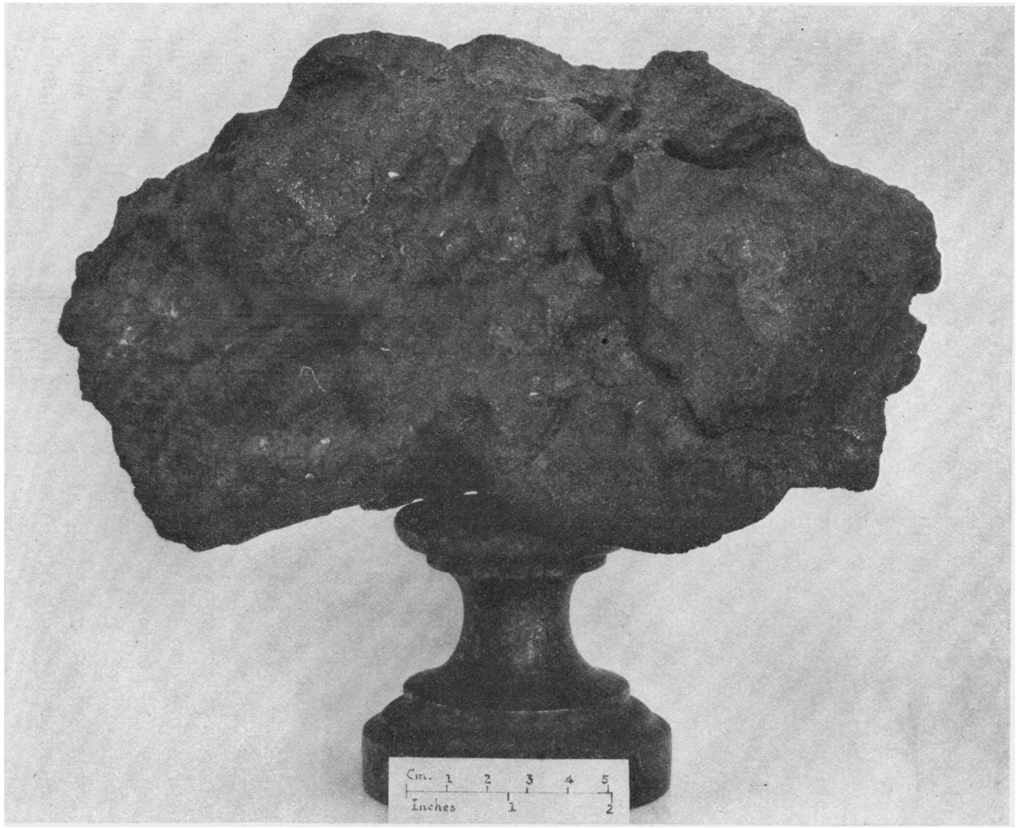

Fig. 1. Rose City, Michigan, Aërolite

Side view, showing agglomeratic character of the fragment and deep pitting due to melting along zones of cementation.

The appearance of a longitudinal section of the largest mass, the one studied, is shown in Fig. 3. Small particles of nickel-iron are numerous and are scattered uniformly through the areas which are cross sec-

Fig. 2. Rose City, Michigan, Aërolite
End view.

tions of the surface knobs. Many of these particles are triangular or approximately triangular in outline, as shown in the section. Others are spongy and irregular. All enmesh portions of the silicate groundmass. The metal is likewise concentrated in long stringers between these

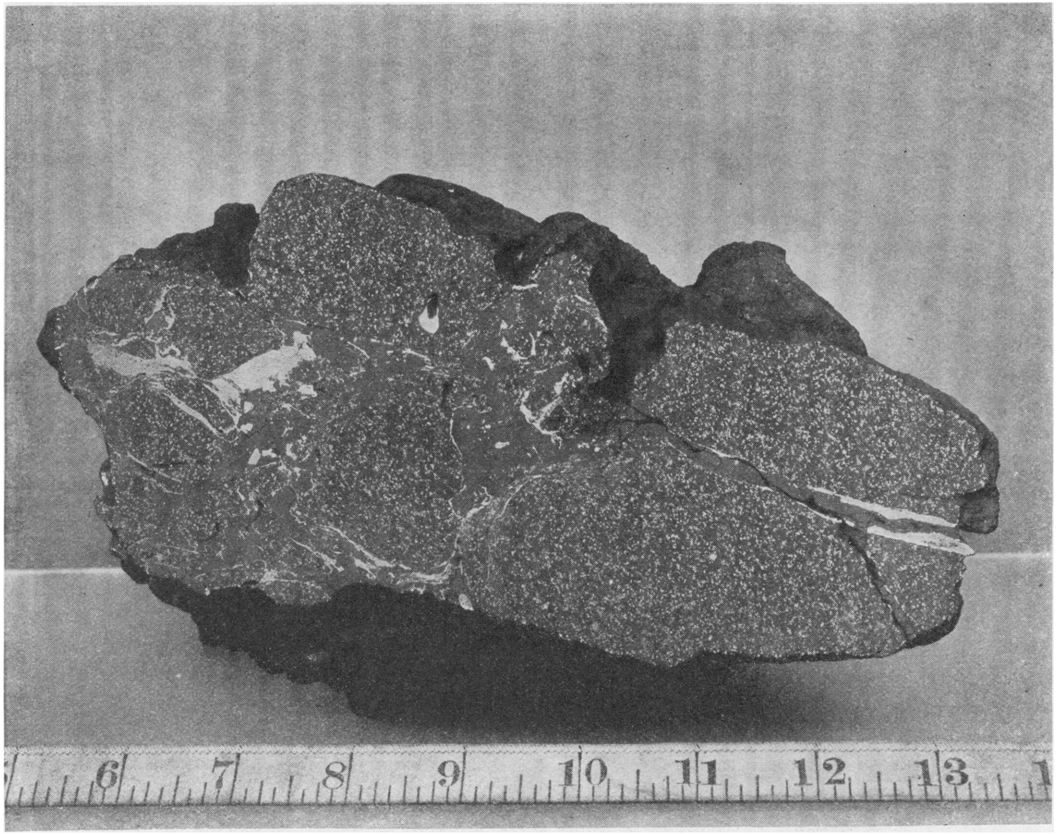

Fig. 3. Rose City, Michigan, Aërolite

Section lengthwise of the mass, showing agglomeratic structure, the zones of dense cementing material and the distribution of the particles of iron.

areas or along portions of the knobs, and many of the stringers are approximately parallel in position. These stringers or larger areas of iron are porous or spongy in texture and contain silicate groundmass within them. Treatment with 5% nitric acid was negative as to the production of Widmanstätten figures, but the iron, by the triangular outline of many of its particles and by their linear arrangement, suggests the presence of octahedral crystalline structure.

The agglomeratic character of the mass which is suggested by its external appearance is still more evident in the section. The somewhat rounded secondary masses are cemented together by finer-grained, denser meteoritic material which seems to be lacking in metallic particles. This material does not seem to be glassy in character. In many places the junction line between secondary masses and matrix is accentuated by stringers of iron. These stringers, of course, are the edges of areas of metal partly covering the surfaces of the secondary masses. In one instance at least the dense cementing material is seen entirely surrounded by iron. This area is shown near the left-hand point in Figure 3. In the section, crevices are seen to have developed in several places along the edges of the secondary rounded masses, showing that these are zones of weakness. Examination of the exterior shows that the pitting caused by surface melting during the passage of the meteorite through the earth's atmosphere has gone most deeply into the zones of cementing material or matrix. This shows that this matrix is more fusible, or at any rate less resistant to fusion, than are the large pebble-shaped bodies or knobs which I have called the secondary masses. These zones of matrix seem to have been the lines along which the rupture of the main meteorite took place. One of these lines of near rupture is shown in Figure 3.

The large pebble-shaped knobs or secondary masses which make up the major portion of the meteorite present numerous angular cavities ranging from 0.1 mm. or less to 0.5 mm. or more in diameter. These seem not to be oriented in position, but in places they are aggregated together so that the rock is somewhat porous in texture. They correspond to the miarolitic cavities occurring in some terrestrial rocks and they are bordered by or have projecting into them minute crystals of iron and silicates. The silicate crystals are apparently enstatite or olivine. Some larger irregular cavities also occur. One cavity oval in outline and 5 mm. in length was observed. One end of this cavity is in dense iron which, with the cavity, forms a pear-shaped area 9 mm. long and 5 mm. in greatest width. This appears in Figure 3.

Under the microscope the major part of the silicate portion of the meteorite is seen to be composed of enstatite and olivine, the former predominating. Both of these minerals are light in color, indicating a low content of iron. The olivine is in grains with rounded outlines and also in subcrystalline development. It is much fractured. The enstatite is very slightly pleochroic. The mass does not appear to be chondritic in structure, but here and there the enstatite occurs in small subspherical aggregates with excentric radial structure. One such aggregate is 1.5 mm. by 2 mm. in diameter. Another shows the laths of enstatite arranged in parallel position. The thin section shows an abundance of minute particles of opaque black matter (chromite?) scattered through it. Some of these are without apparent orientation, others are arranged in dendritic growths associated with the enstatite, and still others are grouped in parallel position in the grains of olivine. Minute nodules of troilite, which are easily recognized by their brassy luster, occur.

There are also irregular areas of a substance of very low relief that would be classed as glass, except that it seems to possess a very slight birefringence.

The presence of anorthite is indicated by the chemical analysis, but the mineral has not been recognized under the miscroscope.

The chemical analysis was made by Mr. J. Edward Whitfield of Philadelphia, on a fragment weighing about forty-five grams, from one of the knobs which seemed to show a good average distribution of metallic iron but no large areas of the metal. Mr. Whitfield's report is as follows:

Separation was made by use of an electro magnet which gave the mineral portion free from metal, but the metallic particles held back mineral that had to be subsequently separated.

Mineral	82.75%
Metal	17.25

The metallic composition is:—

Iron	90.510%
Phosphorus	0.245
Sulphur	0.275
Nickel	8.570
Cobalt	0.400

There were no indications of troilite or schreibersite in the clean metal.

The mineral portion has the following composition:—

Silica	SiO_2	43.71%
Alumina	Al_2O_3	3.44
Chromium Oxide	Cr_2O_3	0.61
Phosphoric Acid	P_2O_5	0.25
Ferrous Oxide	FeO	15.09
Ferric Oxide	Fe_2O_3	None
Calcium Oxide	CaO	3.14
Magnesium Oxide	MgO	26.97
Manganous Oxide	MnO	0.36
Nickel Oxide	NiO	0.57
Cobalt Oxide	CoO	0.08
Soda	Na_2O	1.13
Potash	K_2O	0.18
Sulphuric Anhydride	SO_3	0.68
Ferrous Sulphide	FeS	3.88
		100.09%

Search was made for oldhamite and lawrencite with negative results. The ferrous sulphide (troilite) was all found with the mineral portion, as the electric current through the magnet was kept low.

The original composition of the meteorite, therefore, would be:

Silicates	78.87%
Metal	17.25
Troilite	3.88

Specific gravity, taken on the finely pulverized material, 3.694.