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Some new and little-known meteorites found in Western Australia.

(With Plates VI–IX.)

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DALGARANGA.

Siderite (Om), many small fragments, fell before 1910, found 1923.

WHEN some publicity was given recently in the press to the Gundaring and Kumerina finds, which are described below, Mr. G. E. Willard called upon me in regard to a meteorite which had fallen on Dalgaranga sheep station (27° 45′ S., 117° 5′ E.). He stated that when he was a manager of this station in 1923 he found a crater measuring 75 yards across at the top, 50 yards at the bottom, and 15 feet deep. The surface of the country was 'hard conglomerate' (laterite?—E. S. S.), and pieces of rock up to one cubic yard were pushed up out of the hole, as if there had been an explosion. The NW. side had been thrust upwards more than any other, indicating that the meteorite came from the SE. In and around the crater Willard found 'a hatful' of small ragged pieces of iron like the Henbury (Central Australia) fragments. These original specimens unfortunately had since been mislaid, but he was able to secure for me from the present manager of the station a 40-gram piece. Ten miles to the SE. he had found in 1923 another small piece of iron, also now lost. In that year a mulga bush (*Acacia* sp.) 15 feet high was growing in the bed of the crater, indicating that the meteorite had fallen prior to about 1910. No scientist has ever visited the crater, but Willard's story confirmed what I had heard already in Yalgoo, the nearest town to Dalgaranga, when I was there in 1932.

The 40-gram piece from the crater is ragged and deeply indented, with a 4-mm. circular perforation on one edge, where a rod of troilite has burnt out. The whole surface is covered with a fused oxide film. In one hollow this is 5 mm. thick, indicating possibly an original silicate inclusion. A piece of the metal which was sawn off was freed from oxide and then found to contain 8·63% of nickel. The small surface exposed by the saw cut was polished and etched. It gave a very confused figure with many curved boundaries, the result probably of the high temperature produced by friction in the air and impact on the ground, and strains resulting from the impact and explosion. What appear to be bent kamacite plates are very variable in thickness, from 0·1 to 0·7 mm. Tentatively I have classified the meteorite as a medium octahedrite. It is hoped some time to visit the crater and obtain more specimens for further investigation.

DOWERIN.

Siderite, many small fragments, first known 1932.

In 1932 when visiting Dowerin I was shown several small ragged fragments of iron with a black oxidized surface, which were said to be typical of a large number found on the surface some distance south of the town after a scrub fire. One fragment in my collection weighs 0·35 gram. They are like the Henbury fragments and almost certainly of meteoritic origin. Dowerin is at 31° 12′ S., 117° 4′ E.

GUNDARING.

Siderite (Og–Ogg), one mass of 248 lb. (112·5 kg.), seen to fall April 6, 1930, found May 20, 1937.

This meteorite, measuring $17 \times 16\frac{1}{2} \times 9$ inches ($43 \times 42 \times 23$ cm.), caused a considerable sensation when it was seen to fall at 2 p.m. in bright daylight by a large number of people at various points up to nearly 200 miles away from where it touched the ground at Gundaring, close to the spot predicted by the Government Astronomer (Mr. H. B. Curlewis) after collating all the reports. He estimated that it travelled in a SSE. direction, and first became visible above a point 10 miles SW. of the town of Pingelly and about 50 miles to the NNW. of Gundaring, which is at 33° 18′ S., 117° 40′ E. During the flight it appears certain that it burst into two halves, only one of which has been found. Its fall was accompanied by the usual phenomena of an intense drumming or rumbling noise, and severe vibration of the air, with a loud explosion almost over the village of Cuballing, after which several observers stated that two objects were visible travelling along almost parallel courses.

The public interest was keenly aroused and a number of long articles about it appeared in the daily press. From time to time a search for the object was made by local farmers and by residents of the nearby town of Wagin. In August, 1931, an australite of 10 grams was found near Gundaring, and was thought at first to be connected with the fall, being possibly part of a large shower resulting from the disintegration of a molten meteorite. This on consideration appeared extremely unlikely, and that there was no connexion is proved by the fact that no further australites have been reported from the district.

It was not till May, 1937, that F. Quinn found this large iron on his farming block no. 14355 close to the Cancanning public hall, nine miles NNE. of Gundaring. There is good reason to believe that it is one half of the object seen to fall in 1930. It was found right on the surface of the ground, which it had indented to only a slight extent, one reason for which was probably its low angle of impact, 45° or less. It was lent to the writer in 1937 to exhibit at a meeting of the Royal Society of Western Australia, after which it was held by a friend of the finder till February, 1938, when I again obtained a loan of it with permission to remove a portion for examination. Ultimately it will probably find a resting-place in the Western Australian Museum or Perth Observatory. Fig. 1 (pl. VI) shows its appearance.

The surface is broadly and not very deeply eroded. There were only comparatively few, 0·5–1·0 cm., roughly hemispherical pits caused by the rapid burning out of troilite nodules during the flight through the air. The troilite is in spheroids and amygdales rather than cylinders, only one cavity of the latter type being observed, 1·5 cm. deep by 0·5 cm. in diameter. The skin of slag is very thin, and dark brown to black in colour.

The slice removed weighed just under 4 lb., and the sawn section measuring 14×8 cm. was polished and etched, bringing out a very clear and beautiful crystallization, shown in fig. 2. Over almost the whole area the kamacite is crystallized in three parallel sets of plates, each highly schillerized, and making angles of approximately 60° with one another. The blades range from 0·5 to 2 mm. wide, with an average of about 1·4 mm., which would place the meteorite at the lower end of the broad octahedrite class, Og. Round a 1 cm. nodule of troilite, there is an irregularly oriented group of much wider plates, several reaching 4 mm., and having somewhat scalloped edges, similar to those in Youndegin, described by Brezina, and in Wonyulgunna, described below. As a whole, therefore, the meteorite overlaps into the broadest group, Ogg, in this way also resembling the Youndegin fall. There are the usual thin plates of taenite bordering all the kamacite, and a number of interstitial areas of eutectic (plessite). Many of these show an octahedral arrangement of the very narrow secondary blades of kamacite. Two small inclusions of cohenite are seen in the section, each about 6×1–2 mm. These were noticeable in sawing the slice, being so hard as to blunt the saws in a very short time, and delay the cutting quite appreciably. The rest of the section was comparatively soft to cut. The nickel content of the mass is 8·18%. No complete analysis has been made of it.

KUMERINA.

Siderite (Of), one mass of 118 lb. (53·5 kg.), found 1937.

In February, 1937, W. G. Armstrong sent a 35-gram fragment of iron to the *Western Mail* newspaper, which he had broken from a large mass he had found close to Batthewmurnana Hill, which is 20 miles SSE. of the centre of the Kumerina copper field. The position of the find was approximately 24° 55′ S., 119° 25′ E. Arrangements were made for the whole mass to be forwarded to the Western Australian Museum, where it now lies intact, except for a piece weighing 2·6 lb., used first for analysis and physical examination, and then presented to the British Museum (Reg. no. 1938,220).

The whole mass, whose appearance is shown in fig. 3, measured $14 \times 10 \times 10$ inches ($35 \times 25 \times 25$ cm.). One end is smoothly convex, the other end, and the central girdle, deeply and broadly eroded, showing comparatively few but large thumb-marks. Only two rather small cylindrical holes were noted from which rods of troilite had burnt out.

The iron was very hard to saw and file. No complete analysis has been made, but the nickel content of clean filings was determined to be 9·55%, which lies within Farrington's normal range for fine octahedrites, viz. 8–10·5% Ni+Co. The specific gravities of two fragments of 33 and 47 grams are 7·73 and 7·53. On a section $12{\cdot}5 \times 6$ cm. two small nodules of troilite were observed, 3–4 mm. in diameter. Several ragged pieces of cohenite can be seen under the microscope. The crystallization is unevenly developed, in some areas almost complete, in others represented only by occasional plates or small groups of plates in a structureless background. In such cases the kamacite plates are often lenticular. The kamacite lamellae are 0·2–0·4 mm. wide, but a few broader ones are seen surrounding cohenite (fig. 4).

LANDOR.

Siderite (Of), one mass of about 20 lb. (9 kg.), first known 1931.

In 1931 a Mr. Murphy brought to me five small well-crystallized octahedral fragments of heat-oxidized iron, broken from the ragged edge of a meteorite which he said weighed about 20 lb. It had recently been found near the head of the Wooramel river on Landor sheep station (25° S., 117° E.). The fragments in the writer's collection weigh 2·6 grams. It was not easy on such small surface material to determine the class to which the iron belongs. On polishing and etching one small piece, some kamacite plates 0·3–0·5 mm. in width were seen, as well as an area of eutectic. The class appears to be 'fine octahedrite'. It is hoped that in the future the whole meteorite may be obtained for the Western Australian Museum.

MELLENBYE.

Stone (Cw), broken fragment of 12 oz. (337 gm.), found before 1932.

When I was in Yalgoo in 1932 I observed this fragment on a shelf in an hotel, and persuaded the lessee to give it to me. It appeared to form one-fourth or less of the whole original body, which was said to have been found by two gold prospectors between Mellenbye and Kadji-Kadji station homesteads at about 28° 51′ S., 116° 15′ E. The brown fused crust is intact on two sides, and the interior much rusted. The specific gravity is 3·32, indicating the presence of about 5% of nickel-iron. The mass was sawn in the British Museum, and a piece of 81 grams kept there (Reg. no. 1934,623), the remainder being returned to Perth, where it is still in my possession pending an opportunity to analyse it. Dr. L. J. Spencer, who examined it at the British Museum, says it belongs to the common type of chondrite, very like Silverton,[1] which has been described as a 'white hypersthene-olivine-chondrite'. It would come within Prior's group 3 or 4. A polished surface is heavily stained throughout by rust, and shows numerous minute specks and threads of metallic nickel-iron.

MILLY-MILLY.

Siderite (Om), one mass of 58¼ lb. (26·5 kg.), found 1921.

In the Annual Report of the Geological Survey for 1921[2] there was a brief statement of the collection of this meteorite by an aborigine on Milly-Milly sheep station at 26° S., 116° 30′ E. The meteorite had been

[1] L. J. Spencer, Min. Mag., 1934, vol. 23, p. 569.
[2] Ann. Rep. Geol. Surv. W. Austr., 1922, for 1921, p. 53.

known to the natives for many years. It was presented to the Western Australian Museum in the same year, and the main mass is still there. By courtesy of the curator I have been enabled to investigate it in some detail.

The mass measured 10×9×4 inches (25×23×10 cm.), and the gross weight was 58¼ lb. (26·5 kg.). It is very deeply and broadly thumb-marked on both sides (fig. 5), but shows no signs of burnt-out troilite rods or nodules on the surface, or of unoxidized troilite on the one cut face. The iron was very hard to cut, and during the cutting small octahedral fragments, with thinly oxidized faces having a solid angle of 70½°, broke off the edges of the cut. It is a medium octahedrite, with average width of kamacite plates 1·2 mm., the structure being very perfectly and strongly marked after etching. All the kamacite plates show an oriented schiller, but no flecking (fig. 6). The centres of the figures are occupied by eutectic with parallel structure. No cohenite was observed on the one section, and schreibersite is not prominent. Two small oval masses of troilite or daubreelite (?) were found to colour very readily, and stain the surrounding kamacite during etching. An analysis was made of a sawn-off fragment with the following results:

Fe.	Ni.	Co.	Cu.	Mg.	P.	S.	C.	Si.	Total.
(91·16)	7·84	0·77	nil	nil	0·20	0·01	0·02	nil	100·00

Premier Downs III.

Siderite (Om), one mass of 3½ oz. (99 gm.), first known 1911.

In 1912 and 1914 Simpson and Bowley[1] described two small metallic meteorites (group Om) found on Premier Downs station which occupies part of the Nullarbor Plain. These weighed respectively 3·9 and 4·1 oz. (112 and 116 grams), and were said to have been found 8 miles apart.

In 1918 a third similar iron, weighing 99 grams and coming from the same area, was presented to the Western Australian Museum by Mr. Alister Ewing. It has the same knuckle-bone shape as the other two, and is covered with a thin fused crust of oxide, except on one exposed corner, where there is a crystalline fracture. That it had lain for some years on the ground is proved by the fact that a thin layer of travertine encrusts about one-third of its surface.

All three pieces probably belong to one shower. The approximate site of the fall is 31° 0′ S., 127° 20′ E.

[1] Ann. Rep. Geol. Surv. W. Austr., 1912, for 1911, p. 10. E. S. Simpson, Bull. Geol. Surv. W. Austr., 1912, no. 48, pp. 87–89; E. S. Simpson and H. Bowley, ibid., 1914, no. 59, pp. 205–209.

THANGOO?

It may hardly seem legitimate to include this in a description of meteorites, as, although it was seen to fall close to the observer, it has not yet been found. The unusual circumstances of its fall are, however, my justification.

Flying from Carnarvon to Broome at a height of 1500 feet and in the dark, at 7.10 p.m. on June 15, 1936, Pilot J. M. Woods was startled by a brilliant bluish light which suddenly lit up the wings of the plane like a search-light. He was then over Thangoo station at 18° 30′ S., 122° 0′ E. Banking the machine he saw the trail of a meteorite only 600 yards away. He stated that it looked very brilliant, a long red tail extending right across the sky from the bluish-white glaring head, which he saw strike the ground quite near the coast. The path was at an angle to the ground, and the glare lit up all the surrounding country for some moments. On arriving at Broome, 40 miles farther on, people waiting on the aerodrome said they had seen the fall from there. He suggested that some unexplained aeroplane accidents might be due to collision with meteorites.

TIERACO CREEK.

Siderite (Of–Om), one mass of 92 lb. (41·7 kg.), found before 1922.

This meteorite has been fully described by T. Hodge-Smith and H. P. White.[1] The principal reason for mentioning it here is that in the original description the locality name was inadvertently spelt wrongly as 'Ticraco Creek' instead of 'Tieraco Creek' (26° 20′ S., 118° 20′ E.). Owing to a printer's error the mean width of the kamacite plates is given as 4·08 mm. instead of 0·48 mm., which the context shows to be the correct figure. In the 2-lb. fragment in the Western Australian Museum collection the width varies from 0·2–2·0 mm., with an average of a little over 0·5 mm., placing the iron on the border-line of fine and medium octahedrites. I have detected several inclusions of cohenite in this fragment.

One of the most remarkable features of the meteorite, which is mentioned in the original paper, is the pronounced development of fine octahedral ridges over large areas of the fused crust by differential oxidation of the two nickel-iron alloys during the flight through the air. Where this is most apparent the brownish-black crust is very thin. I have not observed a similar feature on any other Western Australian siderite.

[1] T. H. Smith and H. P. White, Rec. Austr. Mus., 1926, vol. 15, pp. 66–68, pls. II–IV. [Min. Abstr., 3–258.]

Wonyulgunna.

Siderite (Om), one mass of 83·5 lb. (37·8 kg.), found 1937.

This meteorite was found by an aborigine in June, 1937, on Bald Hill (formerly Wonyulgunna) sheep station, just west of the 485 mile post on the no. 1 rabbit proof fence, and about 21 miles SE. of Mt. Wonyulgunna. The site is 24° 55′ S., 120° 0′ E. The whole mass was recovered by Mr. O. M. Bender and handed to me for examination and subsequent presentation to the Western Australian Museum. It measured $42 \times 29 \times 13$ cm. Two slices have been cut from it, one of 2·1 lb. for the British Museum (Reg. no. 1938,357), one of 9 oz. for the Australian Museum, Sydney.

The chief external characteristics are the very deep pits and bores, the latter, and possibly the former, due to the burning out of troilite cylinders and nodules which are abundantly scattered through the mass. The deepest pit is hemispherical, 8 cm. deep and 7 cm. across the mouth. The numerous bores communicating with the surface range from 0·5 to 2·5 cm. in diameter, and are up to 4 cm. deep. One passes right through the mass. The general appearance of one side of the meteorite is shown in fig. 7, pl. VII. The specific gravity of two pieces was found to be 7·68 and 7·74.

No analysis of the meteorite has been made, but clean filings from the surface of the larger section were found to contain 8·26% of nickel. It would be impossible to obtain any accurate figure for the sulphur content owing to the large size and very irregular distribution of the troilite masses. This is true of most meteorites. An approximate estimate is 1 to 1·5% of sulphur.

Etching reveals a very perfectly crystallized structure, with kamacite plates averaging a centimetre in length and 0·5–2·5 mm. wide, the average about 1·2 mm., placing it at the coarser end of the medium octahedrites (figs. 8 and 9, pl. VII; fig. 10, pl. VIII). There are some fairly large interstitial areas of eutectic, one of the largest measuring 7×6 mm. Most of these contain a number of crossing bundles of minute kamacite plates, each plate 0·1 mm. or less in width. There are considerable variations in the arrangement of these secondary kamacite crystals, and the ease with which they can be distinguished. Where most clearly seen, they are arranged in three directions parallel to the primary plates.

Bronze-coloured troilite is abundant, usually as cylindrical masses averaging a centimetre in diameter. One such was found to be enfolded by a thin layer of schreibersite. The latter mineral is scattered irregularly over the surface with the usual narrow, straight or curved outlines. A prominent feature is the large number of solid masses and tablets of cohenite distributed in groups over the section. These doubtless account for the difficulty in cutting at various stages in the sectioning.

YALGOO.

Stone (Cw), fragment of 1 lb. 14 oz. (0·85 kg.), known before 1937.

In 1937 the curator found this fragment amongst some other unrecorded specimens in the store-rooms of the Western Australian Museum, where it might easily have lain for twenty years. An attached slip of paper had written on it 'Portion of a meteorite found near Yalgoo', which is at 28° 23′ S., 116° 43′ E. There is no record as to who found it, or when. The meteorite most like it is the Mellenbye (p. 161), which, however, is much darker in colour, and more heavily rusted than this is, and is less rich in nickel-iron.

The Yalgoo stone has a brown fused crust about 0·5 mm. thick. Within this the matrix is greyish-white with small discontinuous brown areas stained with rust. Pale grey chondrules are visible in it. Small specks of clean metal can be seen on a roughly polished face, the specific gravity of the whole mass, 3·42, indicating the presence of about 10% of nickel-iron, thus placing it in Prior's group 3. No analysis or microscopic examination has been made of the stone.

YOUANMI.

Siderite (Om), one mass of 261 lb. (118·5 kg.), found 1917.

A brief note recording the discovery of this meteorite was published by the writer[1] in 1918, before any detailed examination of it had been made. It is a single large mass brought to Perth by Inspector of Mines A. W. Winzar from uninhabited granite country about 50 miles south of Youanmi, which would be at 29° 30′ S., 118° 45′ E. He informed me that no marks were left on the surface showing the impact, the surrounding rock being denuded away. This indicates a considerable age for the meteorite. The whole of it, except for two slices of about 1 kg. each, is in the Western Australian Geological Survey collection (no. 1/1436). It measures 19 × 18 × 6 inches (48 × 46 × 16 cm.).

The surface is fairly deeply and broadly pitted, with several unmistakable bores left by the burning out of troilite, a cylinder of which, two centimetres in diameter, shows in one of the sections (fig. 13, pl. IX).

[1] Ann. Rep. Geol. Surv. W. Austr., 1918, for 1917, pp. 19, 22.

The usual crust of fused haematite and magnetite covers the surface, and some of the latter penetrates into deeply reaching cracks. The iron was fairly easy to cut with a hand hacksaw except for the surface 2 mm. where it was distinctly harder. No cohenite could be seen in the sections. Etching reveals an imperfect crystallization, especially in the hard periphery, with the structure of a medium octahedrite. Some small areas in one slice are quite featureless. For about 2·5 cm. into the interior from one side the kamacite blades are strongly flecked (fig. 14), but on the whole show practically no schiller. They range from 0·5 to 1·5 mm. in width, with an average of 1·0 mm. Schreibersite is not conspicuous, but in one small section is seen as typical graphic forms. An analysis showed:

Fe.	Ni.	Co.	Cu.	Ca,Mg.	Si.	P.	S.	C comb.	C free.	Total.
91·17	8·08	0·87	0·11	nil	0·01	0·15	0·02	0·01	0·04	100·46

Owing to the irregular distribution of troilite as large masses, none of which was included in the analysed material, the figure for sulphur is not characteristic of the whole mass, which probably contains somewhere about 0·5% of this element.

YOUNDEGIN III and MOORANOPPIN II.

With notes on Youndegin I–VIII, Mount Stirling, and Mooranoppin I.

Siderite (Og–Ogg), several large masses, first found 1884.

Amongst the earliest meteorites recorded in Western Australia were Youndegin I–IV (1884), Mount Stirling (1892), and Mooranoppin I (1893). Apparently most of these were originally found by aborigines on the outskirts of settlement at that time, some distance to the east of York, then the nearest town. Different fragments of the one or more falls passed into the hands of various white people.

They were all holosiderites with broad to very broad kamacite lamellae of the classes Og–Ogg, several with one or more ragged edges. All had similar chemical compositions, whilst each contained a notable number of tablets and grains of cohenite, with very little troilite. Four analyses of them are available (p. 167).

The Youndegin meteorite was found, not at the old Youndegin police post, then on the outskirts of civilization, but just north-west of Pikaring Rock,[1] a granite island-hill, 30 miles to the south-east (see map, text-fig. 1). It has become quite famous because of its size and the presence

[1] Mentioned by L. Fletcher (1887) as Penkarring Rock; and this form was used by E. Cohen (1894) and A. Brezina (1896) for the name of the meteorite. On old maps various other spellings appear.—(Ed.)

	Youndegin. I.	Youndegin. III.	Mt. Stirling.	Mooranoppin I.
Fe	92·67	91·67	92·08	90·82
Ni	6·46	7·01	6·72	7·21
Co	0·55	0·93	0·81	0·88
Cu	trace	0·02	nil	nil
Mn	—	nil	nil	nil
Mg	0·42	nil	nil	nil
P	0·24	0·30	0·17	0·42
S	nil	trace	0·06	nil
C combined	—	0·15	0·24	0·67
C free ...	0·04	nil	trace	nil
Si	nil	0·01	0·01	0·01
Total ...	100·38	100·09	100·09	100·01
Analyst ...	L. Fletcher[1]	H. Bowley[2]	H. Bowley[2]	H. Bowley[2]

[1] L. Fletcher, Min. Mag., 1887, vol. 7, p. 125.
[2] E. S. Simpson, Bull. Geol. Surv. W. Austr., 1916, no. 67, p. 136.

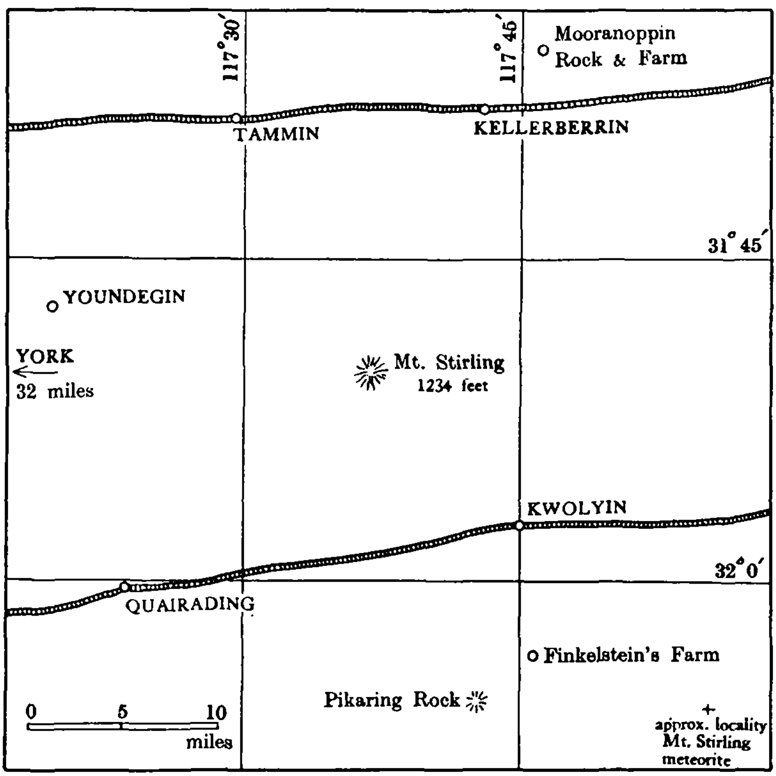


FIG. 1. Sketch-map showing places from which the Youndegin, Mooranoppin, and Mount Stirling meteorites were reported.

in it of cliftonite, a peculiar pseudomorphous form of graphite. In consequence a considerable literature has grown up around it. Originally weighing well over one ton, it apparently burst just before reaching the ground, scattering dozens of fragments over an area of about 10 square miles. Of these the most important pieces found up to the present are:

Youndegin fragments.

Serial no.	Date found.	Finder.	Weight. lb.	kg.	Resting place.
I.	1884	A. Eaton	25¾	11·7	British Museum.
II.	,,	,,	24	10·9	Melbourne Museum.
III.	,,	,,	17½	7·9	Perth Museum.
IV.	,,	,,	6	2·7	British Museum.
V.	1891	L. Knoop	382½	173·5	Ward-Coonley collection.
VI.	1892	,,	2,044	927·0	Vienna Museum.
VII.	1929	— Finkelstein	9	4·1	E. S. Simpson's collection.
VIII.	1891–1929	Knoop and others	30±	14±	Many fragments in private hands.

One piece was made into a horseshoe and hung for many years in a blacksmith's shop at York.

Through the courtesy of the Western Australian Museum Trustees I have been enabled to examine Youndegin III. Three cuts across it were made by means of a circular machine-saw with a blade one-eighth inch thick. The iron, like that of Youndegin I, was very hard to cut, 10 hours being occupied in making the three cuts, each of about 9 square inches. In filing the surfaces, too, the files were rapidly blunted. This hardness was traced to two constitutents, viz. cohenite and a hard, probably carbon-bearing, variety of kamacite forming about one-quarter of the whole. The distribution of the two types of kamacite was rendered visible by the filing. Widmanstetter figures were produced readily by etching with $2E$ HNO_3 (i.e. approx. $2N$ HNO_3) in which some meteorite filings had been dissolved. A very coarse octahedral texture was brought out with plates of kamacite 0·5–6·0 mm. wide possessing a marked schiller (fig. 12, pl. IX). The hard variety of kamacite is in groups of plates of average size. Cohenite is an important constituent, very irregularly distributed as rather thick tablets and ragged grains. Several large inclusions of it are shown in the accompanying figure (fig. 12); one particularly large one, like a hand with index-finger extended, appears on the upper side towards the left. Two long thin slabs of cohenite are just below it, and two other pieces are near the centre of the lower edge. H. Bowley's analysis shows 0·15% of combined carbon in a sample of saw cuttings of Youndegin III, and A. Brezina describes 'ribs of cohenite' in Youndegin VI, though Fletcher found free carbon (cliftonite), but no combined carbon, in his analysis of Youndegin I. No cliftonite was observed in Youndegin III, but there was a little graphite in the centre of the largest mass of cohenite. Troilite was not seen in any of the sections of it, nor were any characteristic cavities left on the surface by its burning out. Schreibersite is evenly distributed over the etched surfaces as small irregular plates, usually along the junction of two kamacite lamellae, but at times completely embedded in one. The maximum length and thickness are $5 \times 0{\cdot}5$ mm. H. Bowley's analysis of this fragment of Youndegin III is given above. A minute trace of platinum was detected in it, but no iridium or gold.

Youndegin VII (found on Finkelstein's farm) measures $9 \times 5 \times 3$ inches ($23 \times 12 \times 7{\cdot}5$ cm.). It is deeply eroded and has one long ragged edge where the fragment has been torn from its parent when the pitting had eaten almost entirely through from either side. No characteristic troilite drill holes or hemispherical pits are seen on the surface, nor is troilite exposed in a small section ($6 \times 4{\cdot}5$ cm.). Etching reveals some cohenite, and the very broad plates of schillerized kamacite characteristic of this fall. A damascene structure is seen crossing the kamacite plates; cf. Fletcher's original description of Youndegin I.

The main Mount Stirling meteorite of 200 lb. (90·7 kg.), now in the Sydney Museum, is recorded as having been found 25 miles (probably by cart track) south-east of the mount. Pikaring Rock is 19 miles in a direct line SSE. of Mount Stirling. A second small piece of 14¾ oz. (0·42 kg.) was found in the same locality, and is also in the Australian Museum, Sydney. A fragment from the larger piece was analysed by H. Bowley with the results given in the table above. They closely resemble those for Youndegin I and III. Mount Stirling has an octahedral structure with very broad lamellae, 0·5–4·0 mm. Taenite partings are narrow and not usually complete over the whole length of the kamacite blades. Small areas of eutectic are not uncommon. The kamacite plates have a pronounced schiller appearing in a different set at every rotation of 120°. On the polished section of a small specimen in the Western Australian Geological Survey collection, there is no troilite, but three typical masses of cohenite, the largest 5×2 mm. Schreibersite is not plentiful, and lies mostly between the kamacite blades, rarely embedded in them or in the eutectic. The resemblance of this meteorite to Youndegin is very close, and in view of the description given of the locality, there is no doubt that both pieces of Mount Stirling are portions of the Youndegin fall.

Mooranoppin Rock and Farm are 34 miles north of Pikaring Rock, and it is related that the original Mooranoppin meteorite was brought into the farm about 1893 by an aborigine, who had found it in the unoccupied bush somewhere to the south. It later became part of the Ward-Coonley collection. The resemblance both in structure and composition between it and known parts of Youndegin, strongly suggest that it is another fragment of the same fall. Some very beautiful cohenite is visible in sections of this meteorite (fig. 11, pl. IX). Cohenite is easily recognized by its hardness, brilliant lustre, slightly golden tarnish, and minutely pitted surface produced during polishing owing to its brittleness.

About five years ago the writer was given by the present owner of the Mooranoppin estate, Mr. R. Maitland Leake, a second meteorite, which had been at the homestead for very many years. He believed that it was brought there about the same time and from the same place as Mooranoppin I. This is an angular rhomboid iron, remarkably free from pitting, and completely coated with an unusually thick oxidized crust, fragments of which are still continually flaking off. It weighed 1 lb. 13 oz. (0·82 kg.). This I propose to call Mooranoppin II. On etching a small slice off one end, the kamacite lamellae were found to be very broad (2–4 mm.), whilst cohenite was prominent, and troilite absent. These features serve to link it with Mooranoppin I and the other fragments of the Youndegin fall.

List of Meteorites Recorded from Western Australia.

1892. Ballinoo. Off.
1930. Bencubbin. M.
1923. Dalgaranga. Om.
1932. Dowerin. Siderite.
1930. Gundaring. Og–Ogg.
1894. Hamersley Range (syn. Roebourne). Om.
1937. Kumerina. Of.
1919. Lake Brown. Ci.
1931. Landor. Of.
1932. Mellenbye. Cw.
1921. Milly-Milly. Om.
1893. Mooranoppin. Og–Ogg. Probably part of Youndegin.
1909. Mount Dooling. Om.
1913. Mount Edith. Om.
1916. Mount Magnet (East Mount Magnet). Off–Ogg or Offb.
1892. Mount Stirling. Og–Ogg. Probably part of Youndegin.
1925. Murchison Downs. Of.
1915. Naretha. C.
1902. Nuleri. Om.
1911. Premier Downs. Om.
1922. Tieraco Creek. Of–Om.
1937. Wonyulgunna. Om.
1937. Yalgoo. Cw.
1917. Youanmi. Om.
1884. Youndegin. Og–Ogg.

The dates given are those when the meteorite was seen to fall, or was first found or first known to science.

Explanation of Plates VI–IX.

Western Australian meteorites.

Photographs by E. S. Simpson (figs. 1, 5, 7, 12), F. E. Chapman (figs. 2, 6, 8, 9, 10, 13), B. L. Southern (figs. 3, 4, 14), and H. Bowley (fig. 11).

Plate VI, Fig. 1. Gundaring. Whole mass. $\times \frac{1}{7}$.

— Fig. 2. Gundaring. Etched section, showing regular structure, some large bulbous kamacite, a nodule of troilite, and large areas of eutectic (plessite). $\times \frac{1}{2}$.

— Fig. 3. Kumerina. Whole mass; one end not eroded. $\times \frac{1}{5}$.

— Fig. 4. Kumerina. Etched section. Much of the kamacite is lenticular in form. A mass of cohenite is surrounded by broad kamacite. $\times 13$.

— Fig. 5. Milly-Milly. Whole mass. $\times \frac{1}{4}$.

— Fig. 6. Milly-Milly. Etched section. The kamacite bands show an oriented schiller. $\times \frac{3}{4}$.

Plate VII, Fig. 7. Wonyulgunna. Whole mass, showing tubes (one penetrating the mass) and small deep pits left by burning out of troilite. $\times \frac{2}{7}$.

— Fig. 8. Wonyulgunna. Etched section showing cross-section of rod of troilite. Cohenite is present but not distinctly shown in the photograph. British Museum Collection. $\times \frac{3}{4}$.

— Fig. 9. Wonyulgunna. Etched section. Natural size.

Plate VIII, Fig. 10. Wonyulgunna. Etched section, the same as in fig. 9. Large areas of eutectic (plessite) with small secondary plates of kamacite. Cohenite (black speckled) abundant as slabs, tablets, and grains. Kamacite in places very broad and bulbous (enclosing grains of cohenite). $\times 3$.

Plate IX, Fig. 11. Mooranoppin I. Etched section. Three large masses of cohenite, one club-shaped. $\times 15$.

— Fig. 12. Youndegin III. Etched section. Strong schiller in kamacite. Cohenite; large mass on upper left, two 'ribs' below, and two smaller masses at lower right centre. $\times \frac{3}{4}$.

— Fig. 13. Youanmi. Etched section, with cross-section of rod of troilite. The kamacite pattern shows more distinctly in the photograph than in the specimen. $\times \frac{11}{10}$.

— Fig. 14. Youanmi. Etched section. Flecking of kamacite. Ragged plates of schreibersite. $\times 15$.

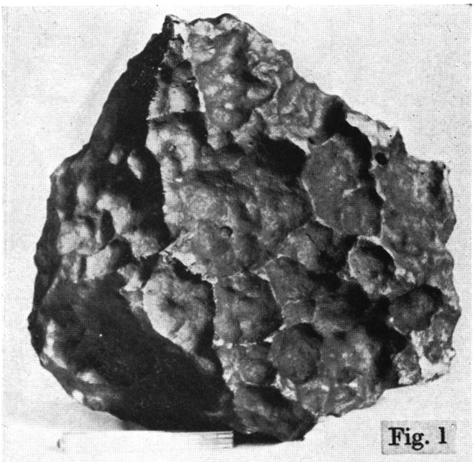
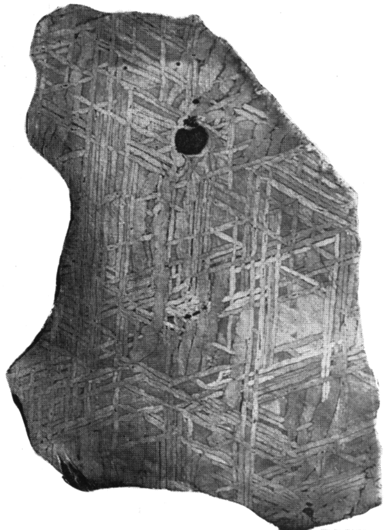


Fig. 1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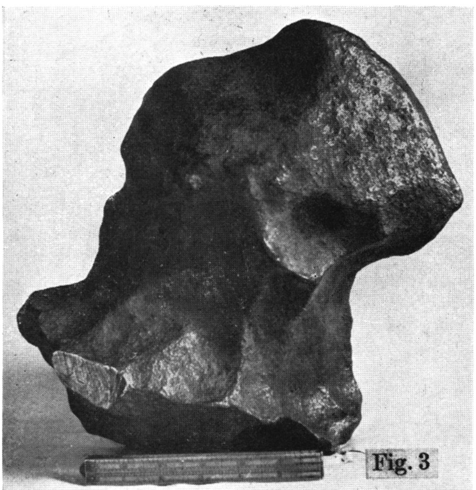


Fig. 3


Fig. 4

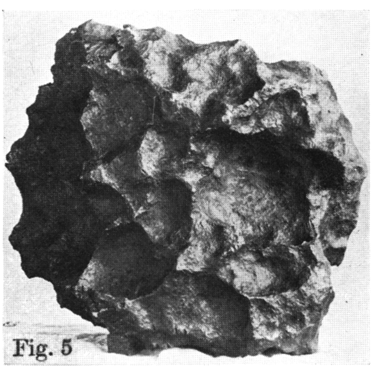


Fig. 5

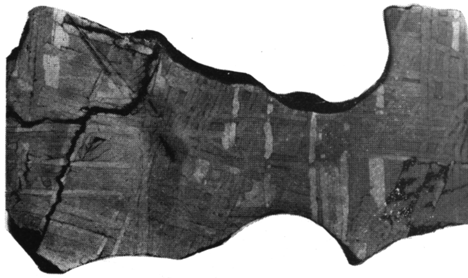


Fig. 6

E. S. SIMPSON · GUNDARING, KUMERINA, AND MILLY-MILLY METEORITES

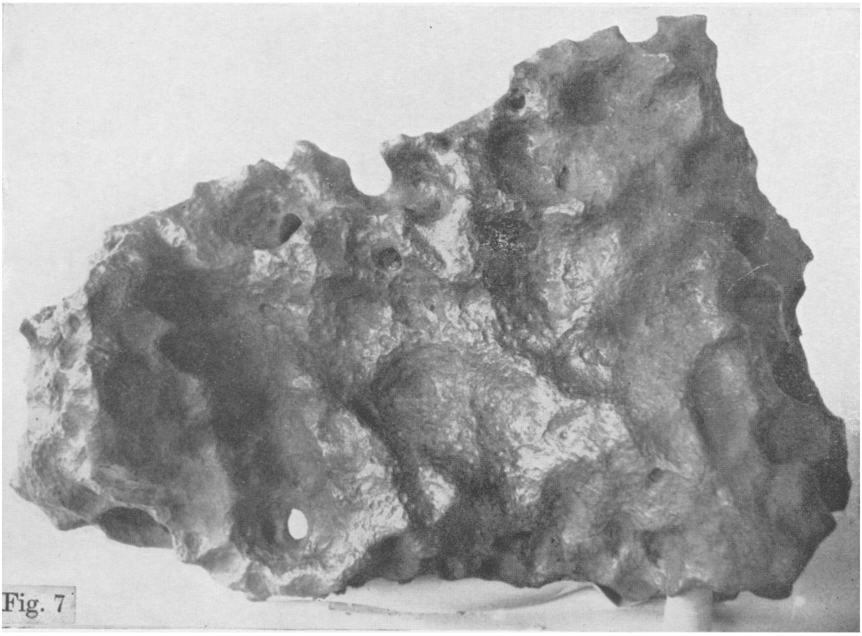


Fig. 7

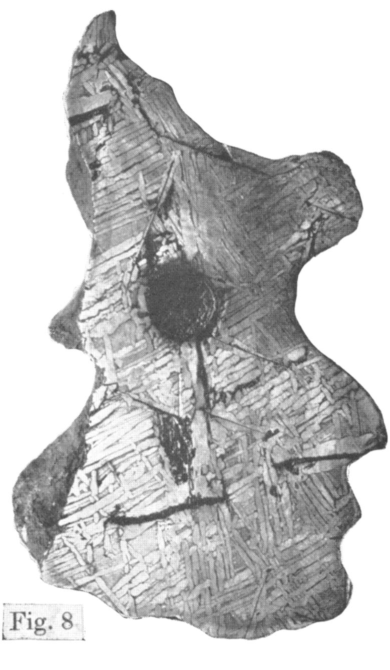


Fig. 8

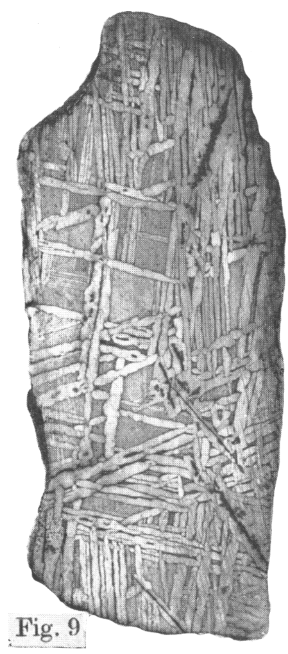
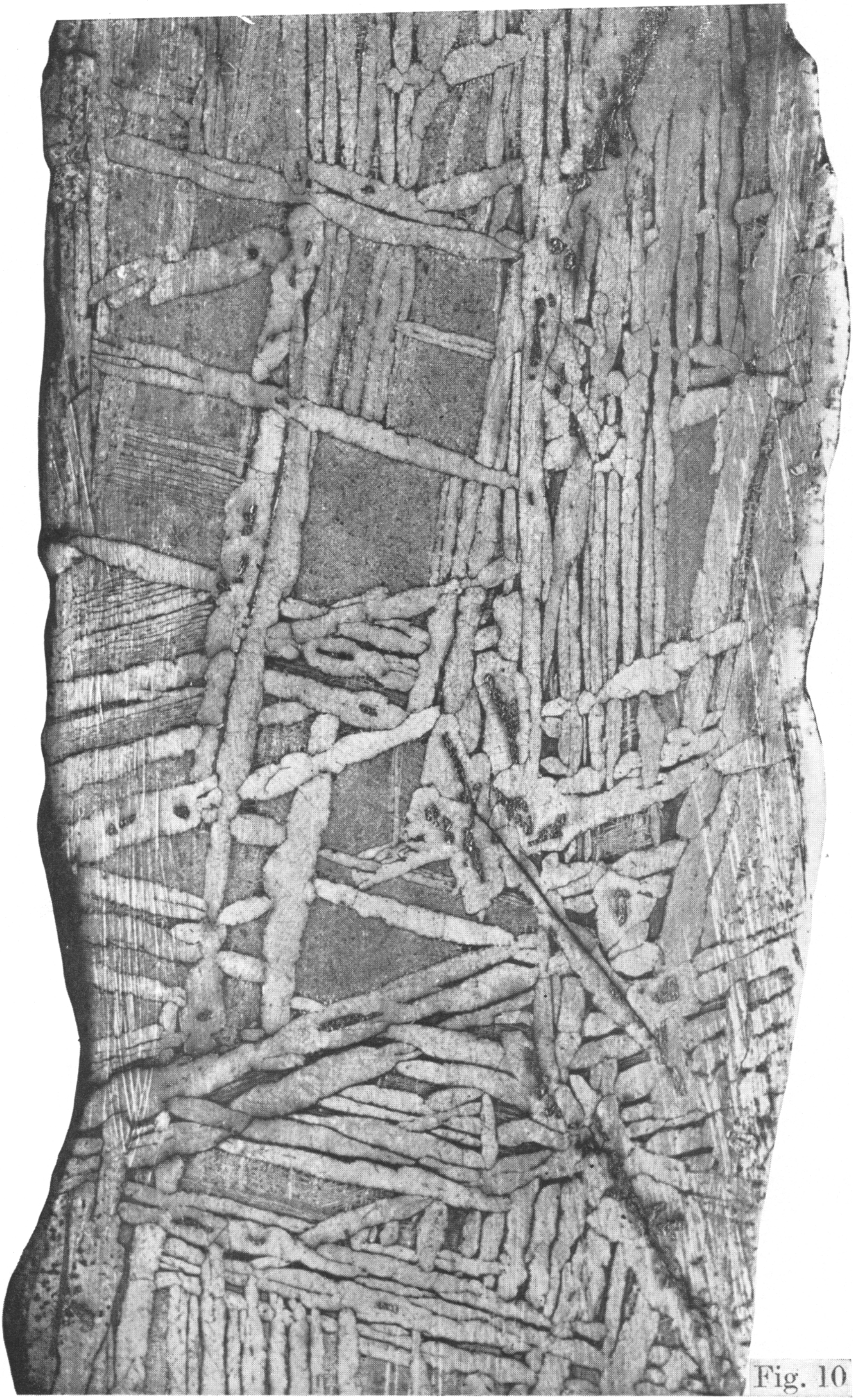


Fig. 9

E. S. SIMPSON : WONYULGUNNA METEORITE



E. S. SIMPSON : WONYULGUNNA METEORITE

Fig. 11

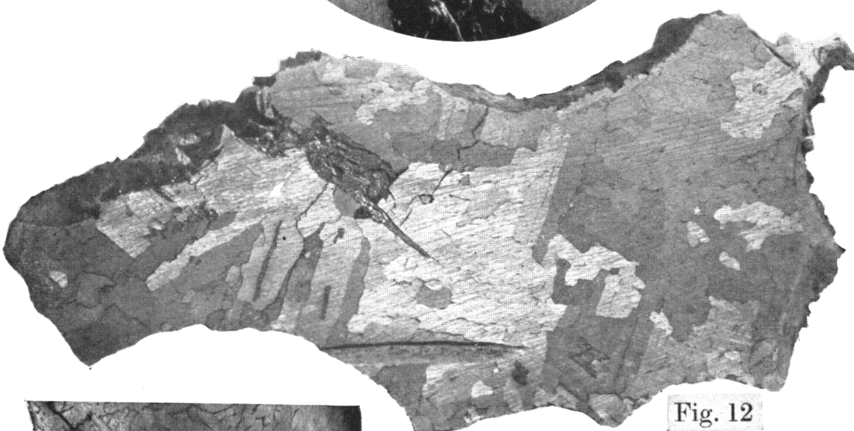


Fig. 12

Fig. 13

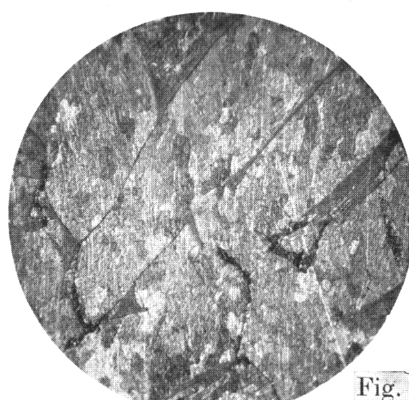


Fig. 14

E. S. SIMPSON : MOORANOPPIN, YOUNDEGIN, AND YOUANMI METEORITES