THE TROUP, TEXAS, METEORITE.

By J. A. Udden,

Of the University of Texas, Austin, Texas.

This meteor was secured soon after its fall by Mr. T. M. Coupland, of Troup, Texas, and by him donated to the University of Texas. It fell close to a negro boy, who was ploughing in a field about 3 miles north of Troup on the morning of April 26, 1917. The boy heard the meteor and "saw it smoking" after it hit the ground. He did not investigate the fall, but an older person, Forrest Lawson, went to the place indicated by the boy and found the meteor about 6 inches below the surface of the ground. It was later during the day brought to Mr. Coupland who first identified it as a meteor. In a letter of the same date to Prof. H. Y. Benedict, of the University of Texas, Mr. Coupland related the circumstances of the observation of the fall as given above and said that the meteor weighed 2 pounds and 4½ ounces; that it was "black on the outside, but about the color of lime rock after the surface was removed. It also appears to have some flakes of bright metal scattered through."

A few days after the fall Mr. Coupland addressed a circular letter to some people in Smith and adjacent counties. In this he inquired for observations on the fall of the meteorite and secured some information worth recording. At Nacogdoches, some 47 miles south-southeast from Troup, one man reported to have seen the fall and two persons reported having noted the sound it produced. The noise the meteor made was also heard at Big Sandy in Upshur County, about 30 miles north from Troup; at Arp, in Smith County, about 7 miles northwest from Troup; and at a pump station located about 17 miles southeast from the same point. At Troup Mr. Coupland states that many people heard an unusual and intense noise on the morning that the meteor fell. A weekly newspaper, the *Jacksonville Progress*, made mention of the fall, from which it has been inferred that the fall was also heard at this place, which lies about 15 miles southwest from Troup.

It was a fortunate circumstance that this meteorite chanced to come into the hands of a man whose education and whose interest

in science enabled him to immediately identify the stone and prompted him to secure not only the stone but likewise all the above facts. These establish beyond any doubt the date and the place of the fall and also the physical phenomena associated therewith.

A part of the original stone, about 170 grams, has not been seen by the present writer. Some two or three grams have been used in making a chemical analysis. There are now extant one piece weighing about 840 grams (pl. 100), another weighing 124 grams (pl. 101), and a few smaller fragments of 2 or 3 grams.[1]

In form this meteorite belongs to the gnathoid or splinter-like type (fig. 1), evidently having originally measured somewhat more than 15 centimeters in length, quadrangular in cross section, thinning in one diameter toward one of its extremities and at the same time turning somewhat abruptly transversely to its longer axis, near its smaller end. At its thickest part it measures about 5 centimeters along one of its transverse diameters and about 4½ centimeters along the other. On one side of its heaviest end is a blunt point, perhaps

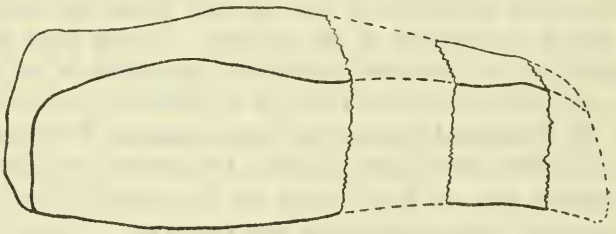


FIG. 1.—ORIGINAL FORM OF THE TROUP METEORITE (IN PART RESTORED). ABSENT PARTS ARE SHOWN IN DOTTED LINES. ABOUT ½ NATURAL SIZE.

due to fusion on the forward side of the stone as it passed through the atmosphere.

As already mentioned, the meteor is quadrangular in cross section, having four flat sides of about equal width. At its thickest end these planes are cut by the smooth surface of a wide cone, which has its apex turned sideways. This points approximately also to the side of one of the four angles of the wedge. It seems likely that this apex was the forward point of the meteor as it fell. If such was the case, the edge nearest this apex would cleave the air as the meteor advanced. All the four sides of the wedge are pitted, but the pitting on the two forward sides is somewhat different from the pitting on the posterior sides. Anteriorly the pits are larger and deeper than on the two posterior faces. Measurements on a number of pits selected at random were made, one measurement of the shortest and one measurement of the longest diameter of each pit. It can hardly be said that these slightly elongated pits have any distinct orientation in any particular direction (pl. 100). It is quite

[1] It is reported that another fragment from this fall has been found near the same place later.

clear that the impingement of the air currents producing the pits was not the same on the two posterior faces of the meteor as that on the anterior faces. Toward the narrow end the pitting appears on only two of the four flat sides of the stone and is markedly smaller than at the anterior end. The sizes of the pits on different parts of the stone are shown in averages in the following table:

Table showing diameters of pits in millimeters on different parts of the surface of the meteor.

	Shortest.	Longest.
On the two anterior sides	9	12
On the two posterior sides	4	7
Farthest back on the posterior sides	2	4

The stone is covered by a brownish black crust measuring from about 0.1 to 0.3 millimeters in thickness. Magnified under a good hand lens the surface of this crust is seen to have numerous small rugosities presenting quite sharp angles. At various points particles of metallic iron barely protrude through the crust. At some widely scattered places are some oval spots where the exterior of the crust is very smooth and almost shiny. These smooth areas resemble in form, size, and distribution some stony chondri that are seen to be scattered through the meteorite when a polished surface of its interior is examined. In some of the chondri the crystalline texture is laminated, and this texture evidently shows through the thin crust in some of the smooth areas seen.

A fracture, or vein, is seen following one of the four sides of the "wedge" at a distance of 3 to 5 millimeters from one of its faces. (See pl. 101.) The course of this vein is sinuous. The vein itself is mostly less than a tenth of a millimeter in thickness and apparently in this stone, as in others of its kind, consists of material like that of the outer fused crust. On the posterior side of the block showing in the photograph there appear three veins running in the same direction near the middle of the section. One of these is evidently the vein seen in the photograph. All three veins no doubt cross the stone obliquely.

The mineral composition and the petrographic characters of this stone must await the attention of the specialists.[2] Meanwhile a brief mention of its most obvious features may be recorded. Its color is gray when freshly laid bare. When exposed to moisture, this soon gives way to a gray speckled with rusty dots, which become especially conspicuous on a polished surface. Its texture is fine grained. It is chondritic, showing small light grains of an oval outline on a polished surface. These measure mostly less than a millimeter in

[2] See p. 477 following.

diameter. Among these are scattered many small particles of iron, small particles of pyrrhotite, and a few chondri of larger size, oval in outline in cross section, and showing eccentric radial structure in some cases. Eight of these larger chondri measure from 1 to 6 millimeters in their shortest diameters and from 1 to 8 millimeters in their longest diameters.

The particles of iron measure mostly from one-tenth to one millimeter in cross section on a polished surface. They are entirely isolated from each other and have, as it appears, a haphazard arrangement through the mass of the stone, except that they do not occur in the chondri and that in a few places on the ground surfaces examined they lie in irregular crescentic lines. On a polished surface the iron has a white, almost silvery, color.

In their shape the iron particles are very variable. Sections seen on a polished surface defy any general description except negatively. None of their sections are circular in outline and very few are limited

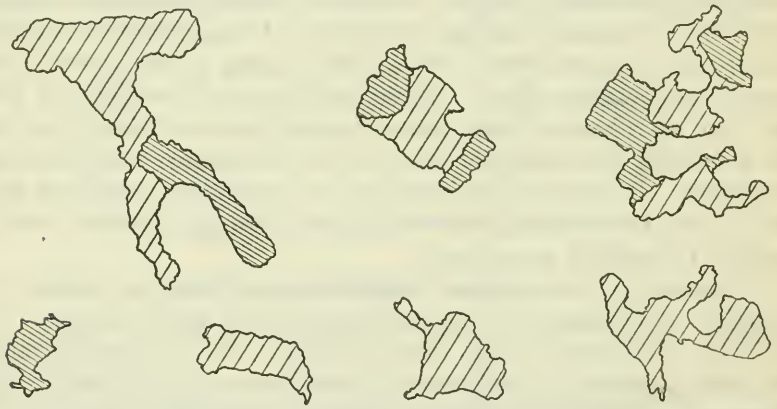


FIG. 2.—OUTLINES OF SECTIONS OF GRAINS OF IRON AND OF PYRRHOTITE FROM THE TROUP METEORITE, AS SEEN ON A POLISHED SURFACE OF THE STONE. THE CLOSELY SHADED AREAS REPRESENT PYRRHOTITE, WHILE THE LIGHT SHADED AREAS REPRESENT METALLIC IRON. MAGNIFIED ABOUT 25 TIMES.

by straight lines. Some of the outlines of such sections are shown in figure 2. Among some grains that were separated from the siliceous matrix three roughly outlined but distinctly square faces were observed under the microscope.

The pyrrhotite present occurs in grains apparently of quite as indefinable forms as the iron grains and in about the same abundance and distribution as these. On the whole, the pyrrhotite grains are slightly smaller in size. On a polished surface the pyrrhotite has a brownish metallic color. By immersing a polished surface of the stone in a solution of copper sulphate the pyrrhotite is soon covered with a bright coating of copper, and the grains of this mineral are thus readily identified. Many of the pyrrhotite grains are closely

adherent to the iron grains, from which some come out as extensions or arms. The boundary between the two is in all such cases sharply defined.

The bulk of the siliceous material, which makes more than 90 per cent of the mass of this meteor, is finely granular, the finest grains measuring near one-sixth of a millimeter in diameter. This has a gray color. The larger chondri are very light gray. The mineral nature of this part of the meteorite has not yet been determined. It can to some extent be inferred from the chemical analysis given below.

The specific gravity of this meteorite, roughly determined, averages 3.6.

The chemical composition of the meteorite has been investigated by Dr. E. P. Schoch, of the University of Texas, assisted by Mr. J. E. Stullken. The following quantitative determinations were made:

	Per cent.		Per cent.
SiO_2	39.68	Na_2O	3.86
Al_2O_3	3.59	SO_3	8.23
Fe (metallic)	3.10	P_2O_5	.51
FeS	8.00	C (graphite)	.80
FeO	22.27	Hg_2O (loss drying at 110° C.)	1.10
CoO	.42	Ignition loss	.90
MnO	1.24		100.03
CaO	2.03		
MgO	4.30		

Doctor Schoch also makes the following observations:

The total sulphur was found to be 6.20 per cent. Treating the sample with nitric acid the free sulphur obtained was 2.91 per cent. This has been combined with iron in the form of ferrous sulphide, which is found to be 8 per cent. The rest of the sulphur (3.29 per cent) is in the form of sulphur trioxide, which amounts to 8.23 per cent.

The total iron is 25.53 per cent. Metallic iron was found to be 3.12 per cent. The iron in ferrous sulphide (8 per cent) equals 5.09 per cent. The remaining iron (17.32 per cent) is in the form of ferrous oxide, which amounts to 22.27 per cent.

The other determinations were made by the usual method and did not give any difficulty.

This piece of meteorite had a black surface. It is easily broken. The fresh surface thus exposed was brownish with many small black and gray specks.

After crushing pieces of this meteorite in a mortar some hard black particles, varying in size up to a small pin head, were easily removed by a magnet and proved to be metallic iron.

The presence of sulphides was easily suggested when dilute hydrochloric acid produced the odor of hydrogen disulphide.

The residue unattacked by hydrochloric, nitric, sulphuric, and hydrofluoric acids consisted of minute black particles, which proved to be carbon in the form of graphite.

It was found that this meteorite was not strictly of uniform composition; the results given represent somewhat of an average.

EXPLANATION OF PLATES.

PLATE 100.

Upper.—The anterior view of the larger fragment of the Troup meteorite. About three-fourths natural size.

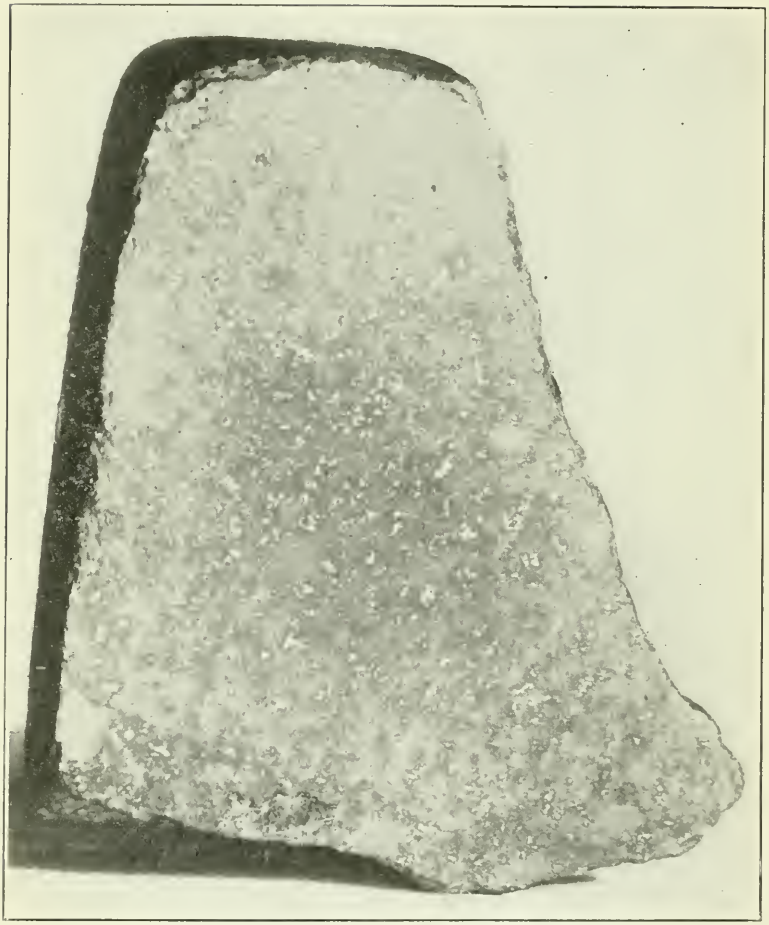
Lower.—The posterior side of the larger fragment of the Troup meteorite. About three-fourths natural size.

PLATE 101.

Polished cross section of the Troup meteorite. The larger iron grains are the lightest spots. Several chondri appear, the largest near the left-hand corner. The dark blotches are due to oxidation of the iron immediately after polishing. A vein runs a sinuous course parallel to the lower margin. Magnified to twice the diameter of the stone.

THE TROUP, TEXAS, METEORITE.

FOR EXPLANATION OF PLATE SEE PAGE 476.



THE TROUP, TEXAS, METEORITE.

FOR EXPLANATION OF PLATE SEE PAGE 476.

MICROSTRUCTURE OF TROUP METEORITE. THE WHITE AREAS ARE MASKELYNITE.

FOR EXPLANATION OF PLATE SEE PAGE 477.