GORDON

THE GROOTFONTEIN, SOUTHWEST AFRICA, METEORIC IRON

BY SAMUEL G. GORDON.

The Grootfontein meteoric iron lies on Farm Hoba, about 20 kilometers west of Grootfontein, in Southwest Africa. When first discovered (in 1920?), only a bit of the upper surface was exposed. Extensive excavations (see Text-figs. 2, 3) have revealed it to be the largest meteorite at present known. Brief descriptions by Schneiderhöhn,[1] Luyten,[2] and Spencer[3] have recently appeared, calling attention to this extraordinary mass.

FIG. 1.—The Grootfontein meteoric iron, showing concavities due to weathering. The meteorite occurred embedded in the ground, and the pit is due to excavations made after its discovery. The fluting on the edges was made in the past by a collector with an oxyacetylene blowpipe. Photograph by the author.

[1] H. Schneiderhöhn, "Das Otavi-Bergland und seine Erzlagerstätten." Zeit. f. prak. Geol. 37 (6) 95–96, 1929. Map on page 88 shows location of meteorite.

[2] W. J. Luyten, New York Times of April 14 and 21, 1929. "The Grootfontein Meteorite." South African Journal of Science, XXVI, 19–20, 1929.

[3] L. J. Spencer, A New Meteoric Iron from Piedade do Bagre, Minas Geraes, Brazil. Min. Mag. XXII (129), footnote on page 272, 1930. Meteoric irons from Southwest Africa. Natural History Magazine, II, (15) 244–246, 1930.

The meteorite was buried in the superficial calcareous tufa (Kalahari Kalk), which had apparently been deposited about it since it fell. About the unaltered core of nickel-iron is a zone of laminated "iron-shale" approximating 30 cm. in thickness which was formed by oxidation or rusting of the meteorite.

The meteorite has the form of a rough rectangular block. Spencer[3] accurately measured the core, and found it to have the dimensions 295 × 284 cm. (about 10 × 9 feet) on the flat upper surface, with a thickness at one end of 111 to 122 cm., and at the other of 55 to 75 cm. He calculated the weight to be about 60 metric tons.

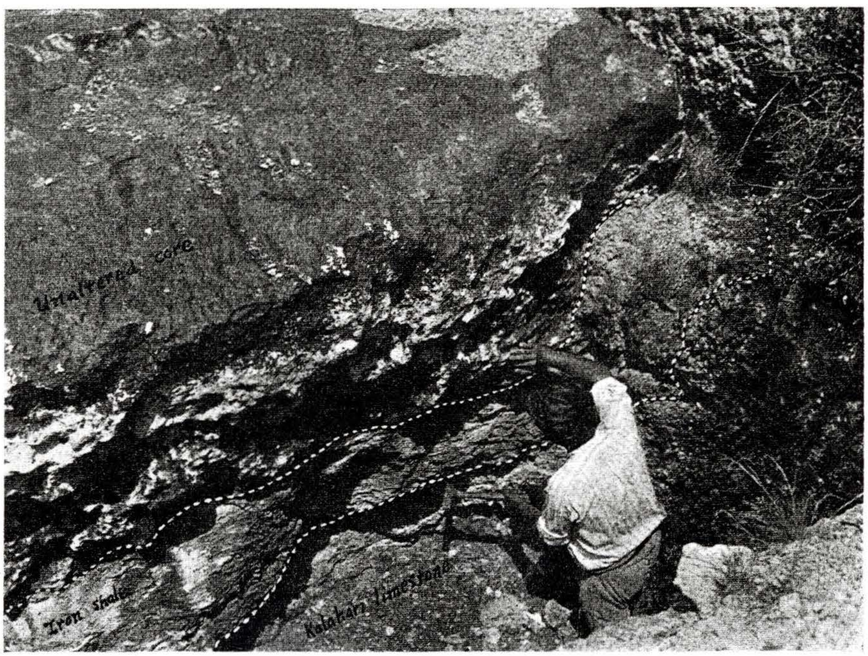

FIG. 2.—Thick laminations of "iron-shale," due to weathering, sheathed the meteorite to a thickness of 22 to 50 cm. Most of the shale has disappeared through weathering and in the excavation of the meteorite. It is best seen on the under side, curving about the unaltered core. Photograph by the author.

The surface of the unaltered core shows the characteristic concavities due to weathering of iron meteorites. The "iron shale" has disappeared through erosion from the upper surface, but in the pit is seen to curve about the core in laminations which form a zone 22 to 50 cm. in thickness (Text-fig. 2). The weight of "iron shale" formed by oxidation of the meteorite was probably fifty tons, which would indicate the weight of the meteorite at the time of fall to have been about one hundred tons.

The specific gravity,[4] determined by weighing a clean sawed piece of 15.5014 grams in CCl_4 (d $\frac{4^\circ}{25^\circ}$ 1.5845) at 25° C., is 7.971.

The meteorite has been damaged in the past by use of an oxy-acetylene blowpipe in endeavors to get specimens. This caused the fluting shown about the edges in the photograph (Text-fig. 1).

Two surfaces of about 80 square cm. and 30 square cm. were polished, and lightly etched with 25% HNO_3. The surface of 80 square cm. showed 8 elongated patches of triolite, the largest measuring 4 × 2 mm. These include some graphite.

The etching developed the structure shown in Text-figure 3. The

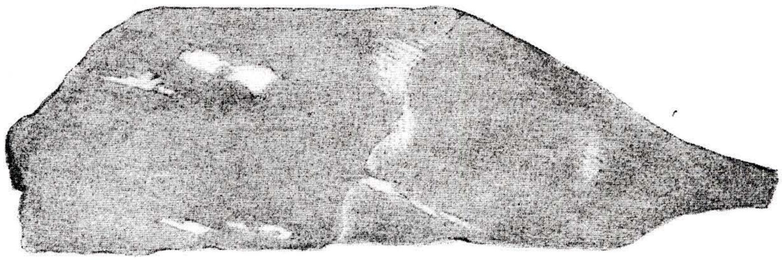

FIG. 3.—Polished and etched surface of the Grootfontein meteoric iron, showing oriented sheen produced on etching. Drawing by Helen Winchester.

drawing indicates the sheen shown in looking at the polished and etched surface at an angle. Upon changing the angle of view, the light oriented patches become dark, and the field light. The boundaries of the patches are irregular, but all are similarly oriented. According to Mr. Frank J. Keelev, who kindly examined polished sections, high powers of the microscope show the cause of the oriented luster or sheen to be due to minute reflections from planes of etching pits or granulations arranged in linear rows, which give the surface an almost fibrous appearance in some of the areas.

More remarkable are veins and areas of intersecting lines, resembling Neumann lines, but differing from these in being crystalline reticulations, slightly raised above the surface, and representing a compound less acted on by the reagent than the matrix.

Some unidentified scattered elongated grains stand in relief on the etched surface. These often show a central cavity, due to solution of some mineral during etching.

Mr. John Burt, who very kindly cut and polished the specimen, tested the meteorite for hardness under a Rockwell machine, diamond cone, 150

[4] According to Luyten (loc. cit.), a partial analysis by the Southwest Africa Company showed Fe 81.29, Ni 17.42, and a specific gravity (of a piece weighing 150 grams) of 7.96.

kg., finding a hardness of 20: which is equivalent to 23.2 Brinell 3000 kg., or 38.6 Brinell 500 kg., or 34.5 under the scleroscope.

A clean sawed piece, weighing 14.1730 grams, was analyzed (Table I). The sample was dissolved in aqua-regia in a flask which was connected with a wash bottle containing aqua-regia to trap any escaping sulfur. The solution was evaporated several times with HCl to dryness, and the residue was taken up with dilute HCl, and bulked to 1000 cc. in a volumetric flask. Iron was determined on portions of 25 cc. by reduction with zinc, and titration with $KMnO_4$. Nickel was determined in portions of 25 cc. by double precipitation with dimethylglyoxime, after adding citric acid to the solution to prevent precipitation of the iron. Cobalt was determined in portions of 100 cc. by precipitation with nitroso-β-napthol, after removal of the iron by means of zinc oxide. The precipitate was ignited and weighed as Co_3O_4. Sulfur was determined in portions of 100 cc. by precipitation as barium sulfate.

TABLE I

ANALYSIS OF GROOTFONTEIN METEORIC IRON
(Samuel G. Gordon, analyst)

Fe	82.40
Ni	16.76
Co	.74
S	.02
P	trace
	99.92
Specific gravity	7.971

TABLE II

PARTIAL ANALYSIS OF "IRON SHALE" ABOUT GROOTFONTEIN METEORIC IRON
(Samuel G. Gordon, analyst)

Fe_2O_3	65.48
FeO	5.60
NiO	8.88
CoO	.59
H_2O	8.47
Specific gravity	4.021

The "iron-shale," derived by oxidation of the meteorite consists of brown laminations, thoroughly seamed with calcite, and stained greenish by nickel compounds. A polished surface under the microscope reveals its heterogeneity. Under oblique illumination grayish patches and reddish areas alternate, with anastomosing veins of limonite throughout the field. The substance is magnetic. The fine powder has the color of raw umber (Ridgway).

Portions for partial analysis of the iron shale (Table II) were prepared by carefully selecting the cleaner fragments, crushing and sieving, and attracting the purer pieces to a magnet.

A gram was dissolved in boiling H_2SO_4 through which CO_2 was passing. FeO was determined by titration with $KMnO_4$. The iron was then reduced by passing H_2S through the solution, and the H_2S was removed by boiling the solution through which CO_2 was passing. Nickel was then determined by precipitation with dimethyglyoxime, after adding citric acid to prevent precipitation of the iron. Cobalt was determined on half a gram by precipitation as potassium cobalti-nitrite, and weighing as $CoSO_4$. Water was determined in half a gram by the Penfield method.

The writer is deeply indebted to Sir Edmund Davis and to Mr. W. R. Feldtmann of the Southwest Africa Company for the opportunity of visiting the meteorite on the Fourth Academy-Vaux Mineralogical Expedition in December, 1929; to Mr. Frank J. Keeley for kindly examining polished slabs under the microscope; and to Mr. John Burt of William Sellers and Company for cutting, polishing, and determining the hardness of a specimen.