A NEW SPECIMEN OF THE MOUNT DOOLING IRON METEORITE FROM MOUNT MANNING, WESTERN AUSTRALIA

J.R. De Laeter
Department of Physics
Western Australian Institute of Technology
South Bentley, Western Australia, 6102

A 701 kg iron meteorite has recently been discovered near the Mount Manning Range in Western Australia. The meteorite has a fan-shaped or delta wing configuration, one side being smooth and slightly concave with a well-defined fusion crust, whilst the other side is rough, convex and possesses numerous regmaglypts. It is probable that the meteorite pentrated much of the earth's atmosphere in an aerodynamically stable orientation, typical of the stalled attitude of delta wing aircraft. The meteorite is a member of Chemical Group 1C. A comparison of the chemical composition, surface features, microstructure and location of this meteorite with the Mount Dooling meteorite confirms that the find is a larger specimen of Mount Dooling. It is possible that other fragments of the Mount Dooling meteorite may be found in the Mount Manning Range region.

DETAILS OF THE FIND

An iron meteorite weighing approximately 701 kg was discovered by Messrs. Joshua Pitt and Alan Pellegrini on Sunday, 19th August 1979, at a site 3 km east of the Mount Manning Range, some 430 km north east of Perth, Western Australia, and approximately 50 km south east of Diemals. The co-ordinates of the discovery point are 32°0′S and 119°40′E. The country is sparsely vegetated, with an annual rainfall of approximately 22 cm. The red loamy soil is approximately 20 cm deep giving way to a stony sub-surface layer. The meteorite was embedded in the ground at an angle of approximately 40° to the horizontal, with about two thirds of it protruding from the ground.

DESCRIPTION

The meteorite has a fan shape as illustrated in Figure 1. Its maximum dimensions are 150 cm by 90 cm. The maximum thickness of the meteorite is 25 cm, tapering off to the trailing edge where it is extremely thin and jagged. A piece of the meteorite has been cut from the trailing edge for analytical purposes, and this is clearly visible in Figure 1. One side of the meteorite is

(a)

(b)

Fig. 1 **Opposite sides of the iron meteorite found near the Mount Manning Range. The smooth side (a) has a slightly hollowed shape and contains a number of holes about 60 mm in diameter. Side (b) shows the rough convex-shaped upper surface which contains numerous well-defined regmaglypts. The jagged, ablated trailing edge of the meteorite is distinguished by the fact that a sample has been cut from this portion of the meteorite. Scale 30 cm.**

smooth, slightly concave with a characteristic fusion crust. The markings on this face indicate that the leading edge of the meteorite was the rounded portion. The upper most side of the meteorite is convex shaped, and the surface is pitted with numerous regmaglypts. Some of these regmaglypts are several centimetres across. Most of them are oval shaped, and are separated by raised portions on the meteorite, which are often quite sharp.

The shape of the meteorite could be described as "delta wing" rather than fan-shaped. Delta wing aircraft were developed to operate at high sub-sonic or transonic speeds. The delta wing has a basically triangular planform with a straight trailing edge and curved leading edge. Despite the advantages of delta wing aircraft at sonic speeds, they have severe disadvantages at low speeds. This is principally associated with the fact that the stalling angle is very large, and once in a stalled attitude it is virtually impossible for the aircraft to alter this condition.

Because of the marked difference in appearance of the two sides of the meteorite, and its unusual shape, it can be hypothesised that the meteorite performed a delta wing-like flight at a high angle of attack through much of the earth's atmosphere. This configuration was apparently maintained because of the aerodynamic stability of delta wing-shaped planforms. In this descent path the underside of the meteorite was smoothed by atmospheric ablation, whereas the upper surface (as depicted in Figure 1B) did not suffer extensive melting. The thin trailing edge has obviously been affected by heat as evidenced by its jagged appearance perforated in some places by holes.

Some of the regmaglypts are 1.5 cm in depth. Although much of this is caused by ablation, terrestrial corrosion has also played an important role. Portions of rusted material up to a centimeter in thickness were removed from many of the regmaglypts, and from the number of layers of iron oxide one can estimate that the residence time of the meteorite on the surface of the earth was several hundred years.

Another interesting feature of the meteorite's surface is the presence of holes, approximately 60 mm in diameter, scattered across the fusion crust and revealing themselves as tubular indentations in parts of the upper surface. These features are undoubtedly due to the presence of cylindrical troilite inclusions which have been selectively corroded with respect to the rest of the meteorite.

A polished and etched face of a portion of the meteorite shows two distinct types of kamacite structure. The coarse grained kamacite consists of somewhat irregular elongated grains a few mms across, oriented in a poorly developed Widmanstätten pattern. The other region does not reveal any obvious Widmanstätten pattern and is more characteristic of a hexahedral structure. Thus, the meteorite tends to exhibit surface characteristics typical of both hexahedrite and coarse octahedrite structures. The meteorite also contains troilite inclusions, roughly circular in cross section, which penetrate into the meteorite for several centimeters. A number of small cracks surround most of these inclusions.

Microscopic examination of the surface using a scanning electron microscope reveals abundant Neumann deformation lines. Iron-nickel phosphide in the form of small rhabdites are present, and in addition there are larger, less numerous schreibersite grains. A semi-quantitative analysis of the rhabdites indicate that the Ni content is in excess of 30%, which is typical of hexahedrites (Reed, 1965). The meteorite also exhibits a secondary structure consisting of recrystallised grains which cluster around the phosphide inclusions. This structure is presumably caused by the same "cosmic" event as described by De Laeter *et al.* (1972) in which larger kamacite grains were recrystallised.

CLASSIFICATION

Table 1 gives the Ni, Co, Ga and Ge concentrations of the meteorite, determined by X-ray fluorescence spectrometry on a flat, polished, inclusion-

Table 1
Analytical data for meteorites

	S.G. g cm^{-3}	Ni (%)	Co (%)	Ga (ppm)	Ge (ppm)	Reference
This meteorite	7.7	6.3	0.45	55	228	This work
Gosnells	7.6	6.1	0.45	51	249	De Laeter *et al.* (1972)
Mount Dooling		6.1	0.45	60	233	De Laeter *et al.* (1972)
		6.26	–	52	234	Wasson (1970)
		6.2	–	55	243	Reed (1972)
	7.8	–	–	–	–	McCall and De Laeter (1965)

free surface using the technique described by Thomas and De Laeter (1972). The specific gravity of a specimen of the meteorite was found to be 7.7 g cm^{-3}.

Wasson (1970) defined chemical group 1 as those irons which fall within the ranges 6.4-8.6% Ni, 56-100 ppm Ga and 190-520 ppm Ge. Members of this group are mostly coarse octahedrites. The Ni and Ga concentrations in this meteorite are slightly low for a group I iron, and more closely fit to an anomalous category I-An 3 which was also defined by Wasson (1970) and contained 10 members. Subsequently Scott and Wasson (1975) have redefined the classification of the iron meteorites in which Group 1C meteorites contain 6.1-6.8% Ni, 49-55 ppm Ga and 212-247 ppm Ge. The new meteorite is therefore a member of this group.

IDENTIFICATION

In 1960 an iron meteorite of mass 1.6 kg was recovered at Gosnells, approximately 19 km south east of Perth in Western Australia. It was shown by De Laeter *et al.* (1972) that this specimen was a member of the chemical group 1-An 3 and was described as being a heat-altered granular coarse octahedrite. Subsequently it was realised that it was chemically and structurally similar to the Mount Dooling siderite which had been found in 1909 and weighed in excess of 31.3 kg. In fact, the meteorite fragment found at Gosnells fitted along one of the fracture surfaces of the Mount Dooling meteorite. It was therefore concluded that the Gosnells meteorite was a fragment of Mount Dooling, and had most probably been transported to the site near Perth by human agency (De Laeter *et al.*, 1972).

According to Simpson (1912), the Mount Dooling meteorite was discovered approximately 7 km east of Mount Dooling in the North Yilgarn Block, Western Australia, at latitude 29°57′S and longitude 119°43′E. However, Mount Dooling cannot be found in maps of the area, nor does it appear in Mines Department records, so that the exact location of this meteorite is unclear. Figure 2 is a map of the area. There exists a "Dooling Soak" surrounded by a hillock of stones about 1 km across. A point 7 km east of Dooling Soak would be at latitude 30°02′S and longitude 119°43′E. Alternatively, there is a hill named "South East Peak" in the Mount Manning Range about 4 km north of Dooling Soak and another hill called "North West Peak" 7 km further north. A point 7 km east of North West Peak coincides with the co-ordinates given by Simpson.

The location of the meteorite found in 1979 is also marked on Figure 2. It is some 3 km east of the South East Peak, and approximately 6 km South South West of the most probable location of Mount Dooling.

An examination of the analytical data listed in Table 1 reveals that the meteorite described in this paper has an identical chemical composition to that of Mount Dooling, and in view of the locations of the two meteorites, the surface features and the microstructure, it must be concluded that the new meteorite is in fact part of the Mount Dooling siderite. Or perhaps more accurately, that the siderite found in 1909, and named Mount Dooling, is a fragment of the meteorite found in 1979.

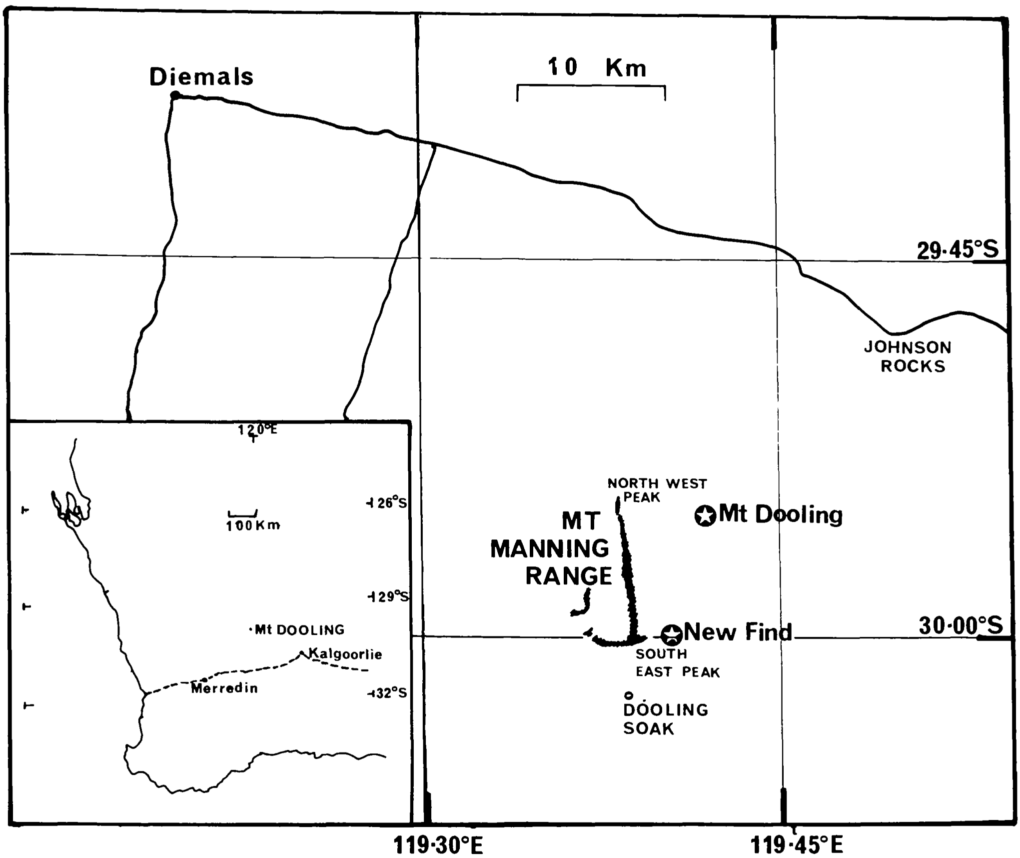

Fig. 2 Map of the Mount Manning Range area, showing the location of the find, and the probable location of the Mount Dooling meteorite.

In view of the fact that three separate specimens of Mount Dooling have now been found, it is possible that other specimens may be discovered in the future. Although it is not entirely clear from which direction the meteorite came, evidence from the site of the present find suggests that it may have landed from the north east. Since the present find is the heaviest fragment, it supports the suggestion by Simpson (1912) that the 1909 find was at the most northerly location. The additional find also supports the conclusion of De Laeter *et al.* (1972) that the fragment found at Gosnells was the result of human transport.

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REFERENCES

De Laeter, J.R., G.J.H. McCall, and S.J.B. Reed, 1972. The Gosnells iron – a fragment of the Mount Dooling octahedrite. *Meteoritics* 7, 469-477.

McCall, G.J.H. and J.R. De Laeter, 1965. Catalogue of Western Australian Meteorite Collections. *Spec. Publ. West. Aust. Museum No. 3.*

Reed, S.J.B., 1965. Electron probe microanalysis of schreibersite and rhabdite in iron meteorites. *Geochim. Cosmochim. Acta* **29**, 513-534.

Reed, S.J.B., 1972. Determination of Ni, Ga and Ge in iron meteorites by X-ray fluorescence analysis. *Meteoritics* 7, 257-262.

Scott, E.R.D. and J.T. Wasson, 1975. Classification and properties of iron meteorites. *Rev. Geophys. Space Phys.* **13**, 527-546.

Simpson, E.S., 1912. Two new meteorites from Western Australia. *Bull. Geol. Surv. West. Aust.* **48**, 83-89.

Thomas, W.W. and J.R. De Laeter, 1972. The analysis of nickel, gallium and germanium in iron meteorites by X-ray fluorescence spectrometry. *X-Ray Spectrometry* **1**, 143-146.

Wasson, J.T., 1970. The chemical classification of iron meteorites: IV. Irons with Ge concentrations greater than 190 ppm and other meteorites associated with group I. *Icarus* **12**, 407-423.

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