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The Mbosi meteoric iron, Tanganyika Territory.

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(With plates XIX and XX.)

[Read March 17, 1931; communicated, with a note, by L. J. Spencer, F.R.S.]

Discovery and General Description (By D. R. Grantham).

THE meteorite is situated on the western slope of Marengi Hill, about 150 yards from the top of the hill and close to the boundary of Mr. Jennes's farm. This place is 10 miles south-east of the Mbosi mission station in Rungwe (formerly Langenburg) district. The latitude and longitude are approximately 9° 7′ S., 33° 4′ E. The locality lies between Lakes Tanganyika and Nyasa, south of Lake Rukwa, and about 23 miles from the border of Northern Rhodesia.

The country-rocks are gneisses with marked parallel banding, containing much felspar and penetrated by pegmatite stringers. The view that these rocks are of sedimentary origin is strengthened by the presence of a dark quartzitic gneiss with occasional streaks of limonite. A fresh, coarse-grained quartz-dolerite crosses the top of the hill.

The meteorite lies exposed for some 2 feet above the surface of the ground. It was buried 2 or 3 feet deep in a red loamy quartz rubble, which is covered by a few inches of soil. Beneath the mass is about a foot of rubble overlying the disintegrated gneiss. The lie of the mass is very similar to that of a rock boulder which has travelled some distance by the 'run of the hill'. There are no signs of a crater or of the impact of a falling body, nor of any charring. When visited by the writer in December 1930 the ground had been excavated on one side of the mass.

The mass was discovered in October 1930 by Mr. W. H. Nott, a land surveyor of Johannesburg, who was erecting a triangulation beacon near by. He ordered a native assistant to go near the spot, but the native refused, explaining that there was a sacred stone

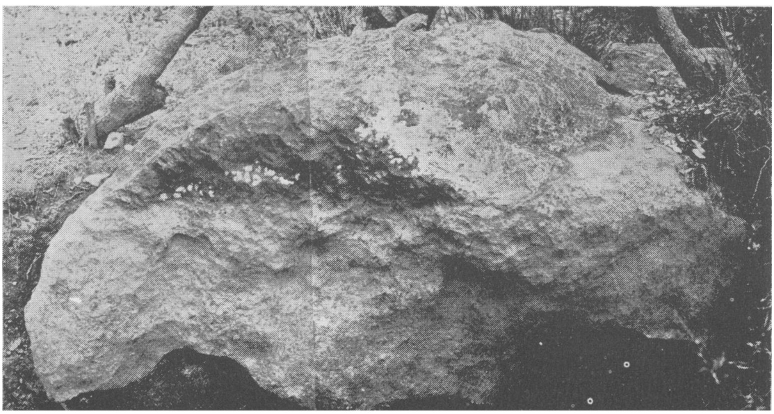


FIG. 1. The Mbosi meteorite; side view as seen in the excavation. (Much reduced: length 10 feet.)

which must not be approached. On making a search himself, Mr. Nott found the mass of iron. He promptly pegged the area as a base metal claim, and it was with his permission that samples were taken by the officers of the Geological Survey.

In addition to the saw cuts and chisel marks made by Europeans in attempts to secure specimens, the mass shows a few ancient tool marks. The local natives when questioned denied any knowledge of the mass, but their demeanour did not carry conviction. They certainly had some rites in connexion with it, but the exact nature of these could not be found out. In view of the lie of the meteorite there could scarcely be any legend of its fall, and the natives must have been attracted to it as being an unusual object.

Scattered through the rubble several feet from the mass are scraps up to an inch square and $\frac{1}{4}$-inch thick of a black nickeliferous iron oxide. These no doubt are fragments of scale detached from the mass during its travel downhill.

As far as can be seen from the present exposure, the meteorite is roughly wedge-shaped, about 10 feet long, 3 feet wide, and 4 feet

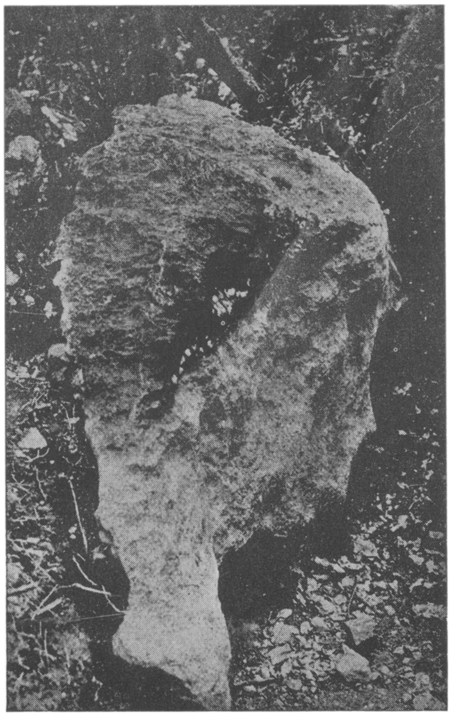


FIG. 2. The Mbosi meteorite viewed from the left end of fig. 1. (Much reduced.)

deep. It is lying on one of the triangular sides of the wedge and pointing nearly south-west. From the measurements of the exposed portion the weight of the mass is calculated to be from 12 to 15 tons, but it is possible that there may be some part still buried in the ground.

The hardness of the iron is comparable with that of hammer-steel. The oxidized skin is still harder as it cannot be cut with a hacksaw. After ten hours' continuous sawing by members of the party in relays a piece of the iron was detached with a cut surface of 5·3 square inches. During the sawing it was noticed that the edges of the cut were slightly magnetic, as they attracted the fine sawdust. Neither the meteorite as a whole nor the piece detached appeared to be appreciably magnetized.

The weathering of the iron is evidently exceedingly slow, it being almost free from rust. A cut surface that had been exposed to the weather for some weeks showed only a slight tarnish. The fine sawdust was only slightly discoloured with rust after a shower of rain overnight.

A sample for analysis was obtained from two $\frac{1}{4}$-inch drill holes, 4 feet apart, going to a depth of 2 inches, the surface $\frac{1}{8}$-inch being rejected.

Chemical Examination (By F. Oates).

The sample for analysis consisted of bright steel-like filings and turnings. The material is almost completely soluble in concentrated hydrochloric acid, there being only a minute residue of colourless silica and silicates. In concentrated nitric acid, after the initial effervescence, the iron assumes the usual passive condition. In dilute nitric acid, solution is nearly complete; and the residue contains a few brownish stony grains, in addition to the silica and silicates left by hydrochloric acid. These residues are evidently mainly due to the contamination of the turnings by foreign sandy material. The results of the analysis are:

Fe.	Ni.	Co.	Cu.	Mn.	S.	P.	C.	Insol.	Total.
90·45	8·69	0·66	trace	nil	0·01	0·11	n.d.	0·03	99·95

The fragments of scale, referred to by Dr. Grantham as occurring in the rubble surrounding the meteorite, gave a strong reaction for nickel, and were therefore no doubt derived from the main mass.

Notes on the Structure (By L. J. Spencer).

The piece sawn from the main mass was sent to the British Museum by Dr. E. O. Teale, Director of the Geological Survey of Tanganyika Territory, for polishing and etching and for further examination. It weighed 430 grams, and the cut surface measures 8 × 5 cm. (about 5 square inches). After smoothing and polishing the cut surface, the weight was reduced to 391·57 grams.

The natural weathered surface of this end-piece shows very distinctly the octahedral structure of the iron. It is cavernous with octahedral surfaces on which there are lamellae in three directions. Cracks parallel to the octahedral faces also penetrate the mass.

The weathered surface showed signs of recent rusting with minute yellow beads (from the sweating out of lawrencite), which gave a strong reaction for chlorine.

Etching with dilute bromine water for fifteen minutes produced little effect, and no prominent Neumann lines were noticed. In very dilute nitric acid beautiful Widmanstätten figures were developed in

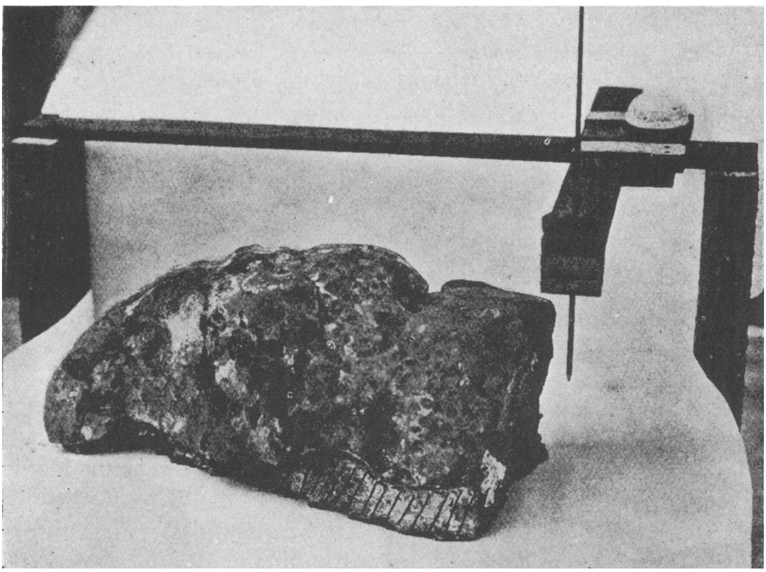


Fig. 3. Model of the Mbosi meteorite, showing the three-dimensional gauge by which it was constructed on one-tenth the scale of the original mass. (Model and photographs of figs. 1–3 by D. R. Grantham.)

one minute, and the etching was stopped after two minutes. The approximately rectangular arrangement of the kamacite bands (plate XIX, fig. 4) shows that the section is approximately parallel to a cube face, and this orientation agrees with the octahedral directions on the weathered surface. The kamacite bands average $\frac{3}{4}$-mm. in width, so that the iron may be classed as a medium octahedrite. Areas of plessite are prominent, but the very narrow bands of taenite are scarcely visible to the unaided eye. One minute speck of troilite was seen on the polished surface, but no schreibersite was detected. A few small angular areas between the kamacite bands show a granular texture with bronze-yellow colour, and perhaps consist of cohenite. One of these areas is seen as a dark elongated triangle near the centre of fig. 5, and much enlarged in fig. 7. They were prominent on the polished surface before etching. A prominent sheen is shown in certain positions by the different bands of kamacite when the specimen is turned about in reflected light. The orientation of the kamacite bands is uniform over the whole section, indicating that the piece consists of a single individual crystal.

The specific gravity has been determined by Mr. M. H. Hey in the Mineral Department of the British Museum by weighing the whole piece (391·57 grams) in benzene; the value 7·39 so obtained is no doubt too low owing to the presence of cavities and crevices in the specimen. A determination in a pyknometer with carbon tetrachloride made on the filings obtained when smoothing the surface gave values ranging from 7·64 to 7·84. Mr. Hey's analysis of these filings, made for the purpose of trying out a new method of separating the iron by distillation in chlorine, gave:

Fe.	Ni.	Co.	Cu.	S.	P.	C.	Total.
90·65	8·53	0·62	trace	n.d.	n.d.	n.d.	99·80

Determinations of the nickel by the dimethylglyoxime method without separating the iron gave Ni 8·48 and 8·33 per cent.

At the suggestion of Colonel N. T. Belaiew, permission was kindly given by Professor Sir Harold Carpenter for some further work to be done on this interesting meteoric iron in the Metallurgical Laboratory of the Royal School of Mines, South Kensington, London. A determination of the carbon content made on 5 grams of the filings gave C 0·073 per cent. The series of beautiful photographs and photomicrographs reproduced on plates XIX and XX is the work of Dr. J. M. Robertson of that Department. Figs. 4 and 5 were taken of the section as first etched for museum display. This etching was, however, too deep for photomicrographs (figs. 6–11), and the surface was repolished and etched with a 5 per cent. solution of nitric acid in alcohol for about 5 minutes. Fig. 8 shows very clearly that 'plessite' is merely an intergrowth of kamacite and taenite on a smaller scale. The taenite band bordering the kamacite on the right of the picture is seen to branch off into the plessite area. Figs. 10 and 11 (magnification 740) clearly demonstrate that the material of some of the bands called taenite is not a simple substance. This set of photomicrographs indicates that meteoric irons should be more intensively studied by metallographic methods.

The Mbosi meteorite thus has characters in common with the many known meteoric irons of the medium octahedrite class, e.g. the Toluca (Mexico) and Cape York (Greenland) irons, agreeing generally with these both in structure and chemical composition. Mr. Oates's analysis gives a Fe/Ni ratio of 10·4, and Ni/Co = 13·2.

Newspaper accounts (e.g. 'The Times', London, of February 17, 1931) gave the weight of this meteorite as 70 (or 84) tons. But it may be mentioned that the 60-ton Hoba[1] meteorite, near Grootfontein in South-West Africa, still holds the record for size of an authenticated meteorite. I am still collecting particulars about the Hoba meteorite and hope soon to give a detailed account.

[1] L. J. Spencer, *Min. Mag.*, 1930, vol. 22, pp. 272–273; *Nat. Hist. Mag.* (British Museum), 1930, vol. 2, p. 245. Min. Abstr., vol. 4, pp. 261, 422.

Explanation of Plates XIX and XX.

Photographs and photomicrographs of the polished and etched section of the Mbosi meteorite, Tanganyika Territory.
(Figs. 4–11 by Dr. J. M. Robertson.)

Fig. 4. The whole section (8×5 cm.) showing Widmanstätten figures with bands of kamacite and areas of plessite; a reflected sheen is shown by several of the bands of kamacite. The very narrow bands of taenite are not seen. Slightly enlarged, ×1·12.

Fig. 5. Central portion of fig. 4. Neumann lines are shown in some of the kamacite bands. Taenite still only slightly in evidence. ×4.

Fig. 6. Taenite band in the centre and two narrower bands to the right. A few Neumann lines in the kamacite end abruptly at the taenite. The small squares and rhombs are no doubt sections of prisms of rhabdite (=schreibersite). ×90.

Fig. 7. Bronze-coloured granular area (dark elongated triangle near centre in fig. 5, perhaps cohenite), bordered on the right by plessite, then a dark band of taenite, and lastly kamacite. ×40.

Fig. 8. Plessite area of two orientations. The taenite band bordering the kamacite on the right branches off into the plessite area. ×40.

Fig. 9. Plessite area (same as fig. 8), showing bands of kamacite (with a few Neumann lines) bordered by taenite. ×90.

Fig. 10. Taenite band (the dark band in fig. 7). ×740.

Fig. 11. Another taenite band. ×740.

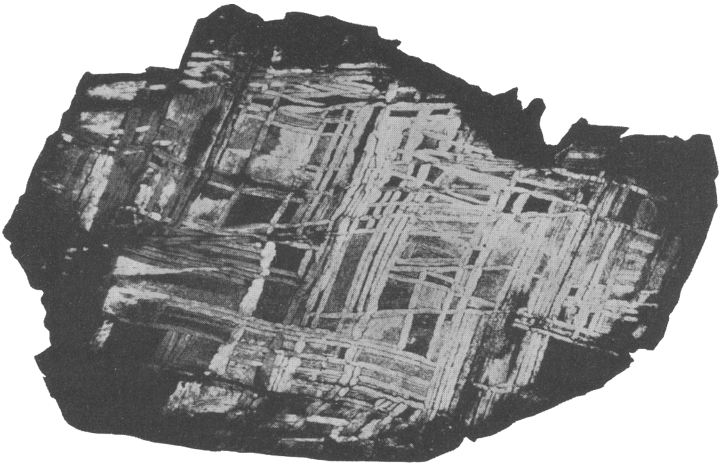


Fig. 4

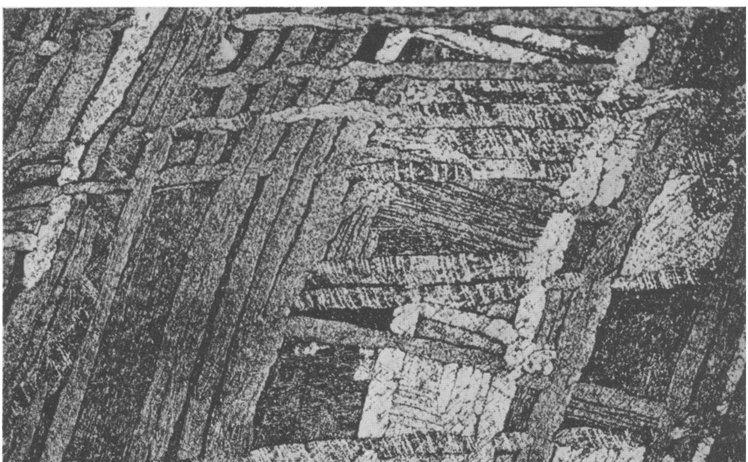
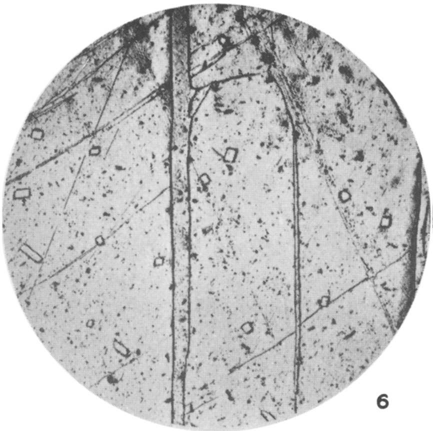


Fig. 5

D. R. Grantham and F. Oates: The Mbosi Meteoric Iron.



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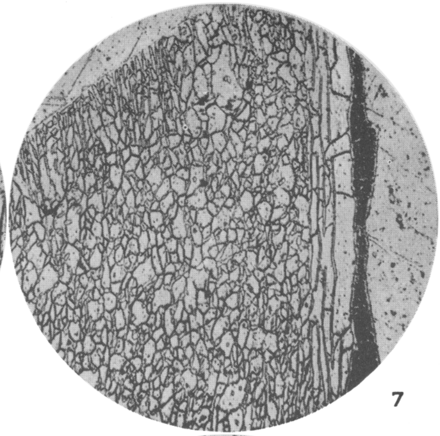

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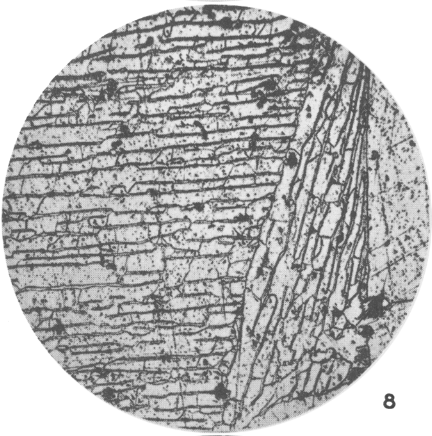

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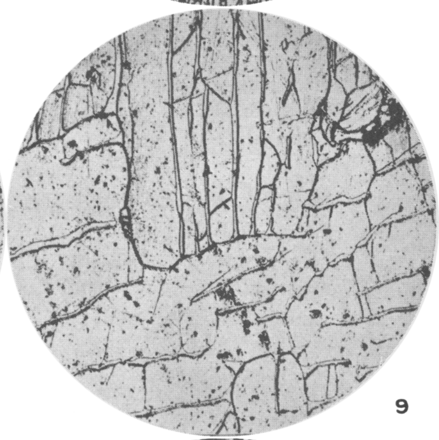

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D. R. GRANTHAM AND F. OATES: THE MBOSI METEORIC IRON.