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Catalogue of Western Australian Meteorite Collections

Volume I

IRONS, STONY-IRONS AND STONES

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Preface

The Meteorite Collection of the Western Australian Museum is a small one but, because it has been made from a part of the earth's surface which has not been extensively collected, it is of great scientific interest. Accordingly, this Catalogue by Dr. McCall and Mr. de Laeter is very welcome, particularly since no list of meteorites in the Western Australian Museum has been published since those in Bernard Woodward's *Guides to the Museum* in 1900 and 1912.

Knowledge of meteorites in Western Australia stems from the discovery of several large lumps of meteoritic iron in the 1880's and 1890's when agriculture was pushing out into the fringes of the original York settlement towards the East. These, of which the first appears to have been brought in during 1884, were called the "Youndegin Meteorites" after a police post which was the last out-post of civilization at the time; they were actually collected near Pikaring Rock in what is now the well-populated Quairading area. It may be safely assumed that these were the first meteorites to come into the collection. They are octahedrites, chiefly interesting because of the unusual abundance of the rare mineral cohenite.

This was the first milestone in the history of these collections. Others that may be mentioned were the discovery of the Ballinoo meteorite in 1892, important because it was found to be an octahedrite of extreme rarity displaying a very fine etch pattern; the discovery in 1916 of another meteorite of the same rare type at Mount Magnet; the discovery of the unique Bencubbin stony-iron meteorite in 1930, which was followed by a second find in 1959—no other meteorites of this type, or anything approaching this type, have been recorded in any part of the world. Another event of recent years was the fall of a stony meteorite at Woolgorong Station on the Murchison in 1960, both because the recovery of this stone allowed a most interesting study of atmospheric ablation producing orientation characteristics, and also because this fall revived interest in meteorites in Western Australia. The most recent, and by no means least significant, increment to our knowledge occurred as late as 1963 when the Mount Egerton meteorite, originally found in 1941 and recorded as a stone of very unusual type, was rediscovered after more than a year's fruitless search. It was found to be a stony-iron meteorite of a type hitherto unknown—again a unique find.

The discoveries of probable meteorite craters must also be significant, for only a handful of occurrences of such craters of any dimensions are known throughout the world and two have been discovered in Western Australia. The Dalgaranga crater was recorded by E. S. Simpson in 1938 but relatively little was known of it until H. H. Nininger and G. I. Huss introduced the details of this occurrence to the scientific world. The much larger Wolf Creek crater, comparable with the world-famous Arizona crater and the lesser-known, analogous craters of Quebec and Algeria, eluded discovery until 1947. In spite of general accounts by F. Reeves & R. O. Chalmers and by D. J. Guppy & R. S. Matheson and further discussions by W. Cassidy, L. LaPaz and G. J. H. McCall it remains a regrettable fact that, as in the case of the smaller Dalgaranga crater, the problems posed by this enigmatic crater must be considered as yet largely untouched because of lack of funds.

The fact that we have such a collection of meteorites of world-wide significance must be largely attributed to the interest and continuing scientific work of a very high standard by the late Government Mineralogist, Dr. E. S.

Simpson. His publications, extending from the early part of this century to the years immediately preceding the second world war, form the backbone of this Catalogue and, in addition, his own personal collection containing many of the specimens figured by him, was passed to the Western Australian Museum on his death and forms an important section of the collection in the Museum.

We now present this Catalogue. In it, all information relating to Western Australian meteorites is brought up to date ; errors which have crept into the literature through the imprecise naming of past falls have been traced, and for this reason it is hoped that the Catalogue will eliminate confusion ; finally it not only lists meteorites but it reviews all relevant work relating to our specimens as well. The authors and I hope that it will be of real use to workers in this field.

W. D. L. RIDE,
Director.

Western Australian Museum,
April, 1964.

Introduction

This catalogue has been prepared to overcome the lack of unified coverage of the various important meteorite collections in Western Australia and because of increasing interest in the scientific study of meteorites at the present time. The catalogue covers the principal collection, that of the Museum, which also includes a large number of specimens on permanent loan from the Geological Survey of Western Australia. Various other minor collections in the State have, however, also been included, to provide as complete coverage as possible. The most important information in this catalogue is that concerning Western Australian finds and falls, but specimens in the collections from other parts of Australia and from countries outside Australia have been given brief entries. Australites and other varieties of tektites have not been included since it is intended to publish a second volume of this catalogue dealing specifically with the substantial and very important australite collections held in this State.

A brief history of the collections is given and the basis for classifications used in this catalogue and to be used in any future supplements to this catalogue is fully recorded. The section dealing with detailed information about the individual meteorites is prepared on an alphabetical basis according to the names of the various meteorites. References are given in this section to mentions in the literature and, for convenience, a separate list of general references is included (p. 17). The detailed information concerns only the Western Australian finds or falls and only in these cases are references to the literature given. The reader interested in obtaining further information concerning other meteorites in this catalogue should refer to either the Catalogue of Australian Meteorites (Hodge-Smith 1939) or to the British Museum Catalogue (Prior and Hey 1953).

The map (Fig. 1) shows the locations of all Western Australian finds, falls and possible impact craters known at the time of writing (August 1963), but one or two of these entries are not as closely defined with respect to location as could be wished.

NOMENCLATURE

A list of synonyms which have, from time to time, been used for Western Australian meteorite finds and falls included in this catalogue is given on p. 63. It has been the endeavour of the authors to use the name most widely accepted in the literature and as far as possible to restrict the use of number I, II, etc., as suffixes to groups of several specimens reasonably believed to stem from a single fall. The usage in Western Australia has, however, been to some extent unsystematic : for example the adoption of the name " Youndegin " for a series of iron meteorites which has no real basis for association with the Youndegin locality, situated to the east of York. In addition, some specimens which appear to derive from the same fall have previously been given new locational names, not numerical suffixes—e.g. Mooranoppin and Mount Stirling—almost certainly part of the Youndegin fall. It has been decided to use new names for any new finds which have been made in this neighbourhood subsequent to the eight " Youndegin " finds listed by Simpson (1938), because of the irrelevance of the name " Youndegin." Thus the very large meteorite recovered from the same locality since that time has been termed the Quairading meteorite, but is in all probability (considering mineralogical similarities) part of the same fall. The names Mooranoppin I and II have been abandoned, all specimens from Mooranoppin (which in any case are of very doubtful locational provenance) being now listed together. The names Mount Edith I and II, and Premier Downs I, II and III are retained since this subdivision by means of suffixes follows the standard usage. Bencubbin II, a recent find, is termed (in suffix) the North Mandiga meteorite, and the original Bencubbin find is now termed Bencubbin I, the South Mandiga meteorite, since these suffixes help to more closely define these unique finds. The meteorite previously called Ashburton Downs (and so listed by Nininger) is now known to be, almost certainly, part of the Dalgety Downs find, and is referred to here as Dalgety Downs I, the very substantial later find of Mason and Henderson (p. 31) being referred to as Dalgety Downs II.

DETAILS INCORPORATED

Data given for each meteorite in this catalogue may include :—

(i) The name by which it is usually known, chief synonyms, locality including latitude or longitude (noting where this is only known within approximate limits). The geographical co-ordinates given refer to the locality described in the text, and were obtained by locating the description on the "10 mile Series"* and obtaining the co-ordinates of this.

(ii) Date and details of fall or find.

(iii) Donor, if any, of Museum specimens.

(iv) Details of classification.

(v) Details of the specimen or specimens which represent each item in the Western Australian collections. The weights given for the various masses are taken from the literature except for those in the Western Australian collections which have been reweighed. Metric units have been used throughout, but where the weight has been converted from the British System, the equivalent British unit is given in brackets.

(vi) Details of known representations in other collections. Information was initially obtained from Prior and Hey (1953), except that details of the masses of meteorites in the Australian Museum, Sydney, are taken from Hodge-Smith (1939).

(vii) References to the literature.

(viii) Analytical and other details : all nickel-iron percentages are expressed by means of the percentage of nickel ; the molecular ratio of MgO/FeO in the silicates is given as magnesium/iron ratio. Olivine in stones has in certain cases been identified by Dr. B. Mason of the American Museum of Natural History using X-ray diffraction (by the method of Yoder and Sahama 1957) and optical methods, and in the case of these meteorites a fayalite index (Fa) is given.

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* Department of Lands and Surveys, Perth, Western Australia. Ten Miles to One Inch Topographical Series. (Natural Scale 1 : 633,600.)

CLASSIFICATION

The classification system adopted* is :—

Basis : proportion of nickel-iron and stony material	I—IRONS (siderites)—consist mainly of nickel-iron.
	II—STONY-IRONS (siderolites)—consist of nickel-iron and stony material, both in substantial amounts.
	III—STONES (aerolites)—stony material is predominant.

The last group (III) is further subdivided :—

III—STONES (i) chondrites—those stony meteorites which evince chondritic structure. Chondrules are rounded, ellipsoidal or angular insets of stony or metallic material. Chondrites include both unaltered types, in which glass (or isotropic material generally considered to be glass) is evident, and recrystallized types in which the glass has been partly or completely lost and the earlier formed minerals tend to recrystallize to inequigranular crystalline aggregates, in which the form of the chondrules may be only faintly recognisable. Chondrules may have excentro-radial (fan-shaped), grated, or micro-porphyritic growth pattern. They may be monosomatic (formed of a single crystal) or polysomatic (formed of several crystals).

III—STONES (ii) achondrites—those stony meteorites which evince no chondritic structure (this seems to be the strict definition but some authorities accept rare chondrules within achondrites, and there seems to be no clearly defined line of distinction drawn between calcium-poor achondrites (p. 16) and chondrites).

MAJOR METEORITE GROUPS

I—IRONS

These are divided into five classes on the basis of etch-patterns developed and nickel-iron ratios.

†(a) Nickel-poor ataxites (D)—nickel less than 6% ; no etch-pattern developed ; entirely composed of kamacite.

(b) Hexahedrites (H)—nickel less than 6% ; intersecting patterns of fine lines (Neumann lines) appear on etching ; almost wholly composed of kamacite, with some schreibersite and daubreelite, commonly present. Granular (recrystallized) hexahedrites are given the symbol (Hb).

(c) Octahedrites (O)—nickel content ranges from 7–14% ; etching reveals octahedral lamellar patterns due to intergrowths of α and γ forms of nickel-iron (kamacite and taenite) with interstitial plessite (a form of eutectoid).

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* The system used here is adapted from that of Prior and Hey (1953) following revisions suggested by Mason (1962).

† E. P. Henderson (verb. comm.) suggests these are only heated zones in hexahedrites, and that nickel-poor ataxites do not form a valid subdivision of the iron meteorites (see also Perry 1944).

There is a sub-classification of the octahedrites (which comprise by far the most common group of irons); this is based on the width of the kamacite lamellae (broadly correlatable with nickel-iron ratio).

Coarsest octahedrites (Ogg)—lamellae greater than 2·5 mm. thick; 6–8% nickel.

Coarse octahedrites (Og)—lamellae 1·5–2·5 mm. thick.

Medium octahedrites (Om)—lamellae 0·5–1·5 mm. thick; 7–9% nickel.

Fine octahedrites (Of)—lamellae 0·2–0·5 mm. thick.

Finest octahedrites (Off)—lamellae less than 0·2 mm. thick; 8–13% nickel.

There is a slight difference between the limiting dimensions stated by Perry (1944), Prior and Hey (1953) and Krinov (1960); the usage of Perry and Krinov is preferred here as being slightly more logical.

Lovering and his co-authors (1957) have proposed a simpler threefold classification of octahedrites, eliminating the coarsest and finest types (Og, greater than 2 mm.; Om, 0·5–2 mm.; Of, less than 0·5 mm.). While this simplification introduces a welcome revision, the authors have repeated the older usage of Rose (1862), Tschermak (1872, 1883), and Brezina (1904) where it has been applied by E. S. Simpson and others, in previous descriptions of Western Australian meteorites.

(d) Ataxites (D)—this is a group of structureless irons separated by Prior and Hey (1953) from other ataxites; these have the same nickel percentages as octahedrites and appear to be thermally-altered (recrystallized) octahedrites (metabollites).

(e) Nickel-rich ataxites (D)—show no lamellar etch-patterns; nickel 9–20% usual, but rare cases of nickel contents up to 60% are recorded. Consist predominately of plessite (or taenite with subordinate kamacite in the form of small inclusions, where nickel is less than 25%).

II—Stony-Irons

These are divided on the basis of mineralogical composition.

(a) Pallasites (P)—olivine stony-irons. Iron commonly shows Widmanstatten patterns.

(b) Siderophyre (Si)—bronzite-tridymite* stony-iron (Mg/Fe ratio about 5 in bronzite; Fe/Ni ratio about 9 in nickel-iron). (Unique.)

(c) Lodranite (Lo)—bronzite-olivine stony-iron, closely related to ureilites (see p. 16, achondrites); (olivine and bronzite both poor in FeO). (Unique.)

(d) Mesosiderites (M)—consist of hypersthene, clinohypersthene and anorthite; olivine is usually present as sparse, separate enclosures. Nickel-iron = Ni 7%. Widmanstatten patterns seen only in large nodules.

* A form commonly referred to as asmanite.

The stony-iron meteorites are mainly classified on the basis of mineral composition but some authorities attempt to add a textural basis ; it has been found that this is somewhat conflicting in the case of the mesosiderites (Hodge-Smith 1939 ; Krinov 1960) and in this catalogue no textural restrictions are used.

Some stony-irons do not seem to fit into any of the four divisions listed above (e.g. Bencubbin I, Lovering in Moore 1962, p. 190 ; Mason 1962a, p. 129) and for these a new class is proposed :

(e) Stony-irons, mixed meteorites (Mm).

III—STONES—(i) chondrites.

These were originally classified by Rose (1862), Tschermak (1872, 1883) and Brezina (1904) on the basis of the molecular ratio MgO to FeO in the pyroxene, hence the names enstatite-, bronzite-, and hypersthene-chondrites. Prior (1922), however, proposed an alternative classification based on the molecular ratio MgO/FeO in the silicate phase taken in bulk. The Prior system is preferable, but some aerolites in the collections covered by this catalogue have been classified according to entries in other catalogues, not based on chemical analyses, using the Rose-Tschermak-Brezina classification. It is noted that the Fe/Ni ratio in the metal phase is roughly correlated with the ratio used as a basis of the Prior classification, but it is the latter which is the important ratio. This ratio can also be correlated with the fayalite index of the olivine, and, identification of the olivine does, perhaps, most satisfactorily fix the position of the stone in Prior's classification (Mason 1962a, p. 72). Prior's three classes are :

(a) Enstatite-chondrites (Cen) ; (MgO/FeO greater than 9).

(b) Olivine-bronzite-chondrites (Cbr) ; (MgO/FeO 9–4).

(c) Olivine-hypersthene-chondrites (Chy) ; (MgO/FeO 4–2).

The usual mineralogical components of the chondrites are :

Enstatite-chondrites :—

enstatite Fs_0*, 50–60 %, clinoenstatite and oligoclase, 5–10 %, plus nickel-iron, 20–28 %, Fe/Ni 13 and over, troilite 7–15 %. Specific Gravity, 3·45–3·66.

Olivine-bronzite-chondrites :—

bronzite Fs_{14-20}, 20–35 %, clinobronzite and olivine Fa_{15-22}‡, 25–40 %, oligoclase, 5–10 %, and nickel-iron, 16–21 %, Fe/Ni 13–8, troilite, 5 %. Specific Gravity, 3·6–3·8.

Olivine-hypersthene-chondrites :—

hypersthene Fs_{20-30}, 25–35 %, clinohypersthene and olivine Fa_{22-32}, 35–60 %, with oligoclase, 5–10 %, and nickel-iron, 1–10 %, troilite, 5 %. Specific Gravity, 3·5–3·6.

However, the mineralogical composition may not exactly correspond with this, if the Prior classification is used, because olivine and pyroxene which are both present in the bronzite- and hypersthene-chondrites take up different proportions of magnesian and iron oxides. The three classes separated by Prior

* Fs = mol. per cent. $FeSiO_3$

‡ Fa = mol. per cent. Fe_2SiO_4

are not parts of a chemically gradational series. They represent three distinct chemical divisions separated by hiatuses, the hiatus between enstatite- and olivine-bronzite-chondrites being particularly marked.

Two further classes of chondrites are distinguished by Mason (1962) who has modified Prior's classification—these rare groups were formerly included by Prior in the olivine-bronzite-chondrites. They are :—

(d) Olivine-pigeonite-chondrites (Cp)—consist of olivine Fa $_{32-40}$, nickel-iron, less than 6%, pigeonite, 5%, oligoclase, 5–10%, troilite, 5%. Specific Gravity, 3·4–3·6.

(e) Carbonaceous chondrites (C)—may or may not contain olivine chondrules in a dense carbonaceous groundmass composed of serpentine or amorphous hydrated silicate. Specific Gravity 2·2–2·9.

The Rose-Tschermak-Brezina system (*op. cit.*) made use of the following distinctions in the case of each of the subdivisions—

mineralogy :
enstatite-, hypersthene-, and bronzite-chondrites (based on pyroxene present)

colour :
white, intermediate, grey, or black

structure :
crystalline, spherical, brecciated, veined

composition :
whether carbonaceous or not.

The last three groups of terms are entirely applicable to the more modern Prior-Mason classification used here.

III—Stones—(ii) achondrites.

There are two principal achondrite subdivisions, made on the basis of calcium content and these were originally further subdivided according to mineralogy. The basis of classification used by Prior can be broadly applied to the calcium-poor achondrites in the same manner as it is to the chondrites.

(a) Calcium-poor achondrites—

(1) Aubrites (Au)—enstatite-achondrites corresponding in composition to enstatite-chondrites. Most are brecciated.

(2) Diogenites (Di)—hypersthene-achondrites broadly corresponding in composition to olivine-hypersthene-chondrites, though the hiatus between these and enstatite-achondrites is even more marked, and calcic plagioclase (bytownite) may be present as an accessory.

(3) Ureilites (U)—pigeonite-olivine-achondrites, compositionally similar to olivine-hypersthene-chondrites.

(4) Chassignites (Cha)—olivine-achondrites compositionally similar to olivine-pigeonite-chondrites (possibly a recrystallized form of the same).

(b) Calcium rich achondrites—

(1) Angrite (An)—augite-achondrite consists of augite (calcium-rich, FeO rich and titaniferous) with some olivine and troilite.

(2) Nakhlites (Nk)—diopside-olivine-achondrites with a crystalline granular structure. Olivine is near to hortonolite and felspar nearer to oligoclase than to anorthite.

(3) Eucrites (Eu)—clinohypersthene-anorthite-achondrites with a doleritic or " basaltic " structure. Sherghottites (She)—eucrites with anorthite replaced by maskelynite (due to shock).

(4) Howardites (Ho)—hypersthene-clinohypersthene-anorthite-achondrites, structure generally brecciated.

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Part I—Western Australian Meteorites

STATISTICAL DETAILS

In comparison with the 1,700 meteorites recorded in the latest assessments of world statistics (e.g. Mason 1962) some 48 separate occurrences are listed from this State. However among these are included groups of meteorites believed to come from the same meteorite arrivals: for example, the two Mt. Edith irons, the Youndegin, Mt. Stirling, Mooranoppin and Quairading irons, the two Bencubbin stony-irons, the Yalgoo and Mellenbye stones. Premier Downs and Loongana Station may well come from one meteorite arrival and the small Nullarbor Plain stones also seem to represent a prolific scatter in a single arrival (though Rawlinna apparently represents a separate event). Thus the number of distinct meteorite arrivals represented is probably not more than about 37. It is strange that so few observed falls have resulted in recovery (one certain, two doubtful) but this is probably due to the sparse population of the State. No less than 13 or 14 finds of stony meteorites have been made, a very high proportion considering that only some 35% of the total stony meteorite recoveries come from finds (Mason 1962, p. 3). The statistics of the meteorite recovery are given below in Table I:

TABLE I

		Falls	Finds
Irons	29	1	28
Stony-Irons	4	....	4
Stones	15	1	14
Shale Balls	1	....	1
Doubtful	1	....	1
Total	50	2	48

Notes on this table—

(a) The total number of stones includes one find previously listed as a Western Australian meteorite (*Loongana*, Prior and Hey 1953) but which was probably recovered from just across the South Australian border (p. 33).

(b) The total number of stones includes the *Lake Moore* meteorite which appears to be a section taken from another meteorite and erroneously considered as a separate entity (p. 37).

(c) A large iron meteorite is included in the iron meteorite category but not fully described in this text. This, the *Warburton Range* meteorite, was discovered in December 1963, or January 1964, at a point 25 miles south-west of the Warburton Mission, Western Australia. The total weight of the single mass is 56·5 kg (124½ lb.). It will be described at a later date. It is provisionally identified as a nickel-rich ataxite.

(d) A large fragmented stony-iron meteorite was recovered from the vicinity of Mt. Padbury Station on the 12th March, 1964. Five large masses and numerous small weathered masses total over 272 kg (600 lb.), the largest being 88·4 kg (195 lb.) weight. This meteorite, provisionally classified as a mesosiderite, will be described at a later date.

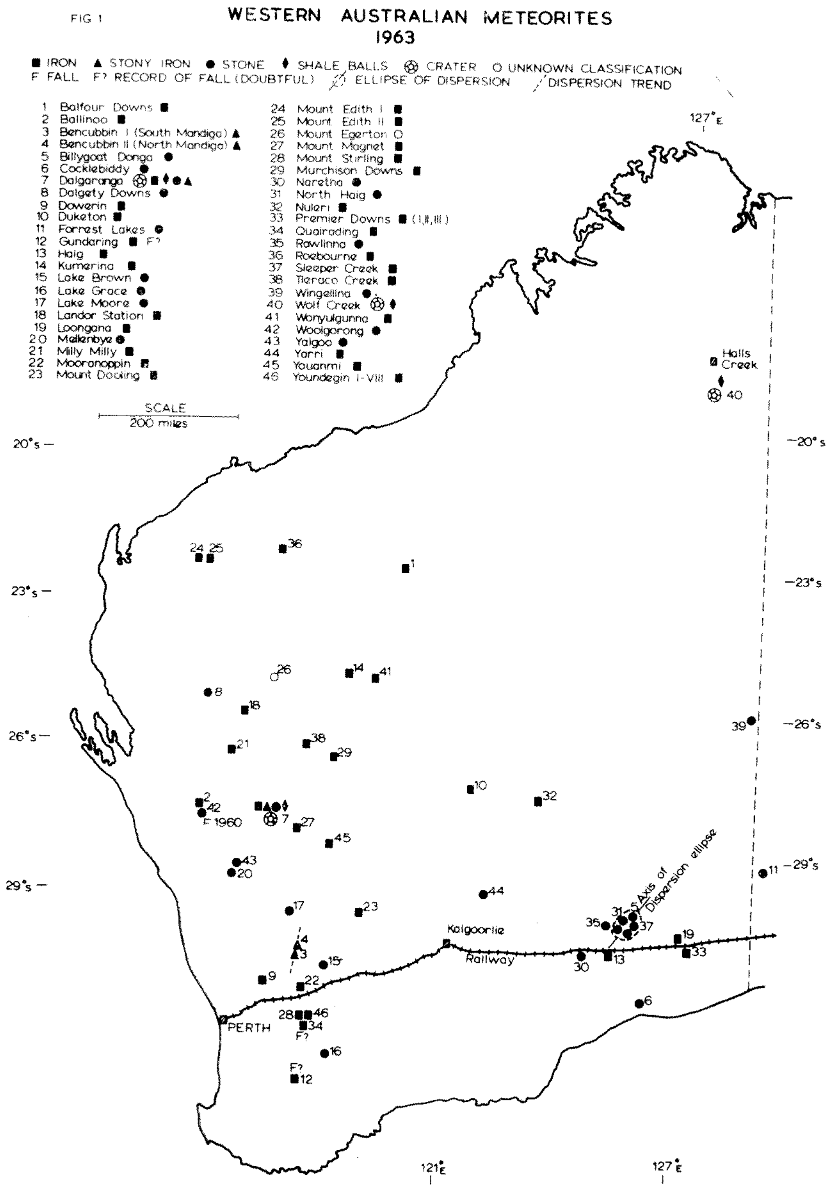

Figure 1. Map showing the location of known Western Australian finds and falls.
Note : No. 37 SLEEPER CREEK should read SLEEPER CAMP.

LIST OF METEORITES

1. **Balfour Downs** — Iron, medium octahedrite (Om)

Find, 1962, by R. N. Beresford, on Balfour Downs Station, about 50–60 miles east of Roy Hill, Western Australia. Exact position unknown but approximate latitude and longitude 22° 45′ S., 120° 50′ E.

One mass, total weight 2·4 kg (5·3 lb.).

This collection : W.A.M. No. 12279, one piece 147 g.

Other collections : American Museum of Natural History, New York, *main mass,* 2·4 kg.

(Plates VIII (c), XIV (a).)

2. **Ballinoo** — Finest octahedrite (Off)*

(Synonyms : Ballinee, Mount Erin)

Find, 1892, by G. Denmack, 10 miles south of Ballinoo, Western Australia, on a tributary of the Murchison River. Position of find given previously as latitude 28° S., longitude 116° 30′ E., but this is almost certainly erroneous. The probable position is 10 miles south of Ballinyoo Springs, latitude 27° 42′ S., longitude 115° 46′ E.

One mass, total weight 42·2 kg (93 lb.).

This collection : W.A.M. No. 1196a, one etched slice weighing 2475 g. Other collections : Field Museum of Natural History, Chicago, *main mass,* 11 kg ; American Museum of Natural History, New York, 3½ kg (3·32 kg in H) ; U.S. National Museum, Washington, 1½ kg (1266 g in H) ; Harvard University, Cambridge, Mass., 2¼ kg ; National Museum, Budapest, 327 g ; Muséum National d'Histoire Naturelle, Paris, 599 g ; British Museum (Natural History), London, 3160 g, 395 g ; Australian Museum, Sydney, 357 g.

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* Perry (1944, p. 138) regards this as transitional to an ataxite and classifies it as finest octahedrite (or ataxite), on account of vestigial octahedral structure.

Analytical details :	Fe	.... 89·91	
	Ni	.... 8·85	
	Co	.... 0·74	
	Cu	.... Trace	
	P	.... 0·50	
	S	.... Trace	
	C	.... Trace	
	Si	.... Trace	S.G. = 7·8
	Total	....100·00	Anal.—Mariner & Hoskins, Chicago. (Ward 1898.) Whitfield records traces of Pd and Ru.

Further analysis :	Ni	.... 10·06%	
	Co	.... 0·54%	
	Cr	.... 59 ppm	
	Cu	.... 253 ppm	
	Ga	.... 44 ppm	
	Ge	.... 91 ppm	Anal.—Lovering *et al.* (1957).

Another analysis :	Fe	.... 89·34	
	Ni	.... 9·87	
	Co	.... 0·60	
	Cu	.... 0·06	
	P	.... 0·48	
	S	.... 0·03	
	C free	.... Nil	
	C combined	0·02	
	Si	.... Nil	
	Mn	.... Nil	S.G. = 7·84
	Total	....100·40	Anal.—O. Sjöström

(Plates V (a) and IX (b).)

3. BENCUBBIN I (formerly Bencubbin) (South Mandiga)

Stony-iron, generally considered to be a mesosiderite but this classification is dubious. Classified here as a stony-iron of mixed type (Mm).

Find, July 30, 1930, at Holland and Breakell's farm, 12 miles north-west of Bencubbin on the west side of North Mandiga road, Western Australia. Latitude 30° 45′ S., longitude 117° 47′ E. Reporter—W. G. Sunter.

One mass, total weight 54·2 kg (119½ lb.).

This collection: W.A.M. No. 12366, *main mass* and one smaller mass weighing 162 g (S1859 Simpson collection). Also several smaller fragments. Both main mass and the smaller cut slice have been polished.

Other collections: Government Chemical Laboratories, Perth, three fragments weighing 506, 35 and 22 g; University of Western Australia, Geology Department, one small mounted fragment; British Museum (Natural History), London, 4491 g; Australian Museum, Sydney, 143·5 g; U.S. National Museum, Washington, 242 g.

References: H, P, S.

SIMPSON, E. S. & MURRAY, D. G. (1932)—*Miner. Mag.* **23**: 32–37.

NININGER, A. D. (1940)—*Pop. Astr.* **48**: 558.

LOVERING, J. F. (1962)—In: *Researches in Meteorites,* ed. by C. Moore. New York, John Wiley. 227 p.

NININGER, A. D. (n.d.)—*Contr. Soc. Res. Meteorit., Northfield, Minn.* **2**: 227.

Analytical details, etc.:

		%	
Ni–Fe	....	69	*Modal analysis:* Iron-nickel ratio 15. MgO/FeO ratio in silicate fraction 8·8.
Olivine	....	12	
Enstatite	....	14	
Anorthite	....	3·5	
Troilite	....	1·5	
Chromite	....	0·2	
Total	....	100·2	S.G. = 5·0.

Analysed at Government Chemical Laboratories, Perth, Western Australia.

Further analysis: metallics analysed separately over 10 mesh fraction 46·6% + ·526 g.

Fe	....	87·51	
Ni	....	5·78	
Co	....	0·63	
S	....	0·74	
Insol.	....	0·75	Fe : Ni = 16 : 1
		95·41	
Oxygen, H_2O, etc., and soluble silicates		4·59	S.G. = 5·32 for complete specimen.
Total	....	100·00	

Non-metallic 30·3% + ·51 g.

		%
SiO_2	....	47·44
Al_2O_3	....	4·13
Fe_2O_3	....	1·10
FeO	....	7·06*
MnO	....	0·56
MgO	....	34·99
CaO	....	2·68
Na_2O	....	0·10
K_2O	....	Nil
TiO_2	....	0·19
Cr_2O_3	....	0·38
Ni	....	0·13
Co	....	0·02
H_2O	....	2·76
C	....	Present
Total	....	101·54

MgO : FeO = 8·3 : 1.

* Approximate owing to presence of carbon and metallic iron.

Anorthite	....	11·7
Chromite	....	0·6
Hypersthene	....	44·0
Olivine	....	40·8
Water, etc.	....	2·9
Total	....	100·0

MgO : FeO = 8·3 : 1.

Anal.—D. G. Murray (1932).

S.G. on five fragments ranging from 90 g to 250 g were 5·16, 5·21, 5·24, 5·38 and 5·67 ; average : 5·32.

S.G. on 4533 g fragment = 5·14.

(Plate XVI (a).)

4. BENCUBBIN II (North Mandiga) Stony-iron, mixed type (Mm)

Find, late 1959, by F. Hardwick at Bencubbin, during ploughing after scrub rolling. Site ¾ mile north of Bencubbin I on east side of North Mandiga road, Western Australia. Reported to G. Watts, a local teacher, who identified it tentatively as a meteorite. Passed to W. H. Butler who donated it to the Museum in 1963. Latitude 30° 45′ S., longitude 117° 47′ E.

One mass, total weight 64·6 kg (142·4 lb.). Brown and yellow mottled mass composed of metal and silicate minerals ; close similarity to the Bencubbin I meteorite recovered from nearby, but appears to have less metal content (?) ; metal does not everywhere enclose silicate in a mesh, but certainly from same fall as Bencubbin I.

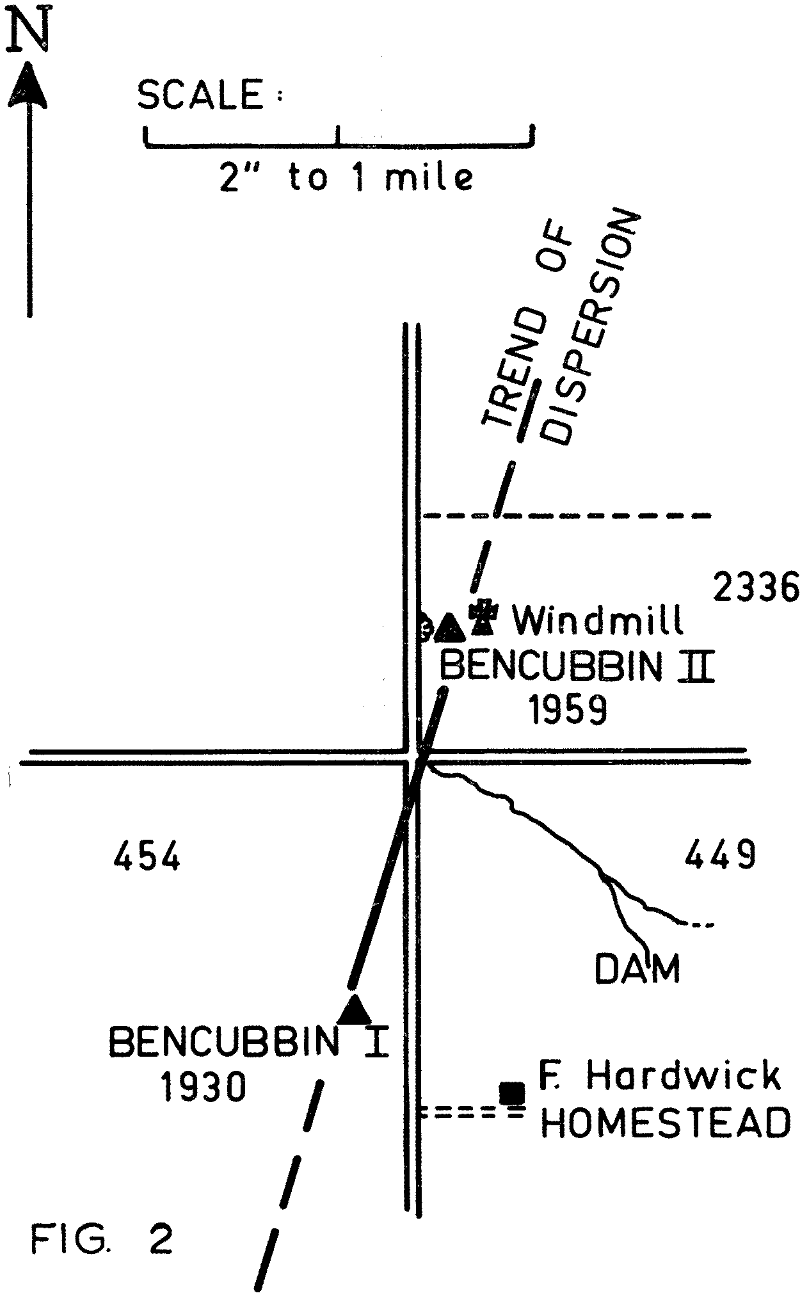

FIG. 2

Figure 2. Sketch map of the location of the two Bencubbin finds.

This collection : W.A.M. No. 12155, original mass.

Other collections : none.

References : description being prepared by G. J. H. McCall and J. R. de Laeter.

Analytical details, etc. : S.G. = 5·1.

(Plate XV (a).)

5. BILLYGOAT DONGA I — Stone, olivine-hypersthene-chondrite

Find, 1962, by T. & P. Dimer, 5 miles north of Billygoat Donga and about 21 miles north-east of Sleeper Camp which is situated about 40 miles north of Haig on the Trans-Australia Line, Western Australia. Latitude 30° 23′ S., longitude 126° 20′ E.

Three masses, total weight unknown. Two lost.

This collection : W.A.M. No. 12277, small polished chip, weight 19 g and thin section.

Other collections : Kalgoorlie School of Mines, 9469, surviving individual of three main masses, 142 g (5 oz.).

Analytical details, etc. : forms a group with four other known finds (North-Haig, Sleeper Camp, and two more finds, one from Johnny's Donga (lost) and one from south-west of Cyanide Donga (reported given to H. H. Nininger). Also strikingly similar to Naretha (p. 46). S.G. = 3·4 (very weathered). A small facetted stone with brown fusion crust. Chondrules apparent on fresh cut surface. Olivine Fa_{25} (Mason).

(Plates XXII (b), XXVII (c).)

BILLYGOAT DONGA II

A further find was made in 1963 by A. J. Carlisle, Jnr. two miles south of Billygoat Donga. Latitude 30° 23′ S., longitude 126° 20′ E. (approx.).

One mass, total weight 142 g (5 oz.). A flat, roughly rectangular facetted stone. Fusion crust covers most of the stone and it shows evidence of orientation. Abundant metal grains show disseminated in the face bare of fusion crust. Distinct surface pitting (regmaglypt) in one face.

This collection : not represented.

Other collections : main mass in the possession of A. J. Carlisle, Jnr.

(Plate XXII (c).)

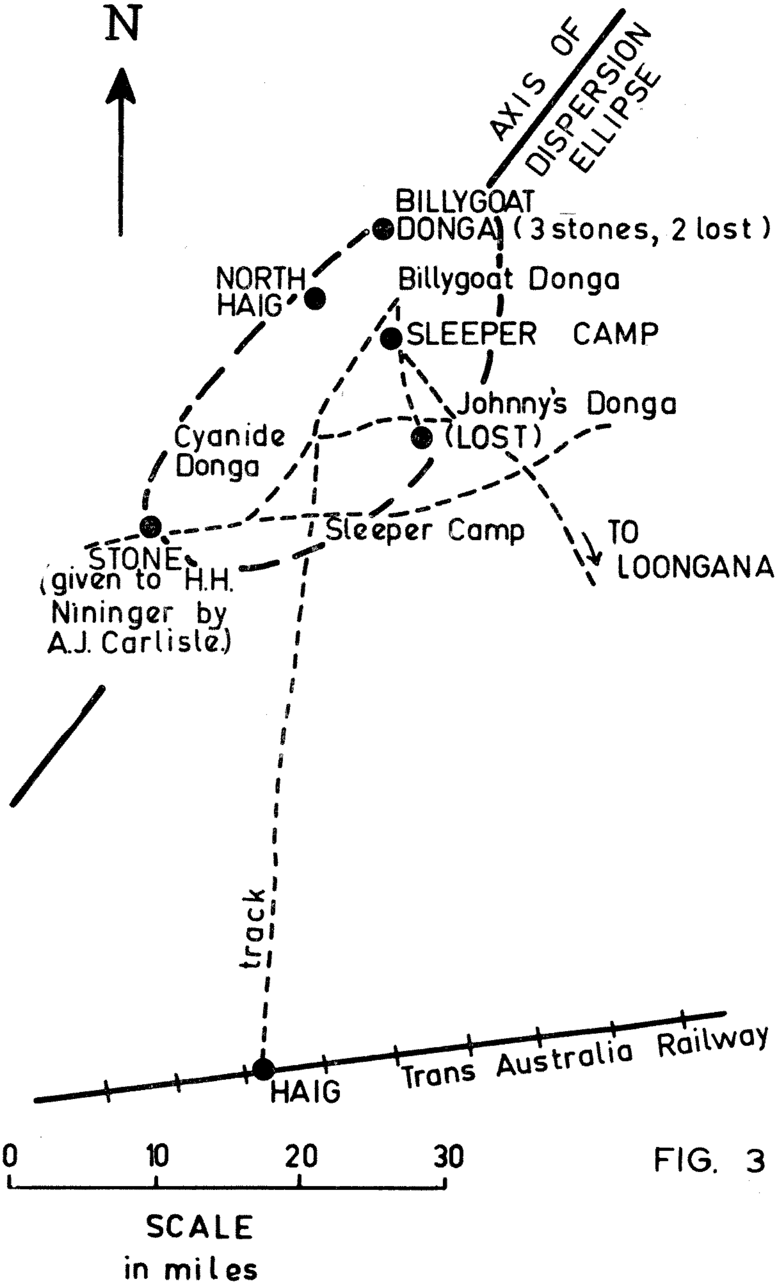

Figure 3. Sketch of the distribution of small facetted meteorite finds north of Haig Station on the Trans-Australia Railway Line.

BILLYGOAT DONGA III

Find, 2 miles north of Billygoat Donga and 14 miles east of the track.

Finder—W. H. Cleverly. Latitude 30° 23′ S., longitude 126° 20′ E. (approx.).

Three specimens, total weight 129 g.

This collection : not represented.

Other collections : Kalgoorlie School of Mines, 9584.1/2/3.

Three weathered specimens were collected by Mr. Cleverly in this locality in December 1963. They are flat angular chips and one, on slicing, showed evidence of chondrules. It appears to be a very weathered specimen of exactly the same type of olivine-hypersthene-chondrite as Billygoat Donga I.

6. COCKLEBIDDY Stone, olivine-bronzite-chondrite (Prior, class 2)

Find, 1949, three miles north of Nallah Nallah Rock-hole which is itself situated 10 miles east-north-east of Cocklebiddy on the Eyre Highway, Western Australia (the Rock-hole is marked on map). Latitude 31° 55′ S., longitude 126° 15′ E. Finder, donor—A. J. Carlisle, who noted a peculiar dint in the ground and found the meteorite a short distance beyond it. One mass, total weight 19·5 kg (43 lb.). Dimensions—9½″ x 7″ x 10″, cracked throughout.

This collection : W.A.M. No. 10625, *main mass,* with cut face and three cut off fragments, weighing 15·4 kg (34 lb.), 726 g, 591 g, 115 g. Also thin section.

Other collections : Government Chemical Laboratories, Perth, a specimen comprising chips weighing 22 g and non-magnetic portion in powder form ; American Museum of Natural History, New York, 141 g.

References : none.

Analytical details, etc. : this is a blackish grey, very fresh meteorite with little or no fusion crust apparent. Its shape is that of a rounded-off, square block. It contains more metal than most chondrites. Chondrules evident in this section, and some quite large ones sparsely evident in cut face.

Magnetic fraction :	Fe	65·01
	Ni	5·47
	Co	0·49
	S	0·73
	P	0·27
	Acid insoluble fraction and SiO_2	19·77
	Acid soluble fraction	8·26
	Total	100·00

Non-magnetic portion :	SiO_2	46·06	
	Al_2O_3	2·99	
	Fe_2O_3	0·97	
	FeO*	11·53	
	MnO	0·4	
	MgO	28·47	
	CaO	2·23	
	TiO_2	0·07	
	Cr_2O_3	0·52	
	FeS	4·91	
	H_2O	1·4	
	Ni	0·37	
	Co	0·04	S.G. = 3·64.
	Total	99·96	

Anal.—Government Chemical Laboratories, Perth, Western Australia.

Olivine Fa_{18} (Mason).

* FeO approximate only owing to presence of metallic iron, sulphides and carbon.

(Plates XVI (b) and XXV (c).)

7. DALGARANGA — Iron, ranging from coarsest to finest brecciated octahedrite.

Dalgaranga Sheep Station, north of Yalgoo, Western Australia.

Associated with crater (p. 60). Latitude 27° 43′ S., longitude 117° 15′ E. Find, 1923, made by G. E. P. Wellard and later finds by H. H. Nininger 1959–1960.

207 masses, total weight 1,098 g, recovered by Nininger (including 27 supposed mesosiderites and aerolites). In addition, other small masses recovered earlier.

This collection : W.A.M. No. S3526, etched fragment of medium octahedrite, weight 38·5 g (original find by Wellard). Also W.A.M. No. 12188 (13·5 g), 12189 (10 g), iron fragments showing twisted character 11·35 g, 12·95 g, 9·95 g (finds by H. H. Nininger).

Other collections : many small fragments recovered by H. H. Nininger, held as far as is known in his private collection (or at Arizona State University, Tempe, Arizona).

References : H, P, S.

SIMPSON, E. S. (1938)—*Miner. Mag.* **25** : 157–158.

NININGER, H. H. & HUSS, G. I. (1960)—*Miner. Mag.* **32** : 619–639.

Analytical details, etc. : Simpson reported nickel 8·6% : bent kamacite plates from 0·1 to 0·7 mm. thick ; surface covered with fused oxide film ; troilite rod present. Widmanstatten figure confused. Nininger reported these iron fragments as being compound, being made up of welded fragments, each showing its own individual octahedral etched pattern (see photographic illustrations, *op. cit.*) ; largest fragment reported by Nininger 57 g (Nininger recognised all variations from finest to coarsest octahedrite, but Simpson only recognised medium octahedrite) ; many irons show heat alteration and pressure effects with some elimination of Neumann lines ; also in a few cases diffusion of taenite recognised ; other specimens neither altered by heat or pressure ; some specimens micro-faulted ; only plessite recognised in some sections, others showed no plessite ; taenite percentage very variable from fragment to fragment ; swathing kamacite encloses some normally crystallized fragments and forms dividing walls in compound fragments producing reticulated patterns ; some specimens composed of kamacite without alterations to taenite. One such specimen carried lamellar arrangement of plates but no Widmanstatten pattern.

(Plates XIII (d), XXVIII (c).)

Stony-iron, mesosiderite or iron with silicate inclusions.

25 masses, total weight not recorded.

This collection : not represented.

Other collections : specimens recovered by H. H. Nininger held as far as is known in his private collection (or at Arizona State University, Tempe, Arizona).

Analytical details, etc. : Nininger (1960) reports that of the 25 fragments of mesosiderite from the centre of Dalgaranga crater there are two distinct types :

1. Normal mesosiderite pattern but metal component pseudomorphed by oxide.
2. Special structure resembling the unique siderophyre from Steinbach, Bavaria.

   Oxidized metal constituents enclosed in matrix of granular silicates which themselves enclosed microscopic sulphide grains.

X-ray diffraction tests on silicate by E. R. Du Fresne showed silicate to be rhombic pyroxene (? bronzite). Oxides shown to be magnetite and goethite and tend to vein the fragments, which are also reported " veined by granite." This feature is surprising and anomalous. The fragments contain troilite, and taenite is locally preserved, some patches revealing traces of Widmanstatten etched pattern, suggesting siderite fragments embedded in mesosiderite matrix. Dr. B. H. Mason reports (written communication) that the pyroxene of the " mesosiderite " fragments of Nininger, separated from a residue left after dissolving a portion of the material in hydrochloric acid, is hypersthene with refractive index $N\gamma = 1{\cdot}704$—$(Mg_{\cdot 66}Fe_{\cdot 34})\ SiO_3$ according to the determinative curves of Kuno (1954). An X-ray powder photograph confirmed the identification of hypersthene. The orthopyroxene determination certainly agrees with mesosiderite classification, yet Mason (verbal communication) dissents from Nininger's view that this is a mesosiderite occurrence or even that silicate overwhelmingly predominated in the mass which formed the Dalgaranga crater (p. 60). Taking into account the predominance of octahedrite material in the recoveries from Dalgaranga, he prefers to regard this as an iron meteorite (octahedrite) characterised by unevenly distributed silicate inclusions.

Stone, chondrite (?)

Two masses, total weight not recorded. Greyish lumps of material reported by Nininger (1960) showing metallic specks and relic structure suggesting chondrites but too weathered for exact identification.

This collection : not represented.

Other collections : specimens recovered by H. H. Nininger held as far as is known in his private collection (or at Arizona State University, Tempe, Arizona).

Analytical details, etc. : see note under Dalgaranga stony-iron.

Shale-balls

Complex of siderites, siderolites (?), aerolites (?) and shale-balls regularly distributed in relation to a small crater (see above), believed not to be an explosion crater but a simple product of fragmentation.

This collection : W.A.M. No. 12190, two shale-balls, collected by H. H. Nininger 10/10/1959 (55 and 38 g).

References : H, P, S.

SIMPSON, E. S. (1938)—*Miner. Mag.* **25** : 157–158.

NININGER, H. H. & HUSS, G. I. (1960)—*Miner. Mag.* **62** : 619–639.

(See also under meteorite craters.)

8. DALGETY DOWNS — Stone, olivine-hypersthene-chondrite

(Synonym : Ashburton Downs)

Find, 1941, six miles south of Dalgety Downs Station, Gascoyne District, Western Australia. Latitude 25° 21′ S., longitude 116° 11′ E. Finder—P. A. Healy.

One mass, broken up on impact into many fragments, total weight 217·7 kg (480 lb.). This meteorite was first discovered by P. A. Healy in 1941 ; a small piece has been kept in the collections of the Government Chemical Laboratories, Perth, since 1941 ; a further sample 3·6 kg (c. 8 lb.) was apparently passed to the Kalgoorlie School of Mines and held in their collection from 1941 onwards. It appears that this specimen was erroneously labelled Ashburton Downs. It was thus listed by Nininger under that name, and in fact a 1·8 kg piece has been represented for some years in the American Museum of Natural History under that name (obtained via Nininger). In 1963 Dr. B. H. Mason and Mr. E. P. Henderson were directed by the finder to the site of the original find and found 214·1 kg (472 lb.) of fragments. This recent collection is referred to as Dalgety Downs II and the original collection of P. A. Healy, Dalgety Downs I.

Dalgety Downs I

One mass, total weight c. 3·6 kg (c. 8 lb.).

This collection: W.A.M. No. 12179, three slices, exchanged with Kalgoorlie School of Mines, 257 g, 90 g, 36 g. Thin sections.

Other collections: American Museum of Natural History, New York, one piece, 1·8 kg; Kalgoorlie School of Mines, one piece, c. 1·1 kg (c. 2½ lb.); British Museum (Natural History), London, small fragment.

References: P (erroneously entered as a stony-iron).

Bowley, H. (1944)—*Rep. Dep. Min. W. Aust.* **1942**: 76.

Analytical details, etc.: S.G. = 3·50. Olivine Fa_{25} (Mason). This is a fine-textured chondrite; the fusion crust is not represented on specimens in this collection. Peculiar features are enclaves of white, iron free material, up to 1 cm diameter, suggesting polymict breccia character (or large hypersthene chondrules), and a distinct parallelism of the metallic specks suggesting lineation or foliation. The specimens are more weathered than those of Dalgety Downs II. Thin sections show it to be a chondrite, not appreciably recrystallized or veined.

	Magnetic Portion	Non-magnetic Portion	Bulk	Mol. Ratios
Mass	1·3221	8·6669	9·9890	
	%	%	%	
Fe	52·7	2·5	9·2	
Ni	7·5	0·4	1·4	
Co	0·4	....	0·05	
FeS	3·0	6·8	6·3	
SiO_2	7·2	42·0	38·6	·6427
TiO_2	....	0·12	0·11	·0014
Al_2O_3	....	3·0	2·8	·0275
Cr_2O_3	....	0·52	0·48	·0032
P_2O_5	....	0·21	0·91	·0013
MnO	0·1	0·30	0·28	·0040
FeO	5·0	13·1	12·1	·1684
MgO	6·5	26·1	24·0	·5952
CaO	0·4	2·3	2·1	·0375
Na_2O	....	1·0	0·9	·0145
K_2O	....	0·1	0·1	·0011
H_2O-	0·4*	0·4	0·4	
H_2O+		0·7	0·6	
Insol.	16·4	....	....	
	99·6	99·6	99·6	

* Calculated from H_2O content of non-magnetic portion.

Mineral Composition

Mol. Ratios		%	%	
·0145	$Na_2OAL_2O_36SiO_2$	7·6		
·0011	$K_2OAL_2O_36SiO_2$	0·6	11·5	Feldspar
·0119	$CaOAL_2O_32SiO_2$	3·3		
·0014	$FeO.TiO_2$	0·2		Ilmenite
·0032	$FeO.Cr_2O_3$	0·7		Chromite
·0008	$Ca_5(PO_4)_3Cl$	0·4		Apatite
·0216	$CaSiO_3$	2·5		
·0040	$MnSiO_3$	0·5		
·1906	$MgSiO_3$	19·1	28·7	Pyroxene
·0498	$FeSiO_3$	6·6		
·2023	Mg_2SiO_4	28·5	40·1	Olivine
·0570	Fe_2SiO_4	11·6		
	FeS	6·3		Troilite
	Fe	9·2		
	Ni	1·4	10·7	Metal
	Co	0·05		
	H_2O—	0·4		
	H_2O+	0·6		
		99·6		

Analysed at the British Museum (Natural History) by Dr. A. A. Moss.

(Plates XIX (a), XXV (b) and XXVII (a).)

Dalgety Downs II

Many fragments, total weight c. 214·1 kg (472 lb.).

This collection : W.A.M. No. 12175, one mass, 4·42 kg (9¾ lb.) (now cut into several pieces).

Other collections : balance (*main mass*) American Museum of Natural History, New York, and Smithsonian Institution, Washington.

References : none.

Analytical details, etc. : S.G. = 3·50. Olivine Fa_{24} (Mason). Similar to Dalgety Downs I but fresher ; the parallelism of metal specks is again evident, but no polymict breccia character has been recognised. Thin section reveals similar character.

(Plate XIX (b).)

9. Dowerin ... Iron

Find, before 1932, south of Dowerin township, Western Australia, after a scrub fire. Latitude 31° 12′ S., longitude 117° 4′ E. Large number of small fragments.

This collection : W.A.M. No. S1172, one small fragment weighing 0·35 g (Simpson collection).

References : H, P, S.

SIMPSON, E. S. (1938)—*Miner. Mag.* **25** : 158.

10. DUKETON (Synonym : Bandya) Iron, octahedrite (Om)

Long known to exist, about 1956 was found in use as a gate-stop on Bandya Station, 10 miles north of Duketon which is 70 miles north of Laverton, Western Australia. Finders—V. R. Lloyd and H. W. Hill (March 1947) ; but originally aboriginals who discovered it partly buried in a sandy spinifex plain. Reporter—M. J. Frost. Latitude 27° 30′ S., longitude 122° 20′ E.

One mass, total weight 118·3 kg (260·7 lb.), 20″ x 14″ x 8″.
This collection : not represented.

Other collections : Geology Department collection, University of Western Australia, No. 38228, original mass with etched, cut-off corner.

References :

FROST, M. J. (1958)—*J. roy. Soc. W. Aust.* **41** : 55.

Analytical details : contains troilite rods.

(Plate V (b).)

11. FORREST LAKES Stone, olivine-hypersthene-chondrite
(Synonym : Loongana)

Find, 1948, 120 miles north-east of Reid Station on the Trans-Australia Railway Line. Latitude 29° 25′ S., longitude 129° 30′ E. (approx.). Information recently given by the finder, T. Dimer, suggests that this meteorite included as *Loongana* in Prior & Hey (1953) does not come from Western Australia but from just over the South Australian border into Maralinga country. However, it must be remembered that precise definition of sites of finds cannot be expected in the case of this featureless country. It is therefore listed amongst Western Australian meteorites, but with the probability recorded that it may have fallen just inside South Australia. The name *Loongana* is unsatisfactory in view of the true location of the find and had in any case been adopted for another meteorite (*Loongana Station*), so the name *Forrest Lakes* has been adopted instead.

One mass, small weathered stone, total weight, 0·5 kg (1·1 lb.).

This collection : W.A.M. No. 12191, two small cut fragments and thin section, weight 38 g.

Other collections : Government Chemical Laboratories, Perth, six fragments totalling 208·5 g.

References : P.

ANON. (1949)—*Rep. chem. Br. Dep. Min. W. Aust.* **1948** : 20.

Analytical details, etc. : the fragments show light grey fresh cut face, and reveal rounded chondrules. Fusion crust is rough and dark brown on some surfaces, light brown and thinner on others. The fragments reveal sharp corners in the fusion crust surface, and the shapes suggest that the mass was small and perhaps cone-shaped. It may have been an oriented meteorite. Reports indicate that there is more material at the site and this suggests a multiple shower. The thin sections show a structure of rounded chondrules enclosed in dark opaque (glassy?) material. Metal is very scarce compared with many stony meteorites. S.G. = 3·4.

Olivine Fa_{26} (Mason).

(Plates XXIV (a) and (b) and XXV (a).)

12. GUNDARING — Iron, coarse octahedrite (Og)

Fall recorded April 6–7, 1930, visual observations.

Find, May 20, 1937, near the point where a possible fall was recorded in 1930, on Quinn's block close to the Soldiers' Hall, 16 miles from Wagin, Western Australia. The mass was lying on the surface. Finder—F. Quinn. Latitude 33° 18′ S., longitude 117° 40′ E.

One mass, total weight 112·5 kg (248 lb.).

This collection : W.A.M. No. G9943, the whole mass with a corner cut off revealing an etched surface. S3533, one fragment with etched face weighing 16 g ; saw cuttings, two bottles 56 g and 80 g (Simpson collection).

References : H, P, S.

SIMPSON, E. S. (1938)—*Miner. Mag.* **25** : 158–160.
LOVERING *et al.* (1957)—*Geochim. et cosmoch. Acta* **11** : 263–278.

Analytical details, etc. :

Ni	.... 8·32 %	
Co	.... 0·61 %	
Cr	.... 48 ppm	
Cu	.... 156 ppm	
Ga	.... 19 ppm	
Ge	.... 38 ppm	S.G. = 7·6. Anal.—Lovering *et al.* (1957).

Further analysis :

Fe	 91	
Ni	.... 8·25	
Co	.... 0·5	
S	.... Trace	
P	.... Trace	
C	.... Trace	Contains troilite nodules. Anal.—E. S. Simpson (1938).

(Plates II (a) and X (a).)

13. HAIG — Iron, medium-coarse octahedrite (Om-Og)

Find, 1951, 36 miles south-south-west of Rawlinna, Western Australia, on the Trans-Australia Railway Line. Latitude 31° 30′ S., longitude 125° 5′ E.

Finder, donor—A. J. Carlisle.

One mass, total weight 480 kg (1,057 lb.).

This collection: W.A.M. No. 10624, whole mass with a small corner removed to reveal an etched surface, and five small cut sections, weight 726, 125·6, 114, 944 and 58 g.

Other collections: Government Chemical Laboratories, Perth, three small fragments, 9·5 g.

References:

ANON. (1955)—*Rep. chem. Br. Dep. Min. W. Aust.* **1954**: 10.

Analytical details, etc.:

(1) Ni 7·36%
Contains troilite.

(2) Government Chemical Laboratories specimen—
Ni 7·52%
Fe 91·90%. S.G. = 7·9.

(Plates VI (a) and XII (c).)

14. KUMERINA — Iron, fine octahedrite (Of)

Find, 1937, Batthewmurnana Hill, near Kumerina, Upper Gascoyne, Western Australia. Latitude 24° 55′ S., longitude 119° 25′ E. Finder—J. Merrick, reporter—J. D. Bowman, donor—W. G. Armstrong.

One mass, total weight 53·5 kg (118 lb.).

This collection: W.A.M. No. 8506, whole mass with one corner cut off revealing an etched surface. S2624, two cut sections weighing 48 g and 33 g and one bottle of crushings (Simpson collection).

Other collections: British Museum (Natural History), London, 1163 g.

References: H, P, S.

SIMPSON, E. S. (1938)—*Miner. Mag.* **25**: 160.

Analytical details, etc.: Ni 9·55%.
S.G. = 7·73, 7·53.

(Plate IV (a).)

15. LAKE BROWN (Synonym: Burracoppin) — Stone, intermediate olivine-hypersthene-chondrite, Baroti type, (Prior class 3).

Find, 1919, at Lake Brown, County Avon, South-West Division, Western Australia. Found resting on the surface near a claypan. Finder—N. A. Stukey. Latitude 31° S., longitude 118° 31′ E. Exact position 16 chains and 22 links west of the 27 mile peg on No. 1 Rabbit Proof Fence.

One mass and some fragments, total weight 9·75 kg (21½ lb.).

This collection: W.A.M. No. 1/2378 (Geological Survey Collection), *main mass*, weighing approximately 9·5 kg and a 56 g fragment (Simpson collection—S1176).

Other collections: British Museum (Natural History), London, 174 g; Kyancutta Museum, South Australia, 375 g; American Museum of Natural History, New York, 137 g.

References: H, P, S.

ANON. (1922)—*Annu. Progr. Rep. geol. Surv. W. Aust.* **1921**: 53.
PRIOR, G. T. (1929)—*Miner. Mag.* **22**: 155–158 (two illustrations).

Analytical details, etc.:

	Magnetic	Total Non-magnetic	Insoluble of Non-magnetic	Bulk Analysis
Fe	63·79*			6·10
Ni	11·27			1·08
Co	0·60†			0·06
Fe		4·29		3·98
S		2·46		2·28
SiO_2	3·17‡	42·51	52·52	39·43
TiO_2		0·38		0·35
Al_2O_3		2·16	5·43	2·00
Cr_2O_3		0·19	0·40**	0·18
Fe_2O_3		3·94		3·65
FeO		12·93	16·24	11·99
MnO		0·27		0·25
NiO		0·35		0·32
CaO		2·03	5·10	1·88
MgO		27·11	18·58	25·15
Na_2O		0·87‡‡	1·93	0·81
K_2O		0·11‡‡	0·25	0·10
$H_2O(-110°)$		0·08		0·08
$H_2O(+110°)$		0·54		0·50
P_2O_5		0·33		0·31
Insoluble	10·73			
		100·55	100·45	100·50

* 66·04 total iron estimated less 2·19 contained in the soluble portion of admixed unattracted.

† Probably too low owing to possible loss on ignition of the α–nitroso–β–naphthol precipitate.

‡ From soluble silicate; the other constituents of which were not determined here.

** From analysis of unattracted.

†† From analysis of insoluble.

S.G. = 3·5.
Anal.—G. T. Prior (1929).
Olivine Fa_{25} (Mason).

(Plates XVIII (a) and (b).)

16. LAKE GRACE — Stone, very weathered olivine-hypersthene-chondrite.

Find, 1956, by Mr. Tom Griffin, three miles north-north-west of Tarin Rock Siding, Western Australia. Latitude 33° 04′ S., longitude 118° 13′ E. This meteorite was turned up on ploughing soft clay farmland and left against a fence for three years before being handed to the South Australian Museum, 1959.

One mass, fragmented artificially (originally reported as a single mass the size of a football). Total weight 10·5 kg (23 lb. 2 oz.).

This collection : not represented, but exchange arranged for a small specimen.

Other collections : South Australian Museum, *main mass,* 17 fragments, weight 10·5 kg.

References : none.

Analytical details, etc. : olivine Fa_{24} (Mason).

17. LAKE MOORE — Stone, olivine-hypersthene-chondrite

Find, before 1959, near Lake Moore(?), latitude 29° 51′ S., longitude 117° 33′ E. (approximate location only).

One mass, total weight 13·6 kg (30 lb.).

This collection : not represented.

Other collections : Arizona State University, Tempe, Arizona, (Nininger collection), weight 56 g.

Analytical details, etc. : olivine Fa_{25} (Mason).

This meteorite is somewhat anomalous ; Nininger collected it and recorded the latitude and longitude and the name in 1959. It could be a mistake for " Lake Brown," but the figure 13·6 kg is greater than the total recovery of Lake Brown. It is entered here with reserve ; investigations as to the validity of this attribution are proceeding.

18. LANDOR STATION (Synonym : Landor) — Iron, fine octahedrite (Of)

Find, 1931, near the head of the Wooramel River, Landor Sheep Station, Western Australia. Latitude 25° 40′ S., longitude 117° E. (approximate location only). Finder—Mr. Murphy.

Six masses (?), total weight 9 kg (20 lb.).

This collection : W.A.M. No. S1858, five small etched chips weighing 2·6 g (Simpson collection).

Other collections : *main mass* reported to be held in Mr. Murphy's private collection.

References : H, P, S.

SIMPSON, E. S. (1938)—*Miner. Mag.* **25** : 161.

Analytical details : S.G. cannot be determined accurately due to small size of specimens.

19. LOONGANA STATION — Iron, medium octahedrite (Om)

Find, north-east of Loongana Station, on the Trans-Australia Railway Line, Western Australia. Loongana Station has latitude 30° 55′ S., and longitude 127° 21′ E. Only a small fragment known, total weight 108 g, but reported to be part of a very large mass, as yet not located. Reporter—D. J. Ritchie.

This collection: not represented.

Other collections: Government Chemical Laboratories, Perth, one etched fragment, weight 108 g.

References: none.

Analytical details: Fe 90%
Ni 7·4% S.G. = 7·6.
Anal.—Government Chemical Laboratories, Perth, Western Australia.

The specimen is a small whole meteorite with angular protuberances, and is so similar to Premier Downs I, that it must be suspected that it comes from the same fall.

(Plate XIV (b).)

20. MELLENBYE — Stone, white olivine-hypersthene-chondrite
(Synonym: Mallenbye)

Find, about 1929, somewhere between Mellenbye and Kadji Kadji Station, Murchison Division, Western Australia. Latitude 28° 52′ S., longitude 116° 17′ E. (approximate).

One mass, total weight 337·6 g. Another fragment weighing 844 g is reported to have been found by G. E. P. Wellard in 1923 (see Yalgoo). This collection: W.A.M. No. S2657, two small pieces weighing 250·7 g and 46 g and a thin section.

Other collections: British Museum (Natural History), London, 81 g.

References: H, P, S. (Hodge-Smith refers to it erroneously as a stony-iron).

SIMPSON, E. S. (1938)—*Miner. Mag.* **25**: 161.

MASON, B. H. and Wiik, H. B. (1964)—*Geochim, et cosmoch. Acta* **28**: 533–538.

Analytical details: S.G. = 3·3 (low value due to oxidation of iron?). Olivine Fa_{27} (Mason). Thin section examination of this stone suggests that it is considerably brecciated and recrystallized. Possibly related to the amphoterites (Mason & Wiik, 1964).

(Plates XXI (a) and XXVI (a).)

21. MILLY MILLY — Iron, medium octahedrite (Om)

Find, 1921 (but known to natives before). Three miles from Milly Milly Station homestead, Murchison District, Western Australia. Latitude 26° 7′ S., longitude 116° 40′ E. Finder—D. Mulcahy.

One mass, total weight 26·4 kg (58·25 lb.), dimension 10″ x 9″ x 4″.

This collection : W.A.M. No. 3702, *main mass,* weighing 24·5 kg (54 lb.). 1/3318 (Geological Survey of Western Australia collection) etched slice weighing 32·5 g. S1168 etched slice weighing 8 g (Simpson collection).

Other collections : University of Western Australia, Geology Department collection, one etched slice ; American Museum of Natural History, New York, 230 g.

References : H, P, S.

ANON. (1922)—*Annu. Progr. Rep. geol. Surv. W. Aust.* **1921** : 53.
SIMPSON, E. S. (1938)—*Miner. Mag.* **25** : 161–162.

Analytical details :			
Fe	....	91·96	
Ni	....	7·84	
Co	....	·77	
P	....	·20	
S	....	·01	
C	....	·02	S.G. = 7·7 Anal.—E. S. Simpson (1938)

Distinct thumb marks. Contains troilite nodules.

(Plate III (b).)

22. MOORANOPPIN — Iron, coarsest octahedrite (Ogg)

Find, by natives, brought in by J. S. Edmondson in 1893. Somewhere south of Mooranoppin Farm, near Kellerberrin. Latitude 31° 35′ S., longitude 117° 46′ E. (approximate).

Two masses (previously called Mooranoppin I and II, but confusion evident in the literature as to which is which). Total weight, 0·82 kg (1 lb. 13 oz.) and 742 g.

This collection : W.A.M. No. 11974, cut section 109·6 g ; 1/4705 (Geological Survey of Western Australia) small etched section, 43 g ; S1164, cut etched specimens 7·8 g and 3·3 g ; S1164 (II) probably *main mass* of the find called Mooranoppin II, fragment with cut etched termination weighing 725 g, also 23 g fragment.

Other collections : British Museum (Natural History), London, 261 g ; Field Museum of Natural History, Chicago, 173 g ; American Museum of Natural History, New York, 256 g ; U.S. National Museum, Washington, 73 g ; Australian Museum, Sydney, etched slice 54 g.

References : H, P, S.

COOKSEY, T. (1897)—*Rec. Aust. Mus.* **3** : 58.
BREZINA, A. (1898)—*Verh. geol. ReichsAnst.* (*StAnst.*) *Wien* **1898** : 62–3.
WARD, H. A. (1898)—*Amer. J. Sci.* **5** : 135–140.
ANON. (1900)—*Bull. geol. Surv. W. Aust.* no. 4 : 97.
ANON. (1916)—*Bull. geol. Surv. W. Aust.* no. 67 : 135–140.
SIMPSON, E. S. (1938)—*Miner. Mag.* **25** : 166.
LOVERING *et al.* (1957)—*Geochim. et cosmoch. Acta* **11** : 263–278.

Analytical details, etc.:

Fe	....	90·82
Ni	....	7·21
Co	....	0·88
P	....	0·42
C	....	0·67
Si	....	0·01
Total		100·01

Anal.—H. Bowley

(probably on the sample previously called Mooranoppin I).

Further analysis:

Ni	....	6·91%
Co	....	0·50%
Cr	....	Less than 1 ppm
Cu	....	175 ppm
Ga	....	79 ppm
Ge	....	396 ppm

S.G. = 7·4

Anal.—Lovering *et al.* (1957) (probably on the specimen called Mooranoppin II).

23. MOUNT DOOLING — Iron, medium octahedrite (Om)

(Synonym: Lake Giles)

Find, 1909, five miles east of Mt. Dooling, North Yilgarn, Western Australia and 70 miles west of Ularring. Latitude 30° S., longitude 119° 22′ E.

Finder—A. P. Brophy, another piece received from J. E. Dore.

One mass, total weight 31·3 kg (69 lb.).

This collection: W.A.M. No. 10639, *main mass*, with cut etched face, 31·3 kg; 1629, thin cut section, etched, weighing 25 g; S1167, two small fragments, etched, weighing 126 g and 66 g; 1/4706 (Geological Survey of Western Australia) small etched slice, 42 g.

References: H, P, S.

ANON. (1912)—*Annu. Progr. Rep. geol. Surv. W. Aust.* **1911**: 10.
ANON. (1912)—*Bull. geol. Surv. W. Aust.* no. 48: 83–89.
ANON. (1916)—*Bull. geol. Surv. W. Aust.* no. 67: 138–139.
LOVERING *et al.* (1957)—*Geochim. et cosmoch. Acta* **11**: 263–278.

Analytical details, etc.:

Fe	....	93·17
Ni	....	5·96
Co	....	0·64
Cu	....	0·02
Mg	....	Trace
P	....	0·27
S	....	0·09
C	....	0·10
Si	....	Trace
Total		100·25

Anal.—E. S. Simpson

Further analysis :	Ni	6·41%		
	Co	0·48%		
	Cr	28 ppm		
	Cu	166 ppm		
	Ga	61 ppm		
	Ge	193 ppm	S.G. = 7·8	
			Anal.—Lovering *et al.* (1957)	

(Plates III (a) and XIII (a).)

24. MOUNT EDITH I — Iron, medium octahedrite (Om)
(Synonym : Duck Creek)

Find, 20th April, 1913, at Mount Edith, Duck Creek, Ashburton District, Western Australia. Latitude 22° 30′ S., longitude 116° 10′ E. Finder—J. Bourke.

One mass, total weight 160·6 kg (354 lb.).

This collection : W.A.M. No. 1/3848 (Geological Survey of Western Australia) cut etched section weighing 6,700 g ; S1166, tiny slice mounted on wax, 2 g (Simpson collection).

Other collections : Field Museum of Natural History, Chicago, *main mass* ; Australian Museum, Sydney, 145 g ; British Museum (Natural History), London, 1·04 kg ; American Museum of Natural History, New York, 8·75 kg ; U.S. National Museum, Washington, 1·5 kg ; National Museum, Budapest, 2¾ kg ; Harvard University, Cambridge, Mass., 30·5 kg.

References : H, P, S.

ANON. (1914)—*Annu. Progr. Rep. geol. Surv. W. Aust.* **1913** : 17.
ANON (1914a)—*Bull. geol. Surv. W. Aust.* no. 59 : 210–212.
FOOTE, W. M. (1914)—*Amer. J. Sci.* **37** : 391.
MAITLAND, GIBB (1914)—*Rep. Dep. Min. W. Aust.* **1913** : 85.
LOVERING *et al.* (1957)—*Geochim. et cosmoch. Acta* **11** : 263–278.

Analytical details, etc. :		Fe	89·45	
		Ni	9·45	
		Co	0·75	
		C	Trace	
		P	0·35	
		Si	Nil	
		Total	100·00	Anal.—E. S. Simpson
Further analyses :	(1)	Fe	89·50	
		Ni	9·45	
		Co	0·63	
		Cu	0·01	
		C	0·02	
		P	0·32	
		S	0·01	
		Si	Trace	S.G. = 7·5
		Total	99·94	Anal.—J. E. Whitfield

(2)	Ni	9·4%	
	Co	0·55%	
	Cr	Less than 1 ppm	
	Cu	147 ppm	
	Ga	15 ppm	
	Ge	33 ppm	Anal.—Lovering *et al.* (1957)

(Plate IX (a).)

25. MOUNT EDITH II — Iron, medium octahedrite (Om)

Find, 1914, two miles from the site of Mt. Edith I. Finder—J. Bourke.

One mass, total weight 165·1 kg (364 lb.).

This collection: W.A.M. (Geological Survey Collection) No. 13323, entire mass with corner cut off, weight 165·1 kg less cut pieces; 13116, two small etched pieces, weighing 10 g and 5·5 g; S1166, thin slice etched, 5 g (Simpson collection).

References: H, P, S.

ANON. (1915)—*Annu. Progr. Rep. geol. Surv. W. Aust.* **1914**: 34.
ANON. (1916)—*Bull. geol. Surv. W. Aust.* no. 67: 140.

Analytical details, etc.:

(1)	Fe	88·48	
	Ni	9·06	
	Co	0·65	
	P	0·49	
	O	1·32	(by difference)
	Total	100·00	

(2) Recalculated neglecting oxygen contribution

Fe	89·66	
Ni	9·18	
Co	0·66	
P	0·50	
Total	100·00	S.G. = 7·5

Schreibersite is freely developed.

Anal.—E. S. Simpson

(Plate II (b).)

26. MOUNT EGERTON (Synonym: Siberia) — Reported as a stony-iron meteorite or as a stone of unusual type—now classified as a stony-iron of hitherto unrecorded type.

Find, 1941, 12 miles from Mount Egerton on one of the headstreams of the Gascoyne River, Western Australia. Finder—T. Gaffney (possibly this is incorrect; a group of prospectors were reported to have been involved in the find, including Mr. Pegler). Reporter—D. J. Browne. Latitude 24° 46′ S., longitude 117° 42′ E. (approximate).

Four fragments, total weight 1·7 kg (3·7 lb.).

This collection: fragments of 77, 43, 14, 6, 4 g lodged in the Museum by Mrs. Pegler.

Other collections: three small stony-iron fragments called "Siberia," totalling 99 g (3½ oz.), in the Kalgoorlie School of Mines collection, are now known to be from this find, since Mr. Pegler is recorded as having supplied fragments to this collection at the time and there is no record of any meteorite find from Siberia, a mining district near Kalgoorlie. All details fit Mount Egerton but it is clear that different samples were handed to Mr. Bowley for examination (see below). One small piece referred to as "Siberia" is held by H. H. Nininger in his personal collection.

References: P.

ANON. (1944)—*Rep. Dep. Min. W. Aust.* **1942**: 76.

McCALL, G. J. H.—A meteorite of unusual type from Western Australia—the Mount Egerton stony-iron. *Miner. Mag.* (in press.)

Analytical details, etc.: this specimen was first reported (Anon. 1944) to consist of four fragments of a meteorite, the largest composed of enstatite crystals with embedded nickel-iron. One fragment, 8·5 x 5 x 2·8 cm weighs 158·3 g and has a S.G. of 3·25. The small fragments are said to be mainly metallic and measure 4·4 x 3·2 x 2·8 cm, weight 121·7 g, S.G. = 6·95 and 3·8 x 2·8 x 2·8 cm, weight 83·9 g, S.G. = 6·626. Also a 15 g fragment used up in analysis. The silicate is enstatite, S.G. = 3·20, R.I. Ng 1·66, embedded with small irregular fragments of nickel-iron. Metal fragments consist mainly of kamacite with occasional areas of schreibersite and troilite. A fragment when struck with a hammer fractured giving a bright steel grey surface revealing no Widmanstatten figures on etching, but Neumann lines. Nickel content of this fragment, 6·38%. Nodules in the nickel-iron show a platy structure, tin-white colour and highly lustrous character on fresh surfaces, tarnishing in the air to dull gold. They are brittle and have a grey streak. They are slowly attacked by hot HCl yielding Fe and P and so identified as schreibersite. A fragment immersed in dilute HCl evolved H_2S with a trace of CaO in solution. Identified as troilite (possibly + oldhamite). Dr. B. H. Mason has identified the "Siberia" fragments as meteoritic and the silicate as pure enstatite. The S.G. of the Siberia fragments is 6·52. The "Siberia" fragments appear on first sight to contain more than one silicate mineral, but this seems to be an illusion and the only silicate is enstatite of fibrous appearance, and this is how the entry in the Kalgoorlie School of Mines records describes Pegler's Mount Egerton specimens—viz. "metallic iron, pyrrhotite + fibrous silicate." Total weight of the Siberia fragments (Kalgoorlie School of Mines collection No. 8506) is 99 g (3½ oz.). It will be noted that the total weight of the original Mount Egerton specimens sent to Government Chemical Laboratories does not amount to anything like 1·7 kg (3·7 lb.)—nor does the Kalgoorlie collection of fragments. It must be assumed that the large silicate fragment is held in a private collection (whereabouts unknown). The Siberia fragments reveal a distinct, ultrafine etch pattern on treatment with 8% HNO_3. Mount Egerton metal was reported to show only Neumann lines. It is not absolutely certain whether the etch pattern is a hexahedrite etch pattern or not; it seems to be composed only of Neumann lines, partly thermally altered, but it has been suggested that these are not Neumann lines, that it is a nickel-poor ataxite pattern, and that it is analogous to the fine pattern of Horse Creek, Colorado (pseudo-octahedrite). One specimen shows coarsely-granular character, a curved boundary between areas of contrasting etch pattern being evident, and this contains a prominent troilite nodule. This is suggestive of iron of extremely coarse octahedrite type, but the absence of taenite precludes this interpretation. B. H. Mason suggested that these meteorite fragments are part of a larger mass, fragmented, possibly an enstatite-achondrite analogous to *Shallowater*.

(Plate XV (b).)

In December 1963, further specimens from the Mount Egerton meteorite were found in the collection of Mrs. C. Pegler, widow of one of the finders. These consisted of six fragments of weights 77, 43, 14, 13, 6, and 4 g. The largest specimen in size weighing 43 g consists of crystals of enstatite up to 4 cm long, well formed and only slightly brecciated, forming a continuous mass, nickel-iron filling the interstitial spaces. This is clearly the silicate-rich material referred to in Mr. Bowley's original description. The silicate forms about 85 % and nickel-iron 15 %. The other large specimen is intermediate between the dominantly metallic material in the Kalgoorlie collection and the silicate-rich specimen described above. Large pure enstatite crystals are set in a continuous nickel-iron base. The metal shows the same unusual etch pattern and granularity as the Kalgoorlie "Siberia" specimen and there can be no doubt that the two are from the same find. This new set of specimens suggests that the Mt. Egerton meteorite is a variable meteorite with areas of nickel-iron showing fine etch pattern and subordinate silicate inclusions, and other areas of pegmatoid enstatite crystallization accompanied by very little nickel-iron. It is probably correctly regarded as a stony-iron but virtually defies classification and may well be an entirely new type. It differs from the unique *Shallowater* unbrecciated enstatite-achondrite in that nickel-iron is present in far more than accessory quantity but it is clearly genetically related to the unbrecciated enstatite-achondrite.

(Plate XV (c).)

27. MOUNT MAGNET — Iron, finest octahedrite (Off)*
(Synonym : East Mount Magnet)

Find, 1916, six miles east of Mt. Magnet, towards Paynesville, Murchison Goldfields, Central Division, Western Australia. Latitude 28° 2′ S., longitude 117° 58′ E. Finder—no record, reporter—H. G. Stokes, donors—J. Connors and H. Taylor.

Two masses, which fit perfectly together, total weight 16·6 kg (36½ lb.) This collection : W.A.M. No. 1/4015 (Geological Survey). Two original masses, one of horseshoe form and a small fragment (both with small sections cut off), weight 750 g, 27½ g ; S1169, etched slice 49 g, etched slice 8 g, saw cuttings (Simpson collection) ; S1174, bottle of schreibersite separated from the meteorite, weight ½ g (Simpson collection).

* The nickel content determined by Lovering (p. 65) is too high for an octahedrite. The Mount Magnet iron might therefore be better classified as a nickel-rich ataxite—it certainly evinces no megascopic etch pattern.

Other collections : British Museum (Natural History), London, 477 g ; American Museum of Natural History, New York, 52 g ; Australian Museum, Sydney, 719 g.

References : H, P, S.

ANON. (1917)—*Annu. Progr. Rep. geol. Surv. W. Aust.* **1916** : 26.
SIMPSON, E. S. (1927)—*J. roy. Soc. W. Aust.* **13** : 47–48.
LOVERING *et al.* (1957)—*Geochim. et cosmoch. Acta* **11** : 263–278.

Analytical details, etc. :

Fe	....	85·66	
Ni	....	13·56	
Co	....	0·77	
P	....	0·05	
S	....	Trace	
C	....	Nil	
Mn	....	Trace	S.G. = 8·0
Total		100·04	Anal.—E. S. Simpson (1927)

Further analysis :

Ni	....	14·72 %
Co	....	0·54 %
Cr	....	Less than 1 ppm
Cu	....	162 ppm
Ga	....	6·4 ppm
Ge	....	Less than 1 ppm

Anal.—Lovering *et al.* (1957)

(Plates VII (a) and VIII (b).)

28. MOUNT STIRLING — Iron, coarse octahedrite (Og-Ogg)

Find, 1892, 25 miles south-east of Mt. Stirling, near Quairading, Western Australia (possibly part of the Youndegin fall). Latitude 31° 58′ S., longitude 117° 55′ E. Finder—aborigines.

Two masses, total weight 92·3 kg (201 lb.) and 680 g (1½ lb.).

This collection : W.A.M. No. S1163, cut etched specimen 47·5 g (Simpson collection) ; 1/4078 (Geological Survey) thin etched section 415 g, etched section 305 g.

Other collections : Australian Museum, Sydney, *main mass* 67·2 kg ; British Museum (Natural History), London, 1·89 kg ; American Museum of Natural History, New York, 416 g, 515 g and 71 g ; Field Museum of Natural History, Chicago, 952 g and 57 g ; H. H. Nininger's Collection, 1·3 kg ; U.S. National Museum, Washington, 272 g ; Technological Museum, Sydney, specimen (weight unknown).

References : H, P, S.

COOKSEY, T. (1897)—*Rec. Aust. Mus.* **3** : 58, 131.
ANON. (1915)—*Annu, Progr. Rep. geol. Surv. W. Aust.* **1914** : 34.
ANON. (1916)—*Bull. geol. Surv. W. Aust.* no. 67 : 136–137.
SIMPSON, E. S. (1938)—*Miner. Mag.* **25** : 166–169.
LOVERING *et al.* (1957)—*Geochim. et cosmoch. Acta* **11** : 263–278.

Analytical details, etc :				
	Fe	....	92·08	
	Ni	....	6·72	
	Co	....	0·81	
	P	....	0·17	
	S	....	0·06	
	C	....	0·24	
	Si	....	0·01	S.G. = 7·9
	Total		100·09	Anal.—H. Bowley
Further analysis :	Ni	....	6·93 %	
	Co	....	0·55 %	
	Cr	....	7·2 ppm	
	Cu	....	225 ppm	
	Ga	....	63 ppm	
	Ge	....	409 ppm	Anal.—Lovering *et al.* (1957)

(Plate XI (a).)

29. MURCHISON DOWNS ... Iron, finest octahedrite (Off)

Find, 1925, Murchison Downs, Murchison Division, Western Australia (Kyarra District). Latitude 26° 40′ S., longitude 119° E. (approximate).

One mass, total weight 33·5 g.

This collection : W.A.M. No. 1/3894 (Geological Survey of Western Australia collection), original mass with cut etched face at one corner, 33·5 g.

References : H, P, S.

SIMPSON, E. S. (1927)—*J. roy. Soc. W. Aust.* **13** : 47.

Analytical details, etc. : nothing recorded. S.G. = 7·5. This specimen is similar to the small twisted irons commonly found near meteorite craters.

(Plate XIII (c).)

30. NARETHA Stone, grey olivine-hypersthene-chondrite

Find, 1915, near the 205 mile post, now the Naretha Railway Station on the Trans-Australia Railway Line, Western Australia, 40 miles east of Kitchener. Latitude 31° S., longitude 124° 50′ E. Finder—Mr. J. Darbyshire.

One mass, three fragments which fit together perfectly to form a single mass, total weight 2·27 kg (5 lb.).

This collection : W.A.M. No. S1177, total weight 36 g (two pieces, Simpson collection). One piece, 1/4709 (Geological Survey of Western Australia collection), weight 661 g (1·45 lb.). Thin section.

Other collections : one piece in Kalgoorlie School of Mines collection, No. 3466, weight 794 g (1·75 lb.).

References : H, P, S.

SIMPSON, E. S. (1922)—*Annu. Progr. Rep. geol. Surv. W. Aust.* **1921** : 53.

Analytical details, etc. : S.G. = 3·4. This is a hypersthene-chondrite of usual type ; Simpson seems to have over-estimated the metal content.

It has a peculiar star-shaped, facetted form like Billygoat Donga (p. 25), and the nature of the brown fusion crust and nature of the cut face suggest that it may well be from the same meteorite arrival. Olivine Fa_{25} (Mason).

(Plates XXIII (a) and (b), XXVII (b).)

31. NORTH HAIG — Stone, olivine-hypersthene-chondrite, polymict brecciated.

Find, 1961, by R. F. Kilgallon, 13 miles due north of Sleeper Camp which is situated 40 miles north of Haig on the Trans-Australia Railway Line.

Latitude 30° 26′ S., longitude 126° 13′ E. (approximate).

One mass, total weight 964 g (2 lb. 2 oz.).

This collection: not represented.

Other collections: Kalgoorlie School of Mines, No. 9229, *main mass*, 964 g (2 lb. 2 oz.).

Analytical details, etc.: partial fusion crust and polymict breccia character; aubrite inclusions (?); chondrules visible. Probably part of a shower with Billygoat Donga, Sleeper Camp, etc. (see note under Billygoat Donga).

(Plate XXI (b).)

32. NULERI .. Iron, medium octahedrite (Om)

Find, about 1902, on the Mount Margaret Goldfields, about 200 miles east of Mount Sir Samuel, close to the eastern boundary of the Nuleri Land District, Western Australia, near the southern end of Lake Throssell.

Latitude 27° 50′ S., longitude 123° 52′ E. Finder—a prospector.

One mass, total weight 120·2 g.

This collection: W.A.M. No. 1/8631 (Geological Survey of Western Australia collection), *main mass*, cut, 93 g; 1/5025 (Gelogical Survey of Western Australia collection) cut section, 5 g; S1165, a tiny slice, 1 g (Simpson collection).

References: H, P, S.

ANON. (1907)—*Bull. geol. Surv. W. Aust.* no. 26: 24–26.
ANON. (1907a)—*Annu. Progr. Rep. geol. Surv. W. Aust.* **1906**: 28.
ANON. (1914)—*Bull. geol. Surv. W. Aust.* no. 59: 213.
ANON. (1916)—*Bull. geol. Surv. W. Aust.* no. 67: 138–139.

Analytical details, etc.:

Fe	93·57	
Ni	5·79	
Co	0·41	
Cu	Trace	
Mg	0·09	
P	0·13	
S	Trace	
C	0·01	
Cl	Trace	S.G. = 7·79
Total	100·00	Anal.—E. S. Simpson

(Plate VIII (a).)

33. PREMIER DOWNS — Iron, medium octahedrite (Om)

Find, 1911 and 1918, Premier Downs, Nullarbor Plain, Eucla Division, Western Australia, near 357 mile peg on the Trans-Australia Railway Line, on a low limestone plateau. Donor—(Premier Downs III) A. Ewing.

Three masses, total weight 112 g, 116 g, 99 g. (Larger two, Premier Downs I and II respectively, found eight miles apart but believed to come from one shower.)

This collection: W.A.M. No. S1170, two cut specimens, 85 g and 18 g and casts of both original finds (Simpson collection).

References: H, P, S.

ANON. (1912)—*Bull. geol. Surv. W. Aust.* no. 48: 87–89 (Premier Downs I).

ANON. (1914)—*Bull. geol. Surv. W. Aust.* no. 59: 205–209 (Premier Downs II).

ANON. (1916)—*Bull. geol. Surv. W. Aust.* no. 67: 138–139.

SIMPSON, E. S. (1938)—*Miner. Mag.* **25**: 157–171 (Premier Downs III).

Analytical details, etc.:

Premier Downs I:	Fe	91·68	
	Ni	7·46	
	Co	0·64	
	Cu	Trace	
	P	0·21	
	S	0·04	
	Si	0·01	
	Total	100·04	Anal.—E. S. Simpson
Premier Downs II:	Fe	88·51	
	Ni	7·58	
	Co	0·89	
	Cu	0·13	
	P	0·31	
	S	Nil	
	C	2·47	
	Si	Nil	S.G. = 7·4
	Total	99·89	Anal.—H. Bowley

(See note under Loongana Station.)

(Plate VII (b).)

34. QUAIRADING — Iron, coarse octahedrite (Og-Ogg)
(Synonym: Youndegin IX)

Find, 1903, slightly buried on a gravel ridge, 21 miles south-east of Quairading near Wamenusking, Western Australia. Latitude 32° 10′ S., longitude 117° 42′ E. Finder—Mr. Johnston, Snr.

Fall, reported in 1897 near this site by Mr. Heal. As this appears to be part of the Youndegin fall it is unlikely to be connected since this post-dates the first Youndegin finds. Donor—E. C. Johnston, 1954.

One mass, total weight 2,626 kg (5,789 lb.).

This collection: entire mass, weight 2,626 kg (5,789 lb.), apparently unnumbered.

References: none.

Analytical details, etc.: Ni 6·85%.

(Plate I (a).)

35. RAWLINNA Stone, olivine-hypersthene-chondrite

Find, near Rawlinna Station on the Trans-Australia Railway Line, Western Australia. Latitude 31° S, longitude 125° 19′ E. (approximate). Finder—Mr. H. F. Carlisle, donor—J. M. Cunningham, M.L.C.

One mass, total weight about 350 g.

This collection: W.A.M. No. 10590, *main mass*, weight 107 g.

Other collections: American Museum of Natural History, New York, 136 g.

References: none.

Analytical details, etc.: mottled brown to black chondrules evident and evidence of crystallinity. Minerals recognised—chrysolite, bronzite, troilite, cohenite, nickel-iron. S.G. = 3·41 (C. R. Lemesurier). Olivine Fa_{20} (Mason).

(Plates XVII (a), XXVI (c).)

36. ROEBOURNE Iron, medium octahedrite (Om)

(Synonym: Hamersley Range)

Find, 1892, 200 miles south-east of Roebourne, eight miles east of the Hamersley Range, Western Australia; found lying in a slight depression on the alluvial plain. Latitude 22° 20′ S., longitude 119° E. Finder—H. R. Hester.

One mass, total weight 87·3 kg (192½ lb.).

This collection: W.A.M. No. 11975, etched section, weight 184 g.

Other collections: Field Museum of Natural History, Chicago, *main mass* consisting of four sections: 19·39 kg, 13·72 kg, 5·22 kg, 1·48 kg; British Museum (Natural History), London, 1·5 kg, 114 g; American Museum of Natural History, New York, 2¼ kg; U.S. National Museum, Washington, 2 kg; University Museum, Bonn, 2½ kg; H. H. Nininger's Collection, 1½ kg; Muséum National d'Histoire Naturelle, Paris, 47 g.

References : H, P, S.

WARD, H. A. (1898)—*Amer. J. Sci.* **5** : 135–140.

BREZINA, A. (1898)—*Verh. geol. ReichsAnst. (StAnst.) Wien* **1898** : 62–63.

ANON. (1900)—*Bull. geol. Surv. W. Aust.* no. 4 : 97.

ANON. (1916)—*Bull. geol. Surv. W. Aust.* no. 67 : 138–139.

LOVERING *et al.* (1957)—*Geochim. et cosmoch. Acta* **11** : 263–278.

Analytical details, etc. :

Fe	....	90·91	
Ni	....	8·33	
Co	....	0·59	
Mn	....	Trace	
P	....	0·16	
S	....	Trace	
C	....	Trace	
Si	....	0·01	S.G. = 7·78
Total		100·00	Anal.—Mariner & Hoskins

Further analysis :

Ni	....	8·04%	
Co	....	0·56%	
Cr	....	44 ppm	
Cu	....	190 ppm	
Ga	....	15 ppm	
Ge	....	49 ppm	Anal.—Lovering *et al.* (1957)

(Plate XI (b).)

37. SLEEPER CAMP — Stone, olivine-hypersthene-chondrite

Find, 1962, by H. Carlisle, about 15 miles north-north-east of Sleeper Camp which is situated 40 miles north of Haig on the Trans-Australia Railway Line. Latitude 30° 28′ S., longitude 126° 20′ E.

One mass, total weight 1·25 kg (2 lb. 12 oz.).

This collection : not represented.

Other collections : Kalgoorlie School of Mines, No. 9248, *main mass*, 1·25 kg.

Analytical details, etc : complete fusion crust covers the fragment which is of facetted form. Probably part of a shower with Billygoat Donga, North Haig, etc. (see note under Billygoat Donga).

(Plate XXII (a).)

38. TIERACO CREEK — Iron, fine-medium octahedrite (Of-Om)
(Synonym : Ticraco Creek)

Find, before 1922, near the head of Tieraco Creek, North Murchison Goldfields, Western Australia. Latitude 26° 20′ S., longitude 118° 20′ E. (approximate).

One mass, total weight 41·6 kg (91¾ lb.).

This collection: W.A.M. No. 1/4077 (Geological Survey of Western Australia collection), slice etched, 700 g and slice, 300 g.

Other collections: Australian Museum, Sydney, 16·47 kg; Harvard University, Cambridge, Mass., 21·9 kg; U.S. National Museum, Washington, 7·08 kg.

References: H, P, S.

HODGE-SMITH, T. and WHITE, H. P. (1926)—*Rec. Aust. Mus.* **15**: 66–68.

SIMPSON, E. S. (1938)—*Miner. Mag.* **25**: 163.

LOVERING *et al.* (1957)—*Geochim. et cosmoch. Acta* **11**: 263–278.

Analytical details, etc.:

Fe	....	89·06	
Ni	....	9·66	
Co	....	0·72	
Cu	....	Trace	
Pt	....	Trace	
Cr	....	Trace	
C	....	0·01	
P	....	0·20	
S	....	0·14	S.G. = 7·59
Total		99·79	Anal.—H. P. White (1926)

Further analysis:

Ni	....	10·55%	
Co	....	0·60%	
Cr	....	Less than 1 ppm	
Cu	....	110 ppm	
Ga	....	13 ppm	
Ge	....	23 ppm	S.G. = 8·1
			Anal.—Lovering *et al.* (1957)

(Plate XII (a).)

39. WINGELLINA — Stone, olivine-hypersthene-chondrite

Find, 1958, on stony ground four miles south-west of the intersection of the South Australian, Western Australian and Northern Territory borders, north of Hinkley Range. Latitude 26° 3′ S., longitude 128° 57′ E. Finder—J. E. Johnson.

One mass, total weight 200 g (7 oz.).

This collection: not represented, but exchange of a specimen arranged on return of main mass to Adelaide from the Australian National University. Other collections: South Australian Museum, Adelaide, *main mass*, 200 g.

(Plate XVII (b).)

40. WOLF CREEK Shale balls

Find, 1947, with the large Wolf Creek crater (p. 60), by F. Reeves, N. Sauve and D. Hart. Latitude 19° 18′ S., longitude 127° 46′ E.

Numerous masses, total weight several thousand kg.

This collection: W.A.M. No. 10474, two shale-balls showing "bread-crust" surface structure (presented by R. S. Matheson). Shale balls (presented by A. F. Trendall).

Other collections: University of Western Australia, about 50 shale balls (collected by G. J. H. McCall) including some with green zaratite (or garnierite?) inclusions. Also Australian Museum, Sydney; American Museum of Natural History, New York; Smithsonian Institution, Washington (numerous specimens); Institute of Meteoritics, University of New Mexico (several large specimens weighing more than 136 kg (300 lb.).)

References: P. See also list of references under Wolf Creek crater (p. 60).

Analytical details: the shale balls consist of iron oxides, mainly limonite with some haematite, minor specks of metallic nickel-iron and possibly schreibersite. They are weakly magnetic and react to a mine detector. No octahedral or other patterns recognisable. The green mineral referred to above tends to vein the iron oxides. Many show bread-crusting and form reminiscent of volcanic bombs; some show radiating structure and central circular voids. S.G. = variable but representative sample from interior of one specimen = 3·7.

(Plate VI (b).)

41. WONYULGUNNA Iron, medium octahedrite (Om)

Find, 1937, at Bald Hill, formerly Wonyulgunna Sheep Station, 21 miles south-east of Mount Wonyulgunna, just west of the 485 mile post on No. 1 Rabbit Proof Fence. Latitude 24° 55′ S., longitude 120° 4′ E.

Finder—an aboriginal, Wally Work, reporter—O. M. Bender, donor—O. M. Bender.

One mass, total weight 37·9 kg (83·5 lb.), 42 x 29 x 13 cm, showing deep pitting.

This collection: W.A.M. No. 68965, *main mass*, with small slice missing, 33·6 kg; S3532, two small fragments weighing 7 g and 8 g and saw cuttings (Simpson collection).

Other collections: Australian Museum, Sydney, 260·5 g; British Museum (Natural History), London, 948 g.

References: H, P, S.

SIMPSON, E. S. (1938)—*Miner. Mag.* **25**: 164–165.

LOVERING *et al.* (1957)—*Geochim. et cosmoch, Acta* **11**: 263–278.

Analytical details, etc. : incomplete analysis.

Ni	....	8·26	
S	....	1–1·5	S.G. = 7·68 and 7·74
			Anal.—E. S. Simpson

Further analysis :

Ni	....	9·05%	
Co	....	0·51%	
Cr	....	1·2 ppm	
Cu	....	118 ppm	
Ga	....	13 ppm	
Ge	....	34 ppm	Anal.—Lovering *et al.* (1957)

(Plates IV (b) and XII (b).)

42. WOOLGORONG — Stone, a veined, recrystallized and brecciated olivine-hypersthene-chondrite. Evidence of oriented form (Chy)

Fall, about 20th December, 1960, recorded on Woolgorong Station, immediately south of the Murchison River, north-north-west of Mullewa, Murchison District, Western Australia. Latitude 27° 45′ S., longitude 115° 50′ E.

Find, July 1961, of numerous fragments in a shallow burial and on the surface at the point of the fall recorded six months earlier, finders—W. Hamlet, C. Monger. Reporter and donor—F. R. Wickman.

Numerous masses, five large fragments and many smaller ones, total weight 32–36 kg (70–80 lb.).

This collection : W.A.M. No. 12123, five large fragments, numerous small fragments, many with fusion crust showing striae and regmaglypts—thumb-prints and elongated regmalgypts ; crust thickened and black, showing polygonal shrinkage cracks on posterior side, thin and brown on anterior side. Chondrules rounded, angular and fragmental up to half a centimetre diameter ; predominantly silicate chondrules, some metal pellets (chondrules). Also felspar-glass-sulphide chondrules. Several fragments show an exact fit and one-third of the entire meteorite mass can be re-assembled. Veining by sulphide—also glassy veins (second type of Krinov).

Other collections : Geological Survey of Western Australia collection 1/4878, fragment showing perfect thumb-prints, weight 458·8 g ; Government Chemical Laboratories, Perth, specimen 562 g ; British Museum (Natural History), London, one small fragment ; American Museum of Natural History, New York, 700 g.

References :

Described by G. J. H. McCall and P. M. Jeffery. (1964) The Woolgorong stony meteorite. *J. roy. Soc. W. Aust.* **47**: 33–42.

Lord, J. H. (1963)—Unpublished record No. 1963/20 of Geological Survey of Western Australia.

Analytical details :

Fe	....	6·31
Ni	....	0·99
Co	....	0·05
FeS	....	6·43
SiO_2	....	39·95
TiO_2	....	0·10
Al_2O_3	....	2·98
Cr_2O_3	....	0·54
P_2O_5	....	0·09
MnO	....	0·29
FeO	....	14·07
MgO	....	24·88
CaO	....	1·89
Na_2O	....	1·04
K_2O	....	0·14
H_2O-	....	0·04
H_2O+	....	0·09
Total	....	99·88

S.G. = (5 random samples, McCall) 3·45, 3·46, 3·53, 3·54, 3·58. Average = 3·51

Anal.—A. A. Moss, British Museum (Natural History).
Ratios Iron/nickel = 6·3
MgO/FeO = 3·14

Normative mineralogical composition

Olivine (close to $Mg_{1\cdot5}$, $Fe_{0\cdot5}$, SiO_4)	46·94
Bronzite*	25·19
Felspar‡	12·69
Ilmenite	0·18
Chromite	0·81
Apatite	0·21
Troilite	6·43
Nickel-Iron (Ni/Fe = 1/6·3)	

Further analysis : carried out by Government Chemical Laboratories, Perth. Anal.—M. B. Costello. Shows no marked divergence. Mineralogical details—optical recognition ; metallic fraction, kamacite 10–12% plus a sulphide, troilite also (chemical test). Silicate fraction : olivine (chrysolite-hyalosiderite) and also pyroxene (non-pleochroic hypersthene), together amounting to 80% ferromagnesians. Oligoclase (partly twinned) (An_{20-28}) c. 5–10%, very variable distribution. X-ray diffraction studies resulted in recognition of kamacite, olivine, orthopyroxene (enstatite-hypersthene) (originally by Jeffery and confirmed by Moss). No X-ray confirmation of troilite but reflected light microscopy confirms ; very tentative identification of rankinite (? unlikely). Mason identified the olivine as Fa_{25}.

(Plates XX (a) and XXVI (b).)

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* Bronzite norm. includes excess $CaSiO_3$.

‡ Felspar norm. values are Or.31 remainder plagioclase, c. An_{40}.

43. YALGOO Stone, white olivine-hypersthene-chondrite (Chy)

Find, exact date not certain but known before 1937. The mass weighing 850 g was found in the store-room of the Western Australian Museum and is labelled " portion of a meteorite found near Yalgoo, Western Australia." The exact provenance is not known; there are marked similarities to Mellenbye (*q.v.*), though it is darker and richer in metal. This is possibly the fragment referred to as " found by G. E. P. Wellard at Mellenbye." Latitude 28° 21′ S., longitude 116° 41′ E. is usually given as the position of this find but this is the position of Yalgoo.

One mass, total weight 0·85 kg (1 lb. 14 oz.).

This collection: W.A.M. No. G8508, whole mass weighing 0·85 kg.

References: H, P, S.

SIMPSON, E. S. (1938)—*Miner. Mag.* **25**: 165.

Analytical details: nickel-iron 10%. S.G. = 3·42 (Simpson) (low value due to iron oxides evident in weathered stone). Olivine Fa_{27} (Mason). (The unusual olivine shared by Yalgoo and Mellenbye supports the view that they are probably parts of one fall.)

(Plate XX (b).)

44. YARRI Iron, medium to coarse octahedrite (Om-Og)

Find, before 1908, by a prospector, near Yarri, Western Australia. Latitude 29° 30′ S., longitude 122° 20′ E. (approximate). The exact locality of this meteorite find is not known.

One mass, total weight 1·5 kg (5 lb. 5 oz.).

This collection: not represented.

Other collections: Kalgoorlie School of Mines, *main mass* 1·5 kg (whole fragment with pitted surface, one corner cut to show etch pattern). One small piece given to H. H. Nininger (exch.).

(Plate XIV (c).)

45. YOUANMI (Synonym: Youanme) Iron, medium octahedrite (Om)

Find, 1917, 50 miles north of Youanmi, Western Australia. Latitude 27° 54′ S., longitude 118° 45′ E. Reporter—A. W. Winzar.

One mass, total weight 118·4 kg (261 lb.).

This collection: W.A.M. No. 10640, whole mass with slice removed; S1175, one slice containing large fragments of troilite, 175 g (Simpson collection); S1171, one slice weighing 110 g, one small fragment weighing 1 g (Simpson collection); 1/4704 (Geological Survey of Western Australia collection), etched slice with troilite nodule weighing 920 g.

References: H, P, S.

ANON. (1918)—*Annu. Progr. Rep. geol. Surv. W. Aust.* **1917**: 19, 22.
SIMPSON, E. S. (1938)—*Miner. Mag.* **25**: 165–166.

Analytical details, etc. :

Fe	....	91·97	
Ni	....	8·08	
Co	....	0·87	
Cu	....	0·11	
Si	....	0·01	
P	....	0·15	
S	....	0·02	
C	....	0·05	S.G. = 7·6
Total		100·46	Anal.—E. S. Simpson.

(Plates I (b) and X (b).)

46. YOUNDEGIN I and YOUNDEGIN II (Synonyms : Penkarring Rock, Pickarring Rock, Yundagin, Yundegin apply to the whole Youndegin group) — Irons, coarse octahedrite (Og-Ogg)

Find, 1884, apparently north-west of Pikaring Rock, a granite hill in the wheat belt, south-east of Quairading, Western Australia (this find has no apparent connection with Youndegin locality). Latitude 32° 2′ S., longitude 117° 35′ E. Finder—A. Eaton.

Two masses, total weight, Youndegin I—11·7 kg (25¾ lb.) ; Youndegin II—10·9 kg (24 lb.).

This collection : not represented.

Other collections : Youndegin I—British Museum (Natural History), London, 9·82 kg (*main mass*) and 317 g ; Youndegin II, *main mass*—National Museum, Melbourne, 10·9 kg (24 lb.).

References : H, P, S.

FLETCHER, L. (1887)—*Miner. Mag.* **7** : 121–130.
———— (1899)—*Miner. Mag.* **12** : 171–174.
———— (1908)—*Miner. Mag.* **15** : 147–152.
SIMPSON, E. S. (1938)—*Miner. Mag.* **25** : 166–169.

Analytical details, etc. :

Fe	....	92·67	
Ni	....	6·46	
Co	....	0·55	
Cu	....	Trace	
Mg	....	0·42	
P	....	0·24	
Insolubles		0·04	S.G. = 7·86, 7·85, 7·72
Total		100·38	Anal.—L. Fletcher (1887)

FIG. 4

SKETCH MAP SHOWING APPROXIMATE LOCATIONS OF THE YOUNDEGIN METEORITE SHOWER

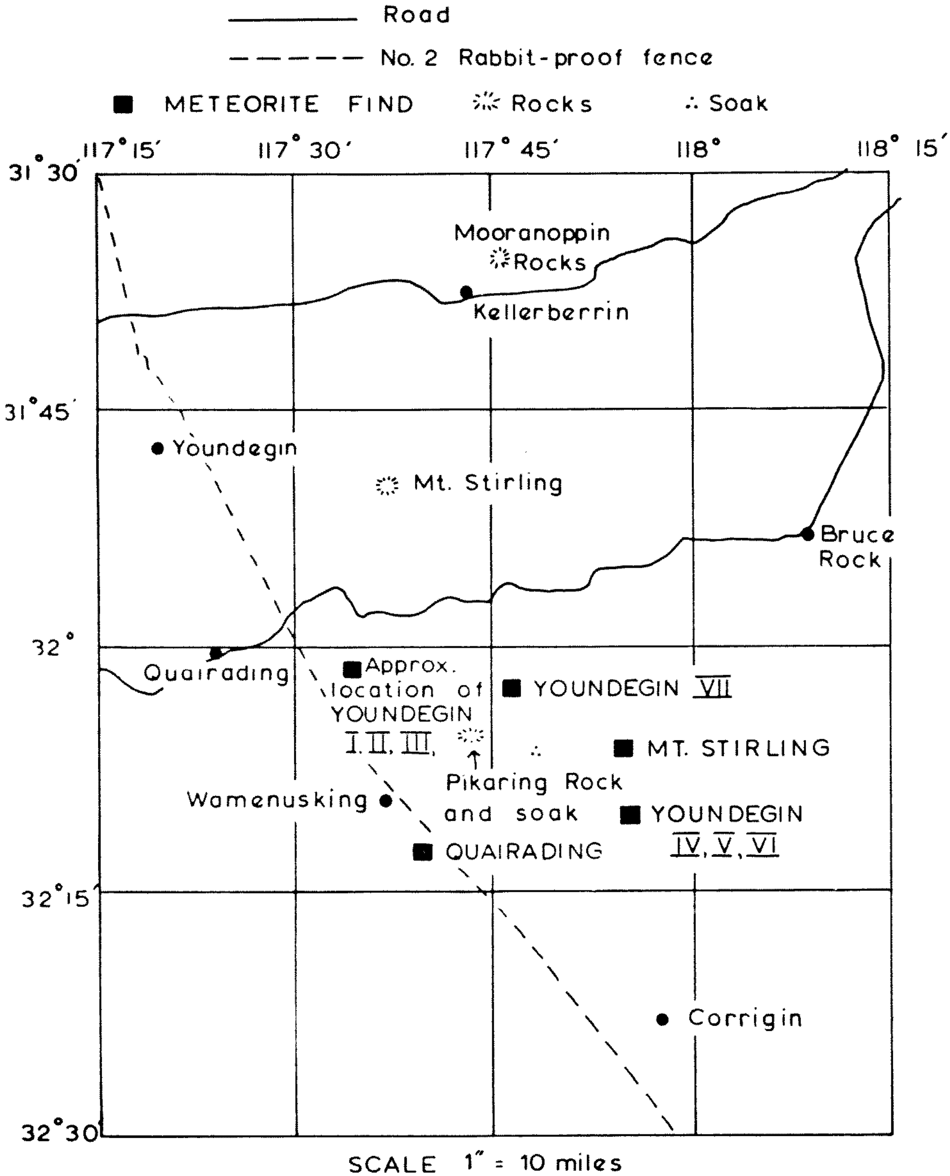

Figure 4. Sketch map showing approximate locations of the Youndegin meteorite shower.

YOUNDEGIN III — Iron, coarse octahedrite (Og-Ogg)

Find, 1884, as Youndegin I and II. Finder—A. Eaton. Simpson believed Youndegin III was found north-west of Pikaring Rock, near Quairading.

One mass, total weight 7·9 kg (17½ lb.).

This collection: W.A.M. No. 11978, three cut etched sections 975 g, 530 g, 80 g; 11977, cut section 5 kg (*main mass*); S1173, polished specimen 23 g (Simpson collection); 1/4703, cut etched slice, 350 g (Geological Survey of Western Australia collection).

Other collections: none (though note Prior and Hey (1953)).

References: H, P, S.

SIMPSON, E. S. (1916)—*Bull. geol. Surv. W. Aust.* no. 67: 136.
———— (1938)—*Miner. Mag.* **25**: 166–169.

Analytical details, etc.:

Fe	....	91·67	
Ni	....	7·01	
Co	....	0·93	
Cu	....	0·02	
P	....	0·30	
Si	....	0·01	
C	....	0·15	S.G. = 7·6
Total		100·09	Anal.—H. Bowley

Reported difficult to cut due to presence of cohenite.

(Plate XIII (b).)

YOUNDEGIN IV, YOUNDEGIN V and YOUNDEGIN VI — Irons, coarse octahedrite (Og-Ogg)

Find, 1884, 1891, 1892 by A. Eaton and L. Knoop. On Knoop's property 10 miles north of Corrigin, 19 miles due east from the 44 mile peg of the No. 2 Rabbit Proof Fence, about eight miles south-east of Pikaring Rock. Exact latitude and longitude not known, but approximately latitude 32° 10′ S., longitude 118° 50′ E.

Three masses, total weight Youndegin IV—2·72 kg (6 lb.), Youndegin V—173·5 kg (382½ lb.), Youndegin VI—927·0 kg (2,044 lb.).

This collection: not represented.

Other collections: Youndegin IV—British Museum (Natural History), London, 2·7 kg (*main mass*); Youndegin V—Field Museum of Natural History, Chicago, 173 kg (*main mass*); British Museum (Natural History), London, three specimens 740 g; American Museum of Natural History, New York, 3·23 kg; Youndegin VI—Naturhistorisches Museum, Vienna, 927 kg.

References : H, P, S.

GREGORY, J. R. (1892)—*Nature, Lond.* **47** : 90–92 (Youndegin V).
ANON. (1893)—*Nature, Lond.* **47** : 469–470 (Youndegin VI).
BREZINA, A. (1895)—*Ann. naturh. (Mus.) Hofmus., Wien* **10** : 358, 368.
ANON. (1900)—*Bull. geol. Surv. W. Aust.* no. 4 : 96–97 (Youndegin V and Youndegin VI).
SIMPSON, E. S. (1938)—*Miner. Mag.* **25** : 157–171.

Analytical details, etc. : none.

YOUNDEGIN VII — Iron, coarse octahedrite (Og-Ogg)

Find, 1929, at Finkelstein's Farm, near (? four miles north-east of) Pikaring Rock, south-east of Quairading. Latitude 32° 3′ S., longitude 118° 46′ E.

Finder—Mr. Finkelstein.

One mass, total weight 4·1 kg (9 lb.).

This collection : S1162f, cut section 169 g (Simpson collection).

Other collections : Government Chemical Laboratories, Perth, *main mass*, 3·9 kg (8 lb. 8½ oz.).

References : H, P, S.

SIMPSON, E. S. (1938)—*Miner. Mag.* **25** : 166–169.

Analytical details, etc. : none.

YOUNDEGIN VIII — Iron, coarse octahedrite (Og-Ogg)

Finds, 1891–1929 by L. Knoop and others.

Several masses, total weight 13·6 kg (30 lb.).

This collection : not represented.

Other collections : several private collections.

References : H, P, S.

SIMPSON, E. S. (1938)—*Miner. Mag.* **25** : 166–169.
LOVERING *et al.* (1957)—*Geochim. et cosmoch. Acta* **11** : 263–278.

Analytical details, etc. :

Ni	....	6·92 %	
Co	....	0·49 %	
Cr	....	2·5 ppm	
Cu	....	155 ppm	
Ga	....	88 ppm	
Ge	....	322 ppm	Anal.—Lovering *et al.* (1957)

METEORITE CRATERS

Two possible meteorite craters were reported by E. S. Simpson (1938). The first, the Dalgaranga crater, is certainly associated with meteorite fragments, but the crater described from east of Pikaring Rock near Quairading and supposed to be associated with the Youndegin-Mount Stirling-Mooranoppin-Quairading multiple fall of iron meteorites has subsequently, in February, 1963, been investigated by G. J. H. McCall and J. B. J. Jeppe using a magnetometer. Geological and geophysical evidence then obtained suggested that this small crater, whatever its origin, has no relation to the nearby occurrence of iron meteorites, and is not an impact crater. The Dalgaranga crater has later been investigated by Nininger and Huss (1960) and visited by McCall and E. P. Henderson, but even so would justify further detailed investigation, including petrographic study of the bed rock and systematic trenching of the interior fill.

Dalgaranga Crater

Latitude 27° 43′ S., longitude 117° 15′ E. Discovered in 1923 by G. E. P. Wellard, who noted metallic fragments associated with it, it was first recorded by Simpson who only described a small, twisted octahedrite fragment. H. H. Nininger and G. I. Huss visited the crater in 1960 and recorded more details of the actual form of the crater and recovered not only iron fragments but silicate bearing fragments, plotting their distribution. The crater is 70′ in diameter and has a maximum depth of about 10′. It is situated exactly on the junction of discontinuous exposure of granite and laterite capping granite. Nininger and Huss recovered 207 specimens weighing 1,098 g. Most were octahedrite specimens but 25 fragments contained enough silicate to be classified as stony-iron and two weathered specimens were regarded as stones. Some weathered fragments have shale ball form (see entries under meteorites, pp. 28–30 for details of these meteorite recoveries). Nininger assesses the total mass as 20,000–30,000 kg (10–20 tons), and suggested that it consisted of 90 % of silicate, sulphide and carbon and only 10 % iron. Mason (verbal communication) suggests that this material is derived from an iron meteorite with silicate inclusions (p. 29). Nininger speculated on the age of the crater suggesting an age of 25,000 years (plus or minus). In September 1963, E. P. Henderson and G. J. H. McCall recovered a few more fragments (mostly weathered). They noted that the fill of this crater is of two types of material, an upper layer of granite boulders and soil and a lower layer of coarse but stratified sediments, composed of material clearly derived from the nearby granite and possibly representing an aeolian deposit in a period of more arid conditions than pertain to the present time. This deposit is being investigated; its presence certainly supports Nininger's suggestion that the crater is of prehistoric age.

References: H, P, S.

SIMPSON, E. S. (1938)—*Miner. Mag.* **25**: 157.

NININGER, H. H. and HUSS, G. I. (1960)—*Miner. Mag.* **32**: 619–639.

(Plate XXVIII (c).)

Wolf Creek Crater

The most remarkable of the Western Australian craters was not discovered to science until June 1947, when it was recognised from the air. It was visited by F. Reeves, N. B. Sauve and D. Hart (1949) and later by D. J. Guppy and R. S. Matheson (1950). Both the original sets of authors considered this to be a meteorite explosion crater, akin to the famous Arizona Crater. Cassidy (1954) searched for minute metallic spheroids without avail, but recovered shale-balls up to more than 136 kg (300 lb.) weight, described by La Paz (1954) as oriented meteorites. This latter interpretation is not favoured by McCall (1964) who considers that the fact that the Wolf Creek shale-balls display the typical forms of volcanic bombs indicates that they must have stemmed from a melt and not simply weathering of fragments of meteoritic iron. Whipple (1952) had earlier noted that the meteoritic origin of this crater is not definitely established and other geologists have considered the existence of diapiric structure and diatremes in this region suggestive of another origin. McCall (1965) however, concludes that its origin is still open to question ; that it is most probably due to meteorite impact explosion and almost certainly is congenetic with the Arizona Crater, but that the remote possibility that it is a reflection of a rare and hitherto unrecognised form of cryptovulcanism should not perhaps, as yet, be completely ruled out—particularly in the light of anomalies of structure. B. Mason and E. P. Henderson recovered further samples from the crater in 1963 and the latter proposes to carry out further metallographic and petrological investigations ; he has suggested (verbal communication), on the basis of preliminary examination that some of the bright specks of nickel-iron include phosphide (schreibersite).

The crater is almost circular but a faint trace of polygonality is evident. It is situated within a crater-mound, rising from the sand-plain country in which sparse exposures of Proterozoic (early Precambrian) (?) ortho-quartzite occur. The strike orientation of the quartzite in crater-mounds is almost perfectly concentric, but the deformation pattern which includes several zones of overturning is not regularly symmetrical, the deformation being restricted to simple upwarping on the east side of the crater wall and much more complex structures elsewhere. No coesite, stishovite, lechatelierite, rock-flour or shatter-cones have been recognised. The crater is filled with wind-blown sand and gypsum, the latter, pierced by sink-holes, occupying the central area of the floor. A radial pattern of faulting has resulted in rifts or grooves in the crater walls. The crater is younger than the laterite which is widely accepted as of Miocene age. Physiographic considerations suggest that an age somewhere between the limits of the Pliocene epoch is the most likely one. It is clearly considerably older than the Arizona crater and this fact alone could account for the absence of minute metallic spheroids. Shale-balls occur mainly on laterite and are often discovered lightly welded into the laterite singly or in groups. They occur both on the laterite peripheral to the crater-mound and also inside the crater as talus on the crater wall (see p. 52 for description of these shale-balls). There is no evidence of magnetic anomaly.

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(Plates XXVIII (a) and (b).)

SYNONYMS

Ashburton Downs—(Dalgety Downs I)

Bandya—(Duketon)

Burracoppin—(Lake Brown)

Duck Creek—(Mount Edith I)

East Mount Magnet—(Mount Magnet)

Hamersley Range—(Roebourne)

Lake Giles—(Mount Dooling)

Landor—(Landor Station)

Loongana—(Forrest Lakes)

Mallenbye—(Mellenbye)

Mandiga—(Bencubbin II)

Penkarring Rock, Pickarring Rock, Yundagin,
Yundegin—(Youndegin I and Youndegin II)

Siberia—(Mount Egerton?)

Ticraco Creek—(Tieraco Creek)

Youanme—(Youanmi)

Youndegin IX—(Quairading)

Part II—Meteorites from Australia

(excluding Western Australia)

(References to all these are given in " Australian Meteorites " by T. Hodge-Smith, Australian Museum, Sydney, 1939)

BARRATTA
(Synonym : Baratta or Deniliquin)

Stone, black olivine-hypersthene- or olivine-bronzite-chondrite

Find, 1945, 30 miles north-west of Deniliquin, New South Wales. Three masses found at this time and two further finds in 1852 and 1899. Latitude 35° 16′ S., longitude 144° 32′ E.

Five masses, total weight recovered 101·5 kg ; weighing 65·8 kg (145 lb.), 14·6 kg (31 lb.), 21·8 kg (48 lb.), 21·8 kg (48 lb.), 79·4 kg (175 lb.).

This collection : W.A.M. No. 11970, fragment, probably part of Barratta No. 5, weight 81 g ; G7553, polished slice, 200 g (Geological Survey of Western Australia).

BOX HOLE

Iron, medium octahedrite (Om)

Find, 1936 or 1937, at Box Hole crater, 120 miles north-east of Alice Springs, Northern Territory. Latitude 22° 37′ S., longitude 135° 12′ E.

Several masses including one of 82 kg, associated with shale balls (see below). This collection : W.A.M. No. 2/1872 (Geological Survey of Western Australia, permanent loan), one etched slice, 1,046 g.

Shale-balls associated with meteoritic iron but no impactite or silicate glass so far recorded.

Meteorite (siderite) and shale-ball association, distributed near to the Box Hole crater, Box Hole Station, Plenty River, Central Australia. Latitude 22° 37′ S., longitude 135° 12′ E. The crater is 575 feet in diameter and 30–52 feet deep and is formed in alluvium.

This collection : W.A.M. No. 2/1873, one shale-ball showing bread crust structure (Geological Survey of Western Australia collection).

CRANBOURNE
(Synonyms : Abel, Beaconsfield, Bruce, Dandenong, Langwarrin, Melbourne, Pakenham, Victoria, Western Port District, Yarra Yarra River)

Iron, coarse octahedrite (Og)

Find, 1854, near Cranbourne, Victoria (six meteorites and also one each at Beaconsfield and Langwarrin, Victoria). Latitude 38° 6′ S., longitude 145° 18′ E.

This collection : W.A.M. No. G8095, a number of small fragments weighing 32 g.

GILGOIN — Stone, crystalline olivine-bronzite-chondrite

Find, 1889, at Gilgoin Station, 40 miles east-south-east of Brewarrina, New South Wales. (Another specimen, weighing 11·9 kg (26¼ lb.) was found in 1920.)

Latitude 30° 23′ S., longitude 147° 20′ E.

Seven masses, total weight 135·2 kg (298 lb.).

This collection: W.A.M. No. 11969, four polished fragments weighing 104 g.

HART RANGE — Iron, medium octahedrite (Om)

Find, from Hart Range area, Central Australia (exact location not known).

Number of masses not known.

This collection: W.A.M. No. 2/2851 (Geological Survey of Western Australia collection), one fragment showing octahedral etch pattern, weight 608 g.

HENBURY — Iron, medium octahedrite (Om)
Broken metallic fragments

Find, 1931, associated with craters and impactites. Seven miles west-south-west of Henbury Station, Finke River, Central Australia. Latitude 24° 34′ S., longitude 133° 10′ E. Finder—H. A. Ellis.

Numerous masses, total weight considerable, more than 907 kg (2,000 lb.).

This collection: W.A.M. No. S2598, slice of iron with polished face, weight 300 g and six small fragments (Simpson collection); 2/1866, 2/1867 and 2/1868 (Geological Survey of Western Australia collection), six distorted fragments of iron weighing 350, 250, 230, 96, 73, and 37 g, slice of iron with etched face and troilite inclusions, 840 g, iron oxide shale-balls 178, 75, 22 and 15 g. Also impactite specimens (see under impactite association for details of shale-ball and impactite).

Other collections: Government Chemical Laboratories, Perth, two fragments of siderite weighing 2·9 kg (6 lb. 6½ oz.) and 2·1 kg (4 lb. 11 oz.).

Impactite and shale-balls

Association of impactite glass, shale-balls, and siderite. Close to and within a series of craters (13, one large oval crater about 200 yards diameter and 12 smaller craters).

This collection: W.A.M. No. 2/1869, 2/1870, 2/1871 (Geological Survey of Western Australia collection); S2598 (Simpson collection); shale-balls 178, 75, 22 and 15 g; impactite slag fragment and black impactite glass fragment.

KYANCUTTA — Iron, medium octahedrite (Om)

Find, June 1932, 28 miles east-south-east of Kyancutta, South Australia. Latitude 33° 10′ S., longitude 135° 25′ E. Finder—L. G. Gardiner.

One mass, total weight 32·7 kg (72 lb.).

This collection: W.A.M. No. 2/1874 (Geological Survey of Western Australia collection), one slice, etched, weighing 750 g.

LAKE LABYRINTH — Stone, intermediate enstatite-chondrite

Fall, February 5th, 1924 (probably part of the Kingoonya fall).

Find, October 1934, eight miles north of Peela Rock-hole and well, Wilgena Station, South Australia, 20 miles north of Lake Labyrinth. Latitude 30° 20′ S., longitude 135° 20′ E.

Numerous fragments, total weight 34 kg (75 lb.).

This collection: W.A.M. No. 2/1875, portion with polished faces weighing 450 g (Geological Survey of Western Australia collection).

LANGWARRIN — Iron, coarse octahedrite (Og)

Find, 1886, five miles south-east of Langwarrin Railway Station, Mornington, Victoria (believed to be part of the Cranbourne shower). Latitude 38° 12′ S., longitude 145° 14′ E. Finder—A. H. Hadley.

One mass(?), total weight, 914 kg (18 cwt).

This collection: W.A.M. No. G8096, a surface fragment weighing 21 g.

MOUNT BROWNE — Stone, spherical olivine-bronzite-chondrite

Fall, 1902, July 17th, 9·30 a.m., Mt. Browne, County Evelyn, New South Wales, with detonations. Latitude 29° 48′ S., longitude 141° 47′ E.

One mass, 11·3 kg (25 lb.).

This collection: not represented.

Other collections: University of Western Australia collection, thin section.

MUNGINDI — Iron, finest octahedrite (Off)

Find, 1897, three miles north-north-west of Mungindi Post Office, New South Wales, just across Queensland border. Latitude 29° S., longitude 149° E.

Finder—L. Troutman.

Two masses, weight 28·1 kg (62 lb.) and 23·1 kg (51 lb.) respectively.

This collection: W.A.M. No. 11971, etched slice with troilite, 120 g.

NOCOLECHE — Iron, medium octahedrite (Om)

Find, 1895, five miles south-west of Nocoleche Station, near Wanaaring, 40 miles north-west of Bourke, New South Wales. Latitude 29° 35′ S., longitude 144° 10′ E.

One mass, weight 20 kg (44 lb.).

This collection: 11973, etched slice, weight 57 g.

Part III—Meteorites from Outside Australia

All but those marked with an asterisk are included in the *Catalogue of Meteorites* (British Museum (Natural History)—Prior & Hey, 1953) or *Principles of Meteoritics* (Krinov, 1960) in the case of Russian meteorites.

ALFIANELLO — Stone, intermediate olivine-hypersthene-chondrite

Fall, 1883, February 16, 3 p.m., Brescia, Cremona, Italy, with detonation.

One mass, 228 kg.

This collection : not represented.

Other collections : University of Western Australia, one thin section.

BARBOTAN — Stone, veined grey chondrite

Fall, 1790, July 24, 9 p.m., at Barbotan, Gers, Landes, France, with detonation and fireball in a shower.

Numerous masses, weight unknown.

This collection : not represented.

Other collections : University of Western Australia, one thin section.

BEAVER CREEK — Stone, crystalline spherical olivine-bronzite-chondrite

Fall, 1893, May 26, 3.30 p.m., at Beaver Creek, West Kootenay District, British Columbia, Canada.

One mass, 14·1 kg (31 lb.).

This collection : not represented.

Other collections : University of Western Australia, one thin section.

BETHANY (Synonym : Gibeon) — Iron, fine octahedrite (Of)

Find, 1899, Mukerop, near Bethany, Great Namaqualand, South-West Africa.

This collection : W.A.M. No. 8629, one slice with etched face, 56 g.

BJURBÖLE — Stone, spherical olivine-hypersthene-chondrite

Fall, 1899, March 12, 10.30 p.m., at Bjurböle, Borgä, Nyland, Finland.

One mass, fragmented, total weight 330 kg.

This collection : W.A.M. No. 12275, two pieces, 138 g.

BLUFF — Stone, brecciated crystalline olivine-hypersthene-chondrite

Find, 1878, Fayette County, Texas, U.S.A.

One mass, 145 kg (320 lb.).

This collection : not represented.

Other collections : University of Western Australia, one thin section.

BOGUSLAVKA (Synonym : Boguslawka) Iron, hexahedrite

Fall, 1916, October 18, 11.47 a.m., on the valley of the Beichikhe River, five km from Boguslavka in the Grodekovo District, Primor'e (Maritime) Territory, R.S.F.S.R.

Two specimens, total weight 256·8 kg.

This collection : cut etched section, weight 58·1 g.

BONITA SPRINGS* Stone, olivine-bronzite-chondrite

Find, 1938, Bonita Springs, Lee County, Florida. Was recovered from a sand mound with human bones and is thought possibly to have formed part of an ancient burial.

Total weight, 41·2 kg.

This collection : one polished slice, 275 g (exch. Smithsonian Institution, Washington).

BRENHAM (Synonym : Haviland Township, Kiowa) Stony-iron, pallasite passing into iron in nodules

Find, 1882, Brenham Township, Kiowa County, Kansas, U.S.A.

20 masses, total weight 907 kg (2,000 lb.).

This collection : W.A.M. No. 12273, fragment, 134 g.

CALLIHAN* Stone, chondrite

Recognised, 1958, near Callihan, Texas, U.S.A.

Number of masses not known, total weight 4 kg.

This collection : W.A.M. No. 12938, cut slice with fusion crust weighing 125·5 g (exch. H. H. Nininger).

CANYON DIABLO (Synonym : Cañon Diablo) Iron, octahedrite (Og)

Find, 1891, Coconino County, Arizona, associated with the well-known crater called variously Coon Butte, Crater Mound, Meteor Crater or Canyon Diablo crater.

Numerous masses, total weight over 30,482 kg (30 tons), many masses showing shale-ball character but native metal cores may reveal Widmanstatten pattern.

This collection : Kalgoorlie School of Mines, Western Australia, two fragments, one (8778) faced and etched complete fragment, weight 104 g (exch. H. H. Nininger, catalogue 34.3857) ; one (2827) complete fragment not faced or etched, weight 15 g.

Impactite and meteorite association

Peripheral to the well-known crater near Winslow, Arizona, U.S.A.

This collection : W.A.M. No. 12058, one bottle of metal spheroids, weight 22 g. Also plate of spheroids, polished from topsoil. Impactite fragments, weight 6 g.

Other collections : University of Western Australia collection, 42017 spheroids, 42021 impactite.

CHINGE — Iron, nickel-rich ataxite

(Synonyms : Tannu-Ola, Chinga, Tschinga, Tschinge, Urgailyk-Chinge, Tchinge)

Find, 1912, in the Urgailyk-Chinge Creek of the Elegest system, Tannu-Ola Range, Tuva Autonomous Oblast, R.S.F.S.R.

Scores of specimens, total weight c. 80 kg.

This collection : cut etched section, total weight 43 g.

DIMMITT — Stone, chondrite

Find, known before 1947, Castro County, Texas, U.S.A.

21 or more masses, weighing 13½ kg.

This collection : not represented.

Other collections : Kalgoorlie School of Mines, Western Australia, one slice (8777), weight 24 g (exch. H. H. Nininger, his catalogue 584.21).

DISKO ISLAND* — Telluric nickel-iron

Blafjeld, Disko Island, West Greenland.

Numerous masses, separate and included in basalt lava.

This collection : W.A.M. No. 12192, one slice of solid iron and one slice of basalt containing specks of iron.

Analytical details : this material contains up to 6·5% nickel and has been reported to show Widmanstatten etched figures. Its origin is obscure but it is certainly endogenous ; natural smelting of adjacent pyrrhotite ores has been suggested. (First described by Baron von Nordenskjold and later by O. B. Bøggyld).

EAGLE STATION (Synonym : Eagle) — Stony-iron, pallasite

Find, 1880, Eagle Station, Carroll County, Kentucky, U.S.A.

One mass, total weight about 36·6 kg (80 lb.).

This collection : W.A.M. No. 8630 (Geological Survey Collection), fragment polished and etched, weight 9 g.

ESTACADO — Stone, crystalline olivine-bronzite-chondrite

Find, 1883, Hale County, Texas, U.S.A.

One mass, total weight 290 kg.

This collection : not represented.

Other collections : Perth Observatory, fragment showing fine needle-like crystals and thin fusion crust, weight 85 g (⅜ oz.).

Estherville — Stony-iron, mesosiderite

Fall, 1879, May 10, 5 p.m., at Estherville, Emmet County, Iowa, U.S.A.

Several masses, weighing over 317 kg (700 lb.). The two largest weighing 198 kg (437 lb.) and 68·5 kg (151 lb.). Also hundreds of small fragments of nickel-iron. Accompanied by fireball and detonation effects.

This collection : not represented.

Other collections : Perth Observatory, small fragment showing complete fusion crust cover and pitted surface, weight 7·1 g (¼ oz.).

Farmington — Polymict, brecciated, black olivine-hypersthene-chondrite

Fall, 1890, June 25, 1 p.m., at Farmington, Washington County, Kansas, U.S.A. with fire-ball and detonation.

Two masses, total weight 89·4 kg (197 lb.).

This collection : not represented.

Other collections : University of Western Australia, one thin section.

Forest City — Stone, spherical olivine-bronzite-chondrite, brecciated

Fall, 1890, accompanied by a fireball and detonations at Forest City, Winnebago County, Iowa, U.S.A.

Numerous masses, total weight 122 kg.

This collection : W.A.M. No. 12274, one piece 80 g.

Gressk — Iron, hexahedrite

Find, 1955, village Pukovo, Gressk District, Minsk Region, Bielorussian S.S.R.

One mass, total weight 300 kg.

This collection : one slice, etched, weighing 500·8 g.

Haviland — Meteorodes

Find, 1937, Haviland, Kiowa County, Kansas, U.S.A., associated with a very shallow crater.

Numerous masses, total weight 907 kg (2,000 lb.).

This collection : W.A.M. No. 12141, 12142, meteorodes (exch. H. H. Nininger).

Hayes Center — Stone, black chondrite

Find, 1941, at Hayes County, Nebraska, U.S.A.

One mass, total weight 4½ kg.

This collection : W.A.M. No. 12057, thin slice weighing 102 g (exch. H. H. Nininger).

Hessle — Spherical olivine-bronzite-chondrite

Fall, 1869, January 1, 12.30 p.m., at Hessle, Upsala, Sweden, with detonation, in a shower.

Numerous masses, total weight unknown.

This collection : not represented.

Other collections : University of Western Australia, one thin section.

IDER* Iron, medium octahedrite

Find, 1961, Ider, Dekalb County, Alabama, U.S.A.

Total weight c. 136 kg (c. 300 lb.). Recovered from a cotton field after 10 years ploughing. Thought to be very old and to have possibly fallen while the sediments (Pennsylvanian) were accumulating. Weathered state indicates great age and terrestrial age determined as over a million years. One of the oldest, if not the oldest known, meteorites but not definitely established that it is "syngenetic" with the sediments.

This collection: one polished section mounted in fibre-glass, 188 g. Shows marginal and vein weathering to magnetite, and brown limonitic exterior film (exch. Smithsonian Institution, Washington).

IMILAC Stony-iron, pallasite

Find, 1822, Imilac, Atacama, Chile.

Numerous masses, totalling several hundredweight, individuals up to 204 kg (450 lb.).

This collection: not represented.

Other collections: Government Chemical Laboratories, Perth, Western Australia, cut polished fragment, 160 g, showing olivine within meshwork of nickel-iron.

JOHNSTOWN Stone, achondrite diogenite

Fall, 1924, July 6th, 4.20 p.m., accompanied by detonations, at Johnstown, Weld County, Colorado, U.S.A.

27 masses, total weight 40¼ kg.

This collection: W.A.M. No. 12282, fragment 158 g and thin section.

KNYAHINYA Stone, polymict, brecciated, grey olivine-hypersthene-chondrite

Fall, 1866, July 9, 5 p.m., at Knyahinya, Nagy-Bereszna, Ungvar, Czechoslovakia, with fire-ball and detonation, in a shower.

Over a thousand masses, 500 kg.

This collection: not represented.

Other collections: University of Western Australia, one thin section.

LADDER CREEK Stone, crystalline spherical chondrite
(Synonym: Greeley County)

Find, 1937, at Ladder Creek, Greeley County, Kansas, U.S.A.

Numerous masses, total weight 35·1 kg.

This collection: W.A.M. No. 12124, cut polished slice weighing 153·3 g (exch. H. H. Nininger).

L'AIGLE — Stone, brecciated, intermediate hypersthene-chondrite

(Synonym : Aigla, Ober-Pfalz, Waldau)

Fall, 1803, April 26, 1 p.m., at L'Aigle, Orne, Normandy, France. Associated with a fire-ball, detonation and a shower of stones.

Numerous masses, totalling 2,000–3,000, total weight 37 kg, the largest 9 kg. This collection : unnumbered specimen, a cut cross section showing the entire section of one fragment, polished face, 177 g.

Other collections : University of Western Australia, thin section.

LOMBARD* — Iron, hexahedrite

Recognised as a meteorite 1953, Lombard, Montana, U.S.A.

Number of masses not known, total weight 7·2 kg.

This collection : W.A.M. No. 12143, one etched section weighing 83 g (exch. H. H. Nininger).

LONG ISLAND — Stone, veined, intermediate hypersthene-chondrite

Find, 1891, Long Island, Phillips County, Kansas, U.S.A.

3,000 masses from one stone, fragmented, 564·3 kg (1,244 lb.).

This collection : not represented.

Other collections : University of Western Australia, one thin section.

MCKINNEY — Stone, black hypersthene-chondrite

(Synonyms : MacKinney, Collin County, Rockport)

Find, 1870, at Collin County, Texas, U.S.A.

Two stones of which the larger weighed 100 kg.

This collection : W.A.M. No. 8628 (Geological Survey Collection), weighing 42 g.

MIGHEI — Stone, carbonaceous chondrite

(Synonyms : Elizabethpol, Elizavetpol, Migei, Migheia)

Fall, 1889, June, at Mighei, Olviopol, Kherson, Ukraine (now U.S.S.R.) with light and sound phenomena.

One mass, 8 kg.

This collection : not represented.

Other collections : University of Western Australia, one thin section.

MOCS — Stone, veined, white, olivine-hypersthene-chondrite

Fall, 1882, February 3, 4 p.m., at Mocs, Transylvania, Hungary, associated with luminous meteor and detonations.

Numerous masses (c. 3,000), total weight 300 kg, the largest stone 56 kg.

This collection : not represented.

Other collections : Perth Observatory, small fragment weighing 7·1 g (¼ oz.) University of Western Australia, thin section.

NESS COUNTY (1894) (Synonyms: Kansada, Ness City, Welmanville) — Stone, crystalline olivine-hypersthene-chondrite

Find, 1894, Ness County, Kansas, U.S.A.

Numerous masses, total weight 36 kg.

This collection: W.A.M. No. 12139, cut section with fusion crust weighing 54·6 g (exch. H. H. Nininger).

OAKLEY — Stone, crystalline olivine-bronzite-chondrite

Find, 1895, Oakley, Logan County, Kansas, U.S.A.

One mass, 27·7 kg (61 lb.).

This collection: not represented.

Other collections: University of Western Australia, one thin section.

OCHANSK (Synonyms: Okhansk, Taborg, Taborsk, Taborskoie Selo, Tabory) — Stone, polymict, brecciated, spherical olivine-bronzite-chondrite

Fall, 1887, August 30, 1 p.m., at Ochansk, Perm, Russia, with luminous meteor and detonations in a shower.

Numerous masses, total weight c. 500 kg.

This collection: not represented.

Other collections: University of Western Australia, one thin section.

PANTAR — Stone, veined chondrite

Fall, 1938, June 16, 8.45 p.m., at Pantar, Lanao, Philippine Islands.

Sixteen masses recovered but reported thousands "as big as rice grains" fell on the roofs. Total weight of large masses c. 10·3 kg.

This collection: W.A.M. No. 12127, cut polished fragment, 22·2 g (exch. H. H. Nininger).

PASAMONTE — Stone, achondrite, howardite

Fall, 1933, March 24, 5 a.m., at Pasamonte, Union County, New Mexico, U.S.A.

Seventy-five stones found in 1934 along a track 28 miles long.

Total weight of 75 masses c. 4 kg.

This collection: W.A.M. No. 12140, four small fragments, two showing fusion crust (exch. H. H. Nininger).

PINON — Iron, nickel-rich ataxite

Find, 1928 or 1930, Pinon, Otero County, New Mexico, U.S.A.

One mass, total weight 17·85 kg.

This collection: W.A.M. No. 12132, cut slice weighing 88 g (exch. H. H. Nininger).

PLAINVIEW — Stone, polymict, brecciated, veined intermediate chondrite

Find, 1917 and 1950, Hale County, Texas, U.S.A., two separate entries by Prior and Hey for Plainview and it is not certain which is here represented.

Numerous masses, weighing several hundred kg.

This collection : not represented.

Other collections : Kalgoorlie School of Mines, one slice (8776), weight 52 g (exch. H. H. Nininger, his catalogue 92169).

POTTER — Stone, polymict, brecciated, grey chondrite, with portions of black chondrite material included.

Find, 1941, at Potter, Cheyenne County, Nebraska, U.S.A. Some authorities put date of finding as 1938.

Numerous masses, total weight 261 kg.

This collection : W.A.M. No. 12133, slice cut and polished, weighing 181 g (exch. H. H. Nininger).

PULTUSK — Stone, veined, grey olivine-bronzite-chondrite

Fall, 1868, January 30, 7 p.m., at Pultusk, Warsaw, Poland.

Numerous masses (100,000), largest 9 kg, associated with a fire-ball and detonation.

This collection : not represented.

Other collections : Perth Observatory, one small fragment with thin fusion crust weighing 7·1 g (¼ oz.) ; University of Western Australia, thin section.

RANSOM — Stone, grey chondrite, metal-rich

Find, recognised as a meteorite 1938, Ransom, Ness County, Kansas, U.S.A.

Four masses, total weight 15 kg.

This collection : W.A.M. No. 12135, cut polished section, weight 317 g, showing fusion crust (exch. H. H. Nininger).

SARDIS — Iron, coarse octahedrite

Find, 1940, Sardis, Burke County, Georgia, U.S.A.

One mass, total weight 800 kg. Turned up during ploughing and possibly a very old meteorite.

This collection : one cut section mounted in fibre-glass, total weight 741 g (exch. Smithsonian Institution, Washington).

SELMA — Stone, spherical bronzite-chondrite

Find, 1906, Dallas County, Alabama, U.S.A.

One mass, total weight 140·6 kg (310 lb.).

This collection : W.A.M. No. 12178, one cut slice, total weight 510 g (exch. American Museum of Natural History, 1963).

SIKHOTE-ALIN | Iron, very coarse octahedrite

(Synonyms : Sichote-Alinsky, Ussuri)

Fall, 1947, February 12, 10.38 a.m. Associated with many small craters. In the Krasnoarmeisk District, Primor'e (Maritime) Territory, R.S.F.S.R.

Thousands of specimens, total weight estimated at 71,000 kg (70 tons), but 23,369 kg (23 tons) collected.

This collection : one etched section 233·5 g.

SOKO-BANJA | Stone, polymict, brecciated, spherical hypersthene-chondrite

Fall, 1877, October 13, at Soko-Banja, Aleksinac, Serbia (now Yugoslavia), with detonation and fire-ball in a shower.

Ten masses, total weight 80 kg (176 lb.).

This collection : not represented.

Other collections : University of Western Australia, one thin section.

SPRINGWATER | Stony-iron, pallasite

Find, 1931, Springwater, Saskatchewan, Canada.

Three masses, total weight 67·6 kg (149 lb.).

This collection : W.A.M. No. 12281, one mass, weight 127 g (exch. American Museum of Natural History).

TENNASILM | Stone, veined, spherical olivine-hypersthene-chondrite

Fall, 1872, June 28, noon, at Tennasilm, Esthonia (now U.S.S.R.), with cloud and detonations.

One mass, c. 28·5 kg.

This collection : not represented.

Other collections : University of Western Australia, one thin section.

TOLUCA | Iron, medium octahedrite (Om)

Find, 1784 (known before 1776), Toluca, Mexico.

Numerous masses up to 135 kg (300 lb.).

This collection : W.A.M. No. 11972, polished etched section, 780 g.

Other collections : Perth Observatory 78·1 g ($2\frac{3}{4}$ oz.) slice ; Kalgoorlie School of Mines, etched slice, 35 g.

TRYON | Stone, grey chondrite

Find, recognised as a meteorite 1934, at Tryon, Macpherson County, Nebraska, U.S.A.

Numerous fragments, total weight 15·9 kg (35 lb.).

This collection : W.A.M. No. 12136, cut section weighing 131·5 g (exch. H. H. Nininger).

VACA MUERTA (Synonym : Dona Inez) Stony-iron, mesosiderite

Find, before 1961, at Vaca Muerta, Taltal, Atacama, Chile.

Numerous masses, total weight about 50 kg.

This collection : W.A.M. No. 12280, 174 g.

Other collections : University of Western Australia, one thin section.

WACONDA Stone, polymict, brecciated, spherical olivine-hypersthene-chondrite

Find, 1873, Waconda, Mitchell County, Kansas, U.S.A.

One mass, 50 kg.

This collection : not represented.

Other collections : University of Western Australia, one thin section.

Acknowledgments

The authors of this catalogue are indebted to the following for access to the collections in their charge and to their records :— Mr. J. H. Lord, Government Geologist ; Dr. L. W. Samuel, Government Chemist ; Mr. B. J. Harris, Government Astronomer ; and Mr. W. H. Cleverly, Head of the Geology Department, School of Mines, Kalgoorlie.

Mr. E. P. Henderson of the Smithsonian Institution, Washington, and Dr. B. H. Mason of the American Museum of Natural History, New York, gave the authors advice during the preparation of this catalogue and Mr. D. Merrilees of the Western Australian Museum Staff assisted the authors in numerous ways throughout the course of the undertaking. Miss R. Hunt prepared the line drawings, and Miss K. Stayt carried out all the clerical work. Messrs. K. Bauer and K. C. Hughes prepared the photographs used for illustration except for the following plates—

Plates XIV (c) and XXII (c) which were prepared from photographs provided by Mr. W. H. Cleverly.

Plates XVII (b), XXI (b) and XXII (a) which were prepared from plates provided by Mr. A. J. Easton of the Australian National University, Canberra.

Plate XIV (a) which was prepared from a photograph provided from Dr. B. H. Mason.

Plates III (b), IV (a) and (b), X (a) and (b), XII (a) and (b) which were prepared from some old photographic plates originally taken by Mr. F. E. Chapman for Dr. E. S. Simpson (the originals being stored at the Western Australian Museum).

Plate I (a) The Quairading Meteorite (main mass).

(b) The Youanmi Meteorite (main mass).

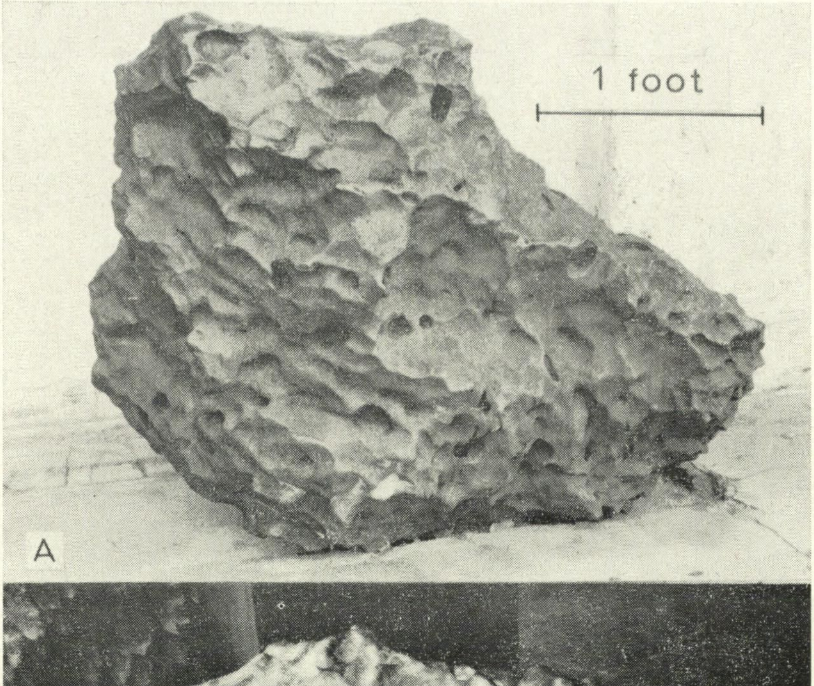

1 foot
A
B
1 foot

Plate II. (a) The Gundaring Meteorite (main mass).

(b) The Mount Edith II Meteorite (main mass).

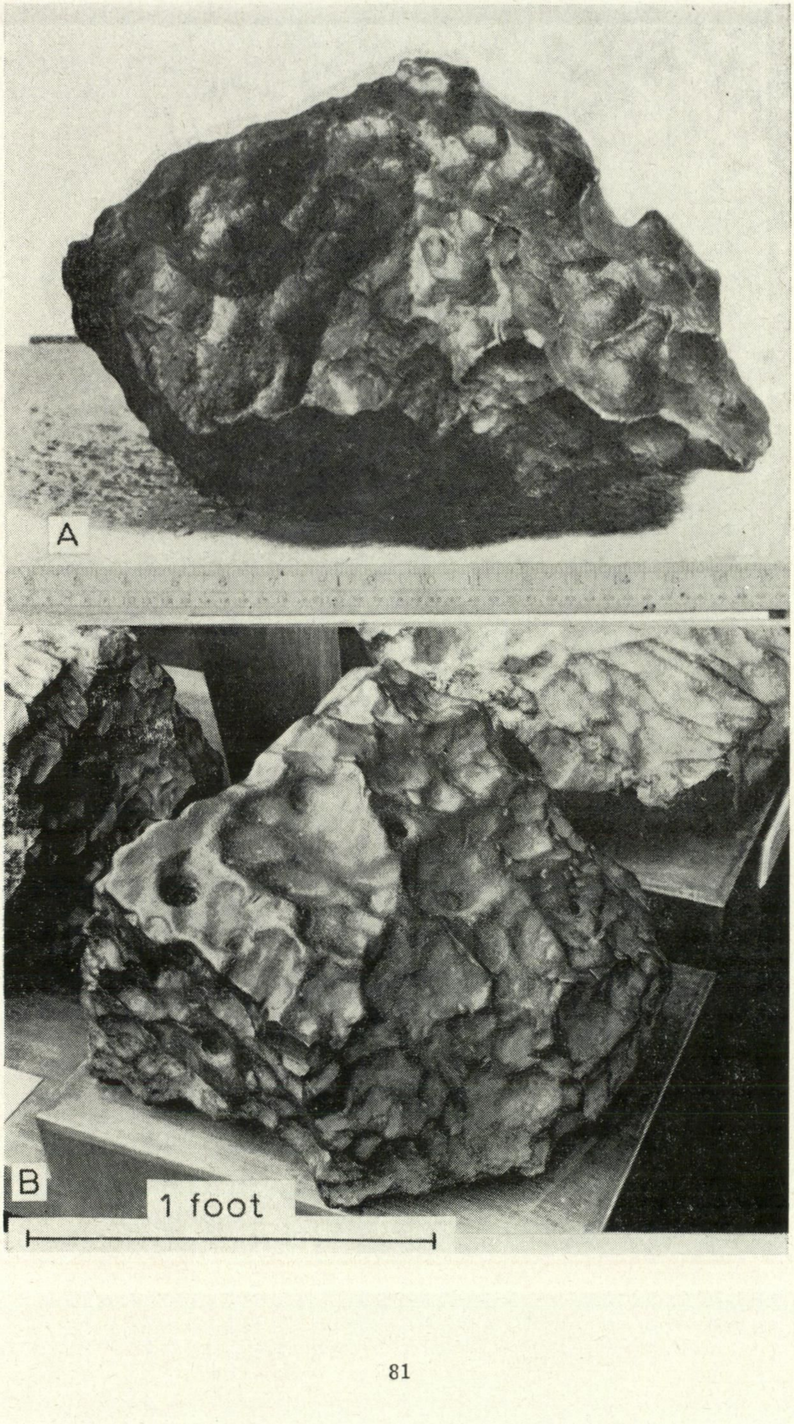

A
B
1 foot

Plate III. (a) The Mount Dooling Meteorite (main mass).

(b) The Milly Milly Meteorite (main mass)—showing also etched cut-face with medium-coarse Widmanstatten pattern.

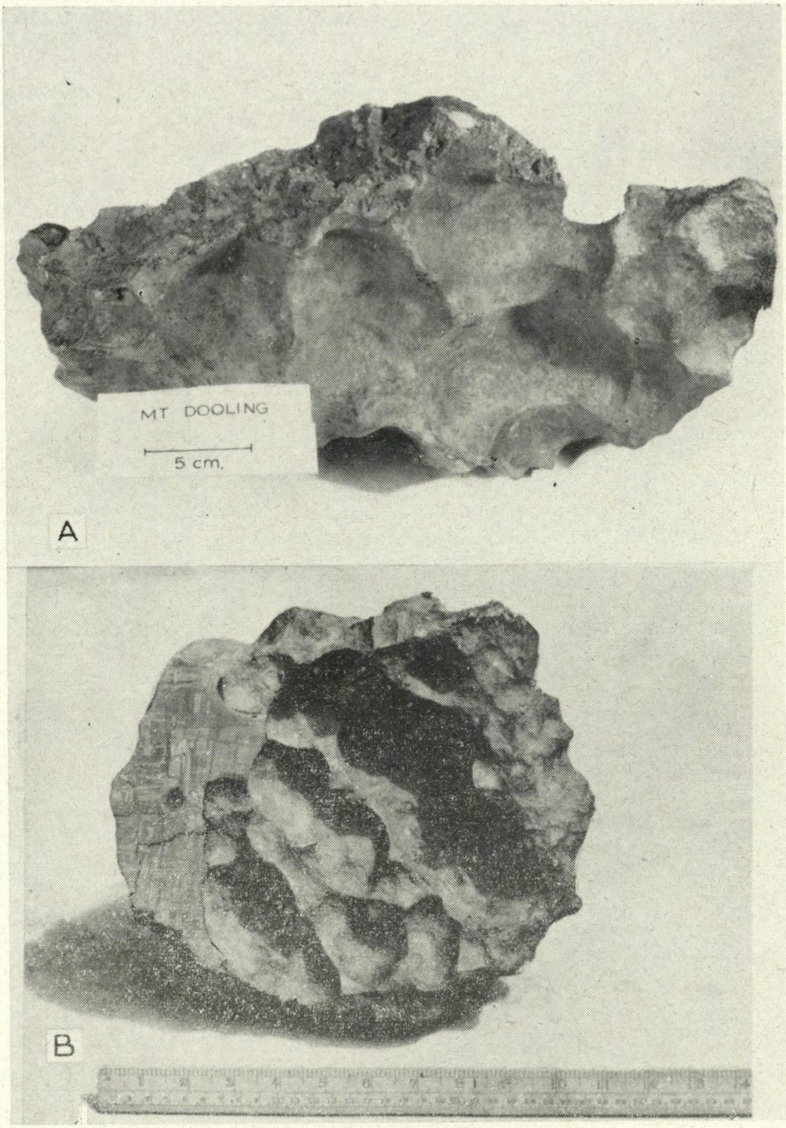
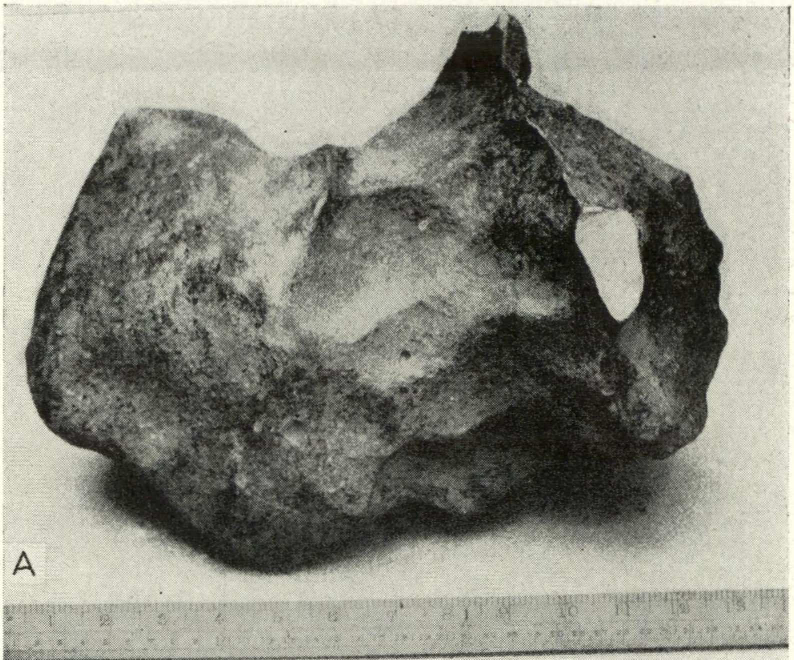

MT DOOLING
5 cm.
A
B

Plate IV. (a) The Kumerina Meteorite (main mass).

(b) The Wonyulgunna Meteorite (main mass)—showing large troilite nodule.


A


B

Plate V.

(a) The Ballinoo Meteorite (complete cross section)—showing etched cut-face. Large dark specks are troilite nodules. The smaller dark specks are schreibersite (Plate IX (b)). The very fine Widmanstatten pattern can just be discerned (upper left).

(b) The Duketon Meteorite (main mass)—medium-coarse Widmanstatten pattern just discernible on cut, etched face.

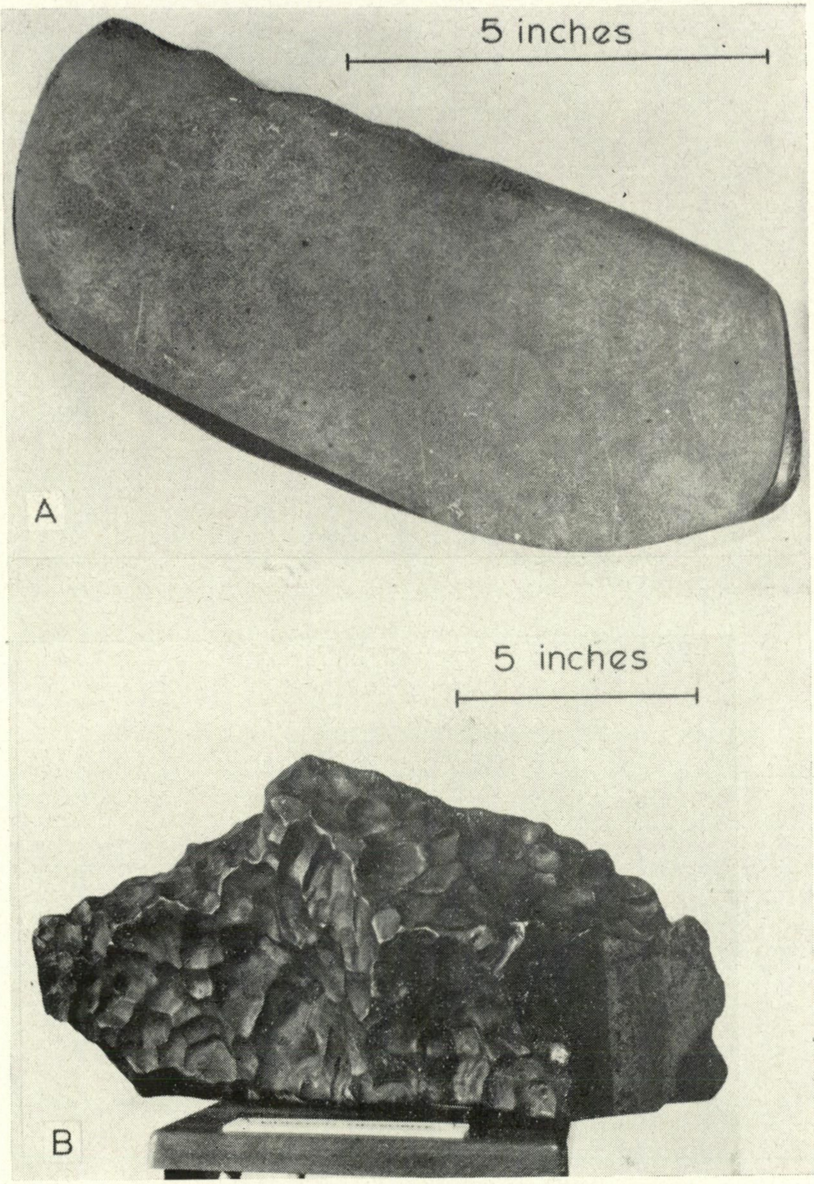
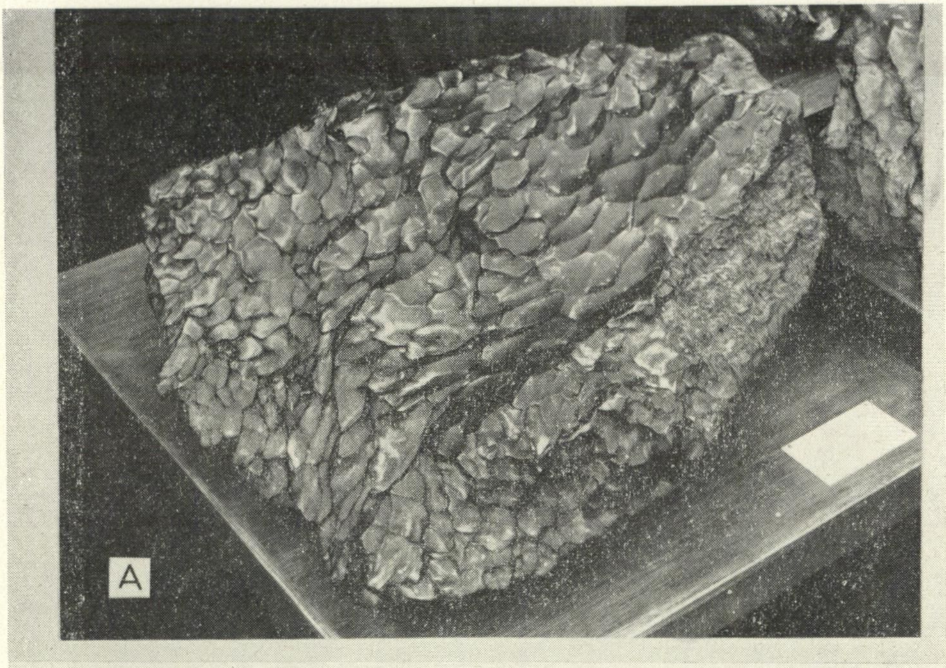

5 inches
A
5 inches
B

Plate VI. (a) The Haig Meteorite (main mass)—showing the surface pattern of regmaglypts, by far the most perfectly preserved of any of the Western Australian iron meteorites.

(b) Breadcrusted shale-balls of iron oxide from Wolf Creek crater.


A

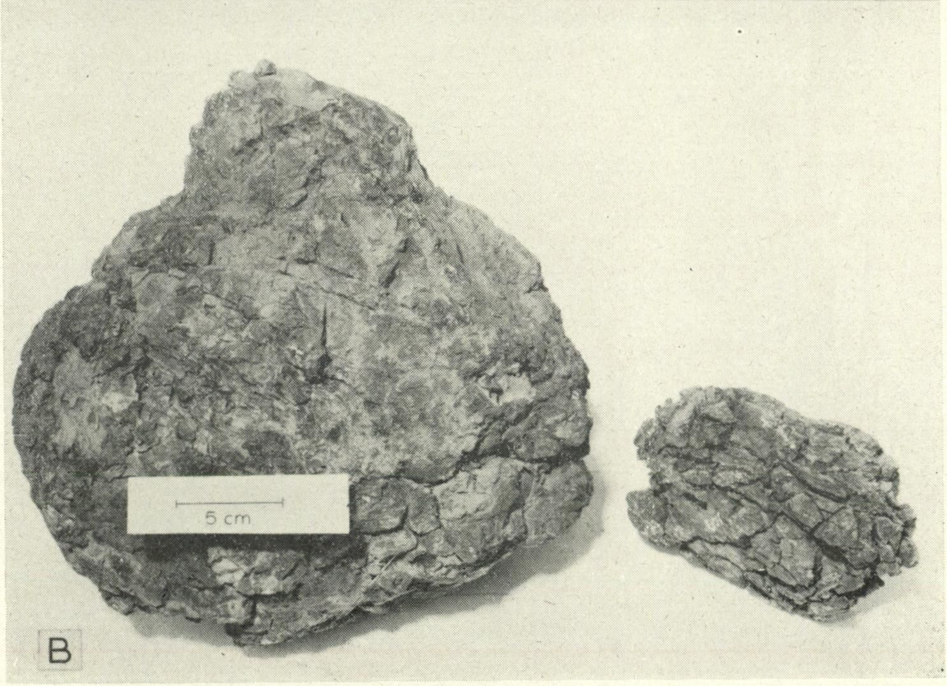
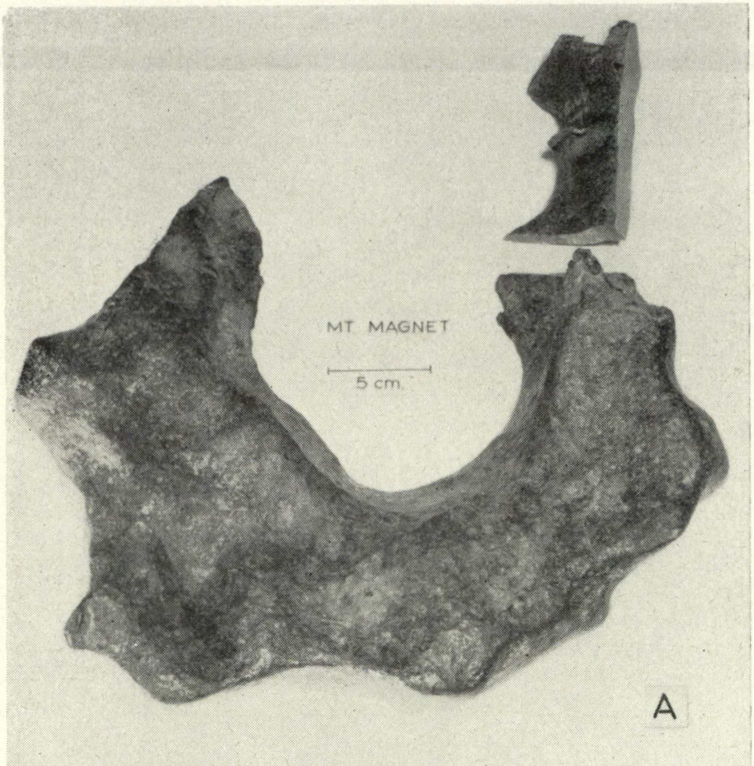

5 cm
B

Plate VII.

(a) The Mount Magnet Meteorite (two main masses).

(b) The Premier Downs I Meteorite (main mass)—showing medium-coarse Widmanstatten pattern.


MT. MAGNET
5 cm.
A

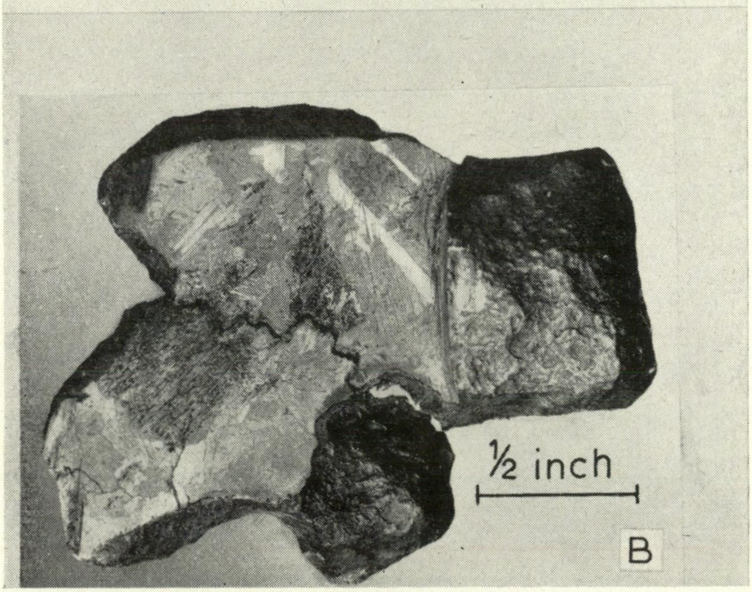

½ inch
B

Plate VIII.

(a) The Nuleri Meteorite (main mass)—showing medium-coarse Widmanstatten pattern.

(b) The Mount Magnet Meteorite (etched face of smaller fragment)—showing prominent silvery veinlets of schreibersite. The very fine Widmanstatten pattern can barely be discerned.

(c) The Balfour Downs Meteorite (etched face)—showing the medium-coarse Widmanstatten etch pattern.

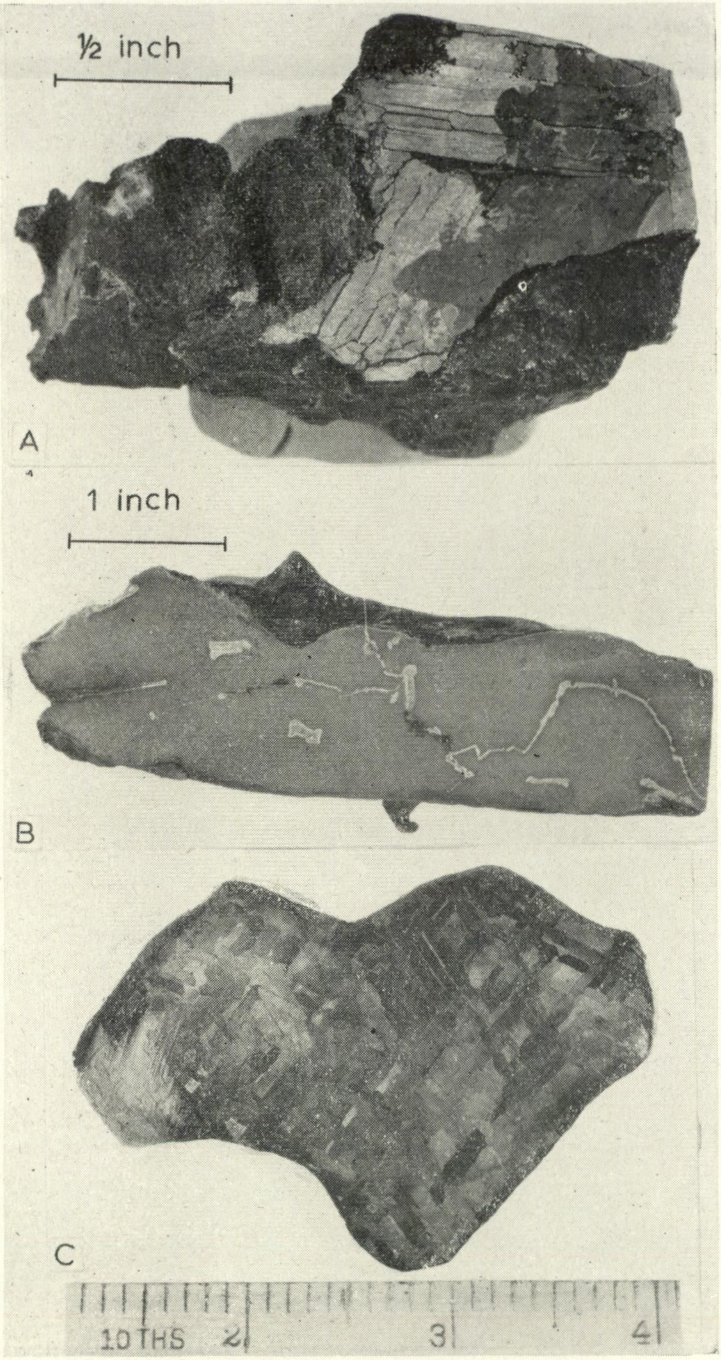

½ inch
A
1 inch
B
C
10THS 2
3
4

Plate IX.

(a) The Mount Edith I Meteorite (etched face of section)—showing large troilite nodules and fine Widmanstatten pattern.

(b) The Ballinoo Meteorite (etched face)—showing a troilite nodule, schreibersite in decussate pattern and fine Widmanstatten pattern just discernible in the background.

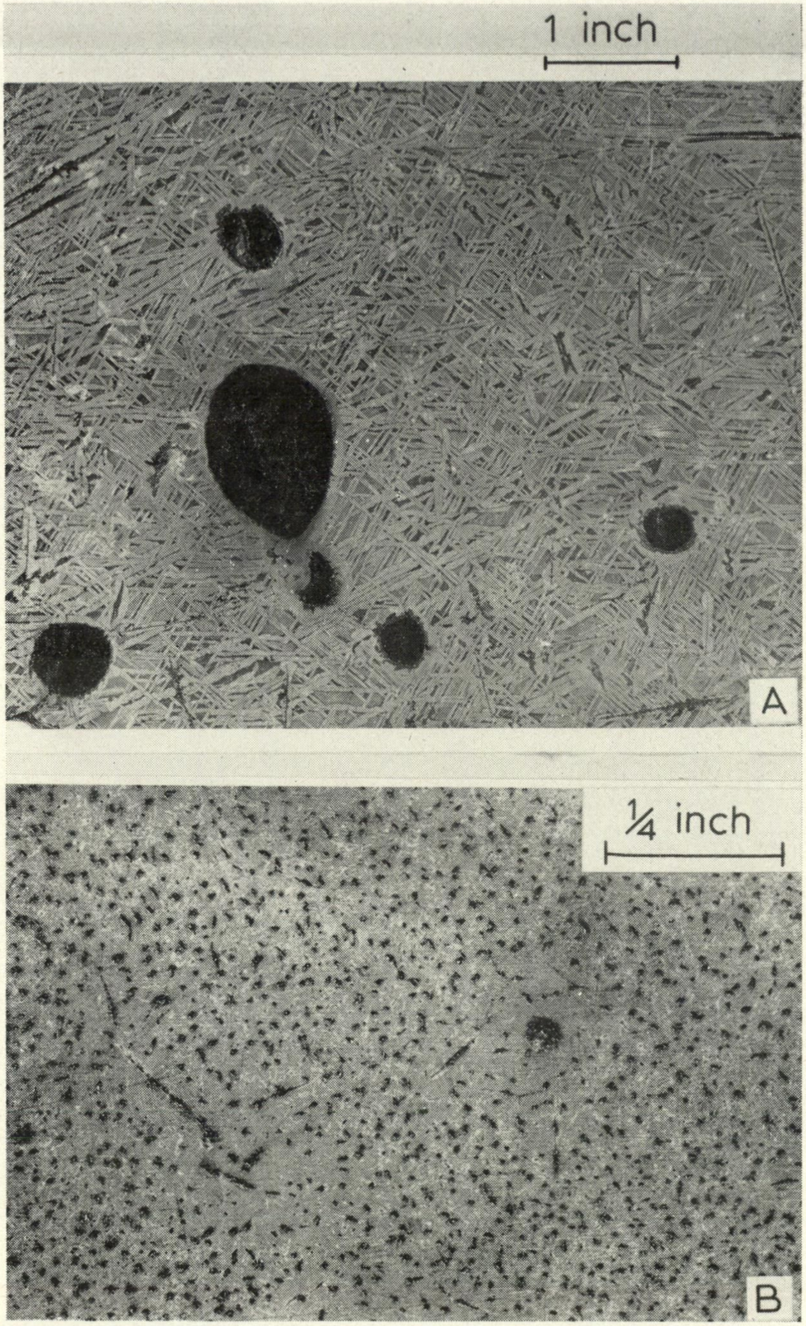
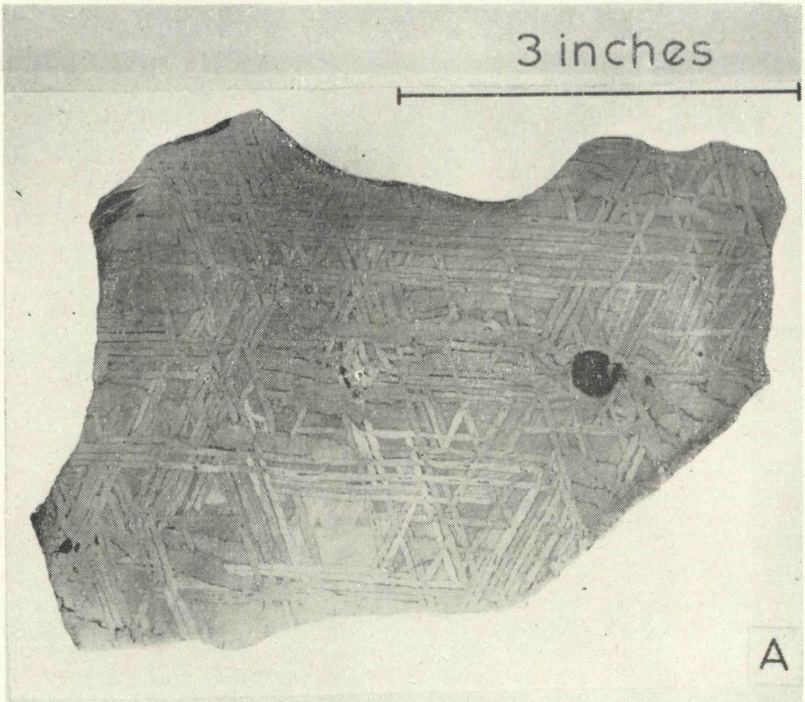

1 inch
A
¼ inch
B

Plate X. (a) The Gundaring Meteorite (etched section)—showing a troilite nodule and medium-coarse Widmanstatten pattern.

(b) The Youanmi Meteorite (etched section)—showing a large troilite nodule and medium-coarse Widmanstatten pattern.


3 inches
A

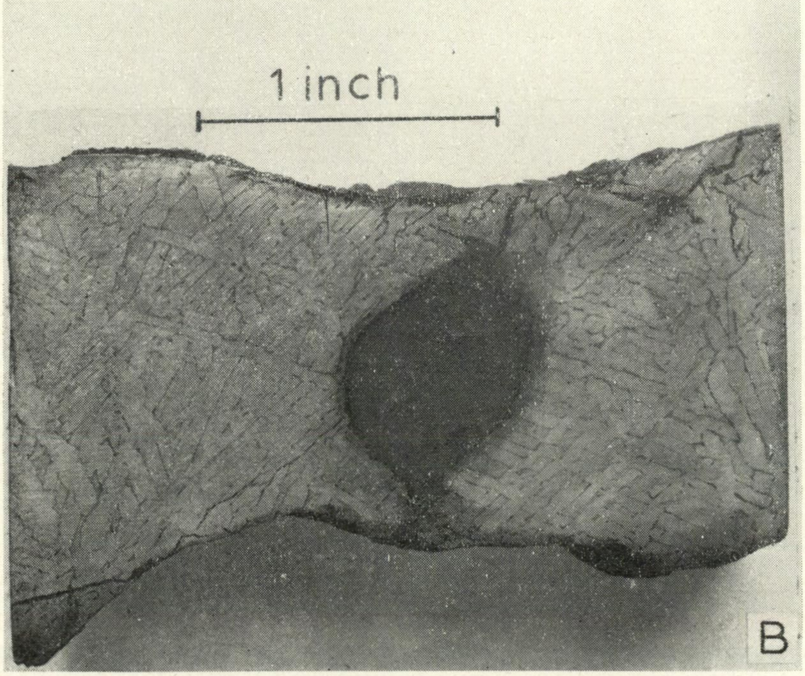

1 inch
B

Plate XI. (a) The Mount Stirling Meteorite (etched section)—showing coarse Widmanstatten pattern.

(b) The Roebourne Meteorite (etched section)—showing medium-coarse Widmanstatten pattern and troilite (black).

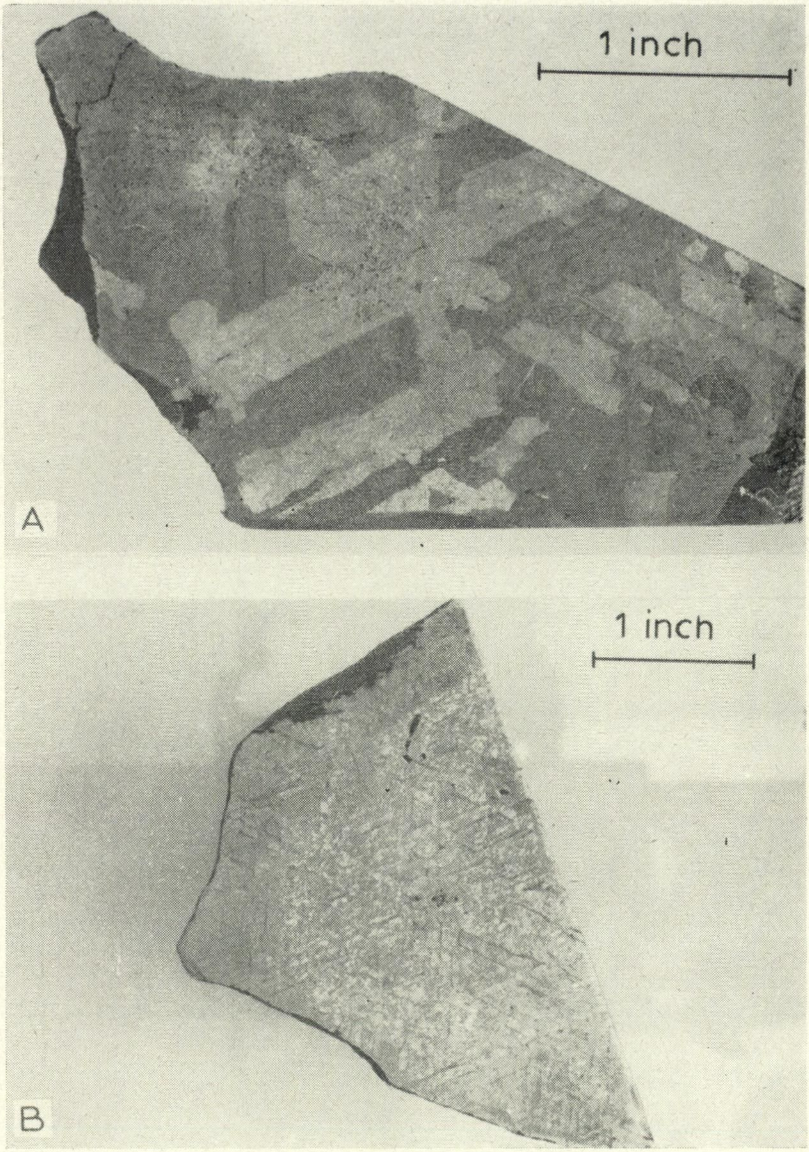

1 inch
A
1 inch
B

Plate XII. (a) The Tieraco Creek Meteorite (etched section)—showing medium-coarse Widmanstatten pattern and schreibersite (lower, centre). The kamacite lamellae (broad), taenite lamellae (narrow) and plessite fields are particularly well seen in this photograph.

(b) The Wonyulgunna Meteorite (etched section)—showing medium-coarse Widmanstatten pattern.

(c) The Haig Meteorite (etched section)—showing medium-coarse Widmanstatten pattern.

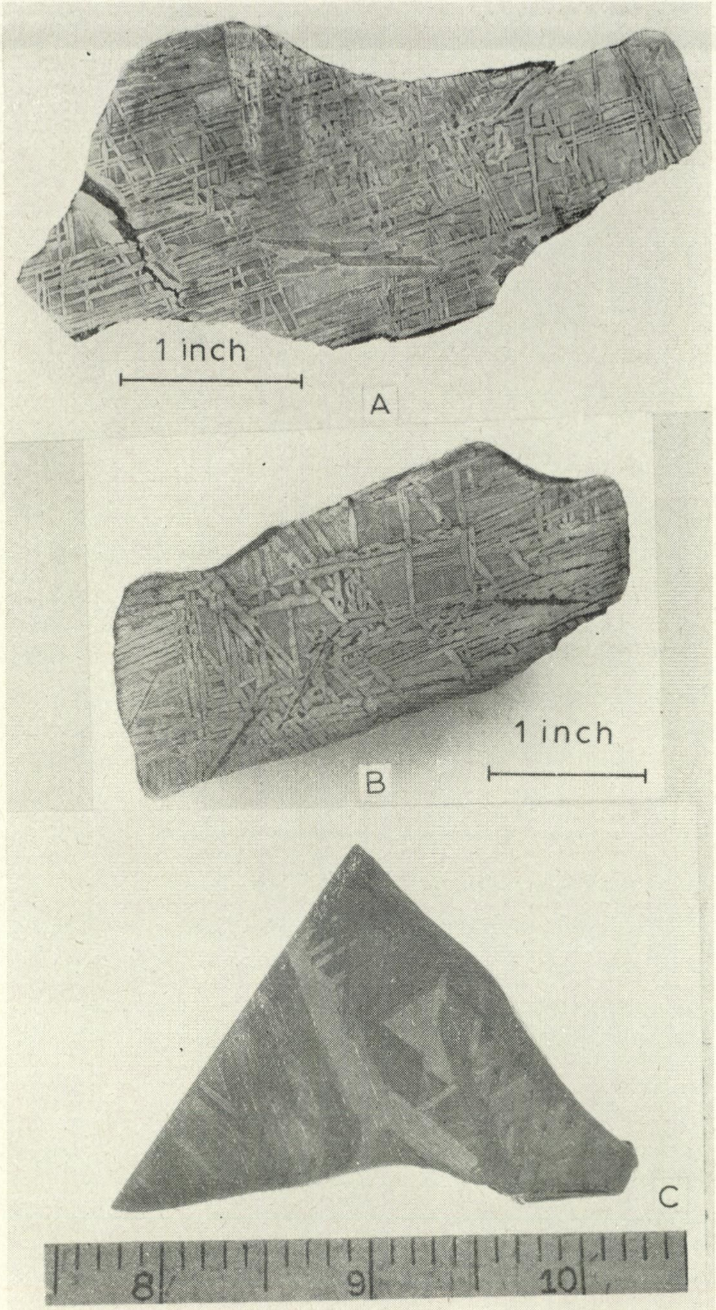

1 inch
A
1 inch
B
C
8
9
10

Plate XIII. (a) The Mount Dooling Meteorite (etched section)—showing medium-coarse Widmanstatten pattern.

(b) The Youndegin III Meteorite (etched section)—showing schreibersite inclusions and coarse Widmanstatten pattern.

(c) The Murchison Downs Meteorite.

(d) The Dalgaranga Meteorite (typical fragment of nickel-iron (S3526)).

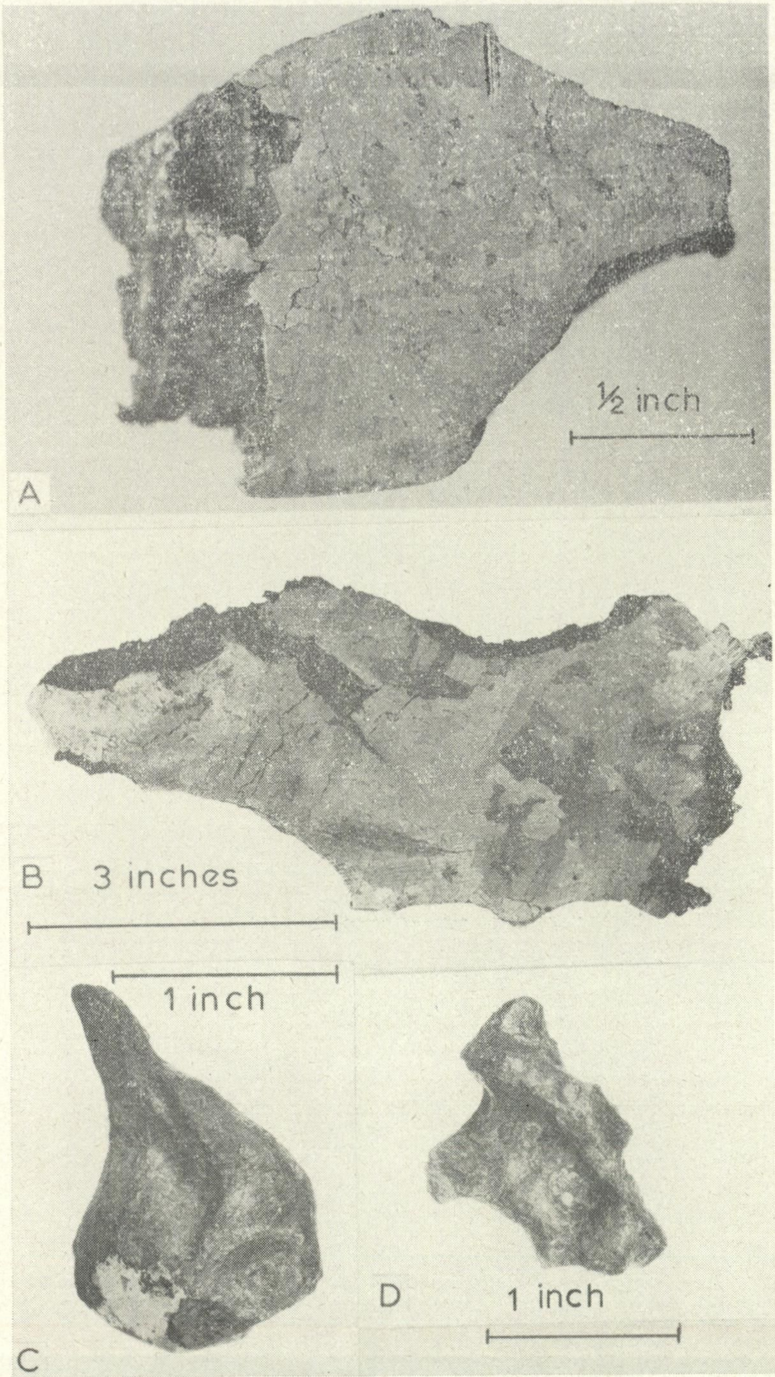

½ inch
A
B
3 inches
1 inch
C
D
1 inch

Plate XIV. (a) The Balfour Downs Meteorite (main mass).

(b) The Loongana Station Meteorite (main mass).

(c) The Yarri Meteorite (main mass)—showing medium-coarse octahedral etch pattern.

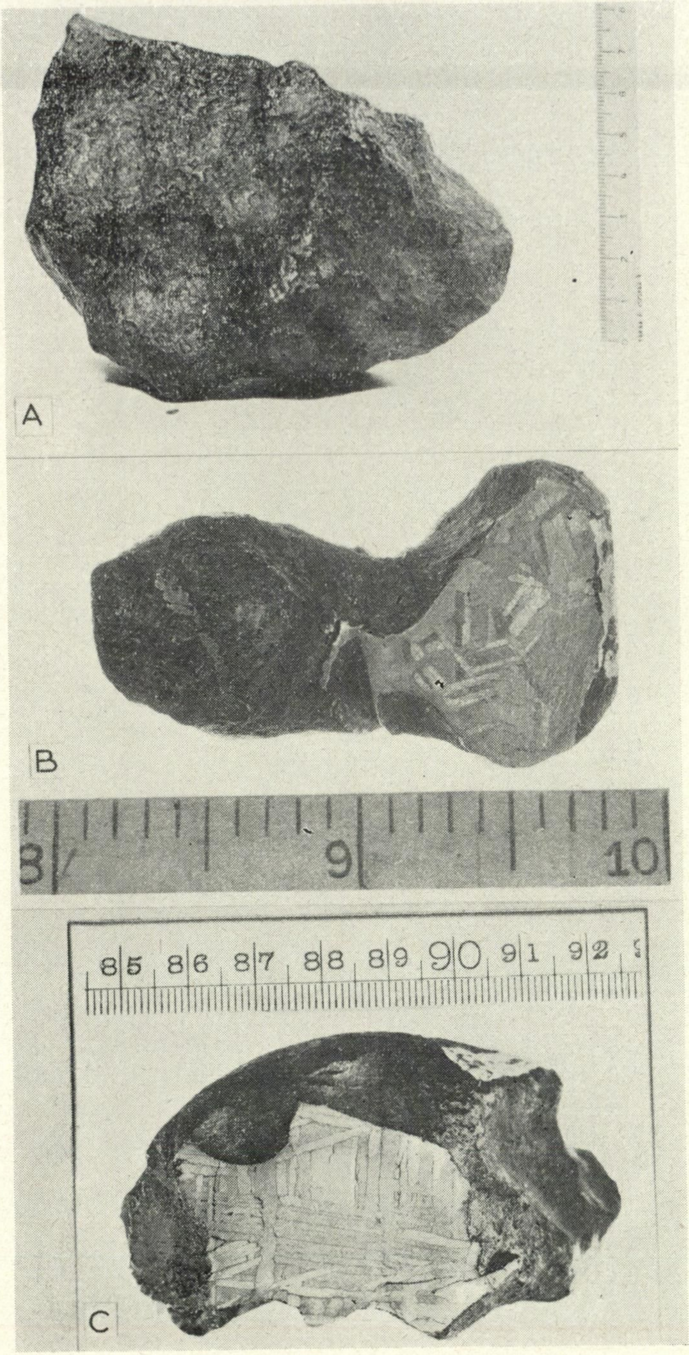

A
B
C

Plate XV. (a) The Bencubbin II (North Mandiga) Meteorite (cut section)—showing distinct alignment of nickel-iron (light grey) which encloses and is enclosed in areas of black chondritic material (which itself encloses light achondritic material).

(b) The meteorite previously called " Siberia " but now known to be metallic fragments with silicate (enstatite) inclusions from Mount Egerton (etched face)—showing fine pattern and silicate inclusions.

(c) Coarse pegmatoid fragment of the Mount Egerton Meteorite (Pegler collection)—showing large clinoenstatite crystals and subordinate nickel-iron (dark).

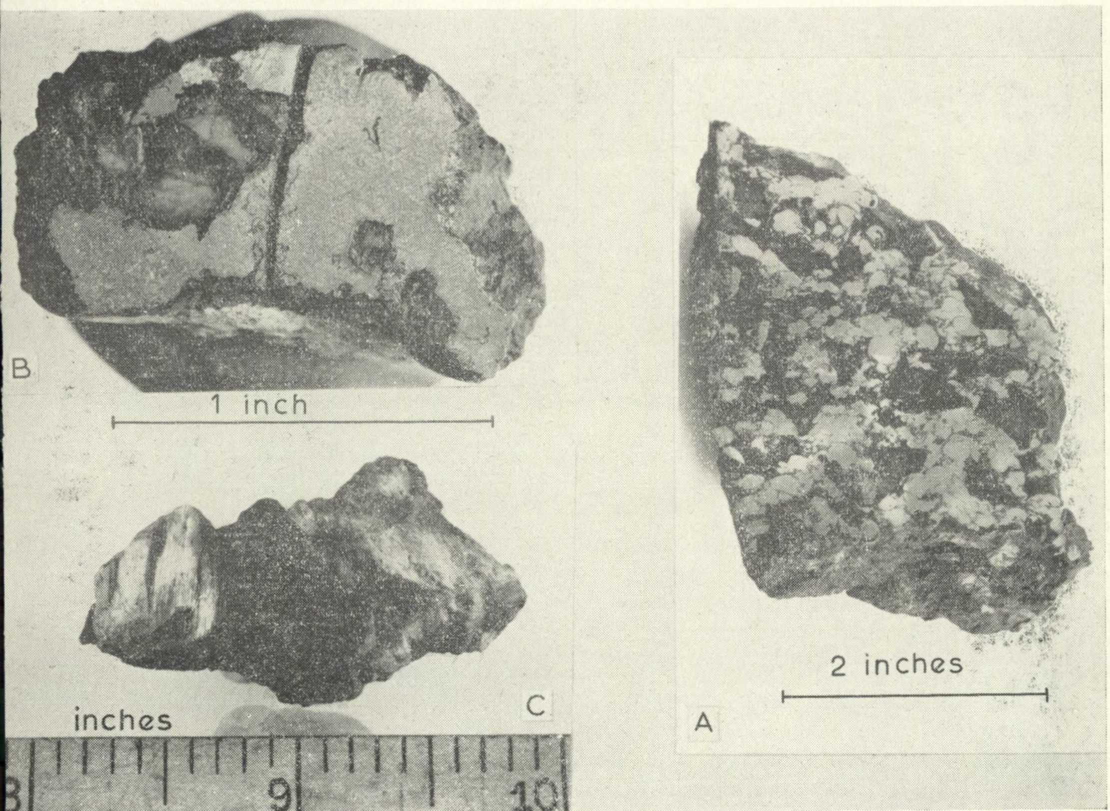

B
1 inch
C
inches
9
10
A
2 inches

Plate XVI. (a) The Bencubbin I (South Mandiga) Meteorite (main mass)—showing cut polished face. The reticulate arrangement of the nickel-iron (white) is evident. A large chondritic enclave shows black at the upper centre of the photograph. Immediately below the achondritic enclaves show lighter within the cells of stony material.

(b) The Cocklebiddy Meteorite (main mass)—the fine texture and abundant nickel-iron is apparent on the cut, polished face of this very fresh olivine-bronzite-chondrite.

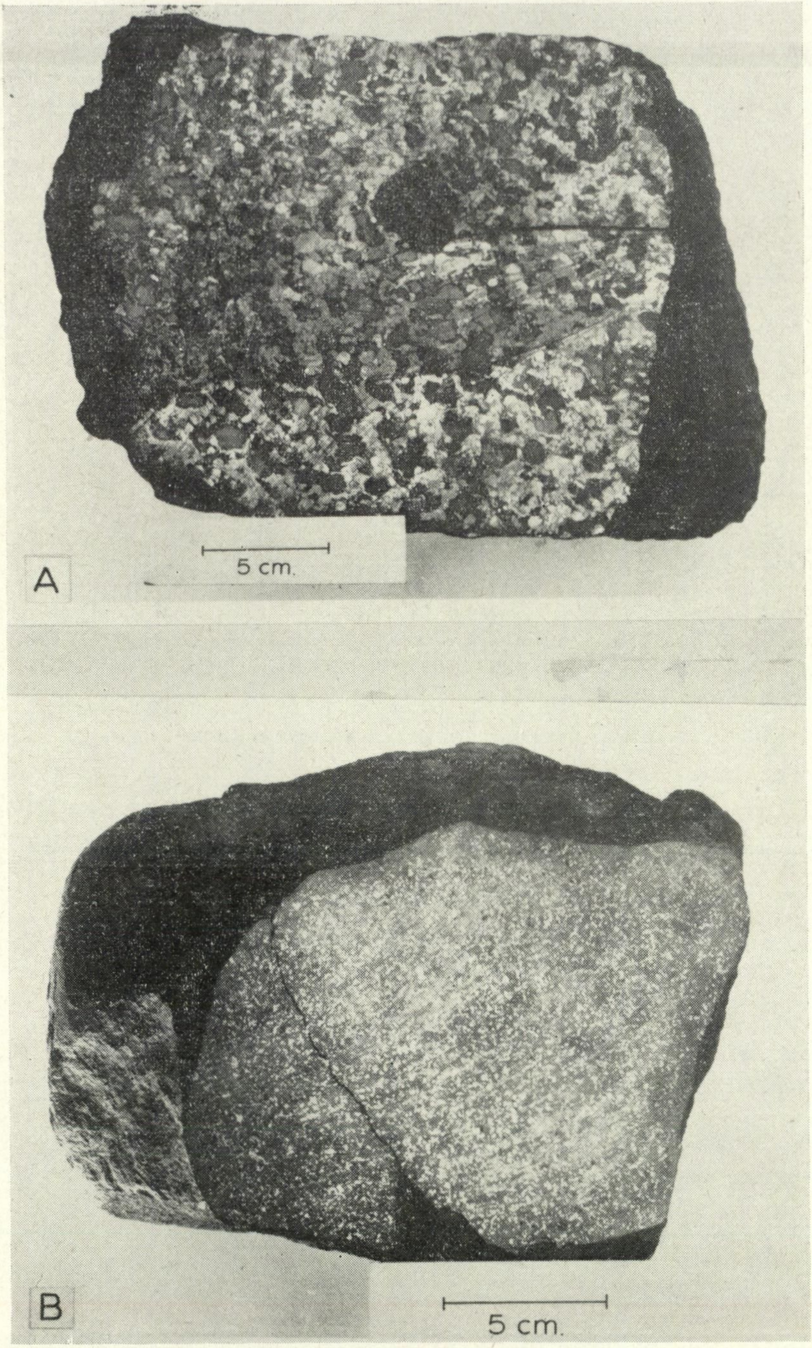

5 cm.
A
B
5 cm.

Plate XVII. (a) The Rawlinna Meteorite (main mass)—this is an olivine-bronzite-chondrite but the nickel-iron is not quite as prominent in the cut, polished face as in the case of Cocklebiddy (Plate XVI (b)).

(b) The Wingellina Meteorite (main mass)—showing dark fusion crust coating the small facetted olivine-bronzite stone.

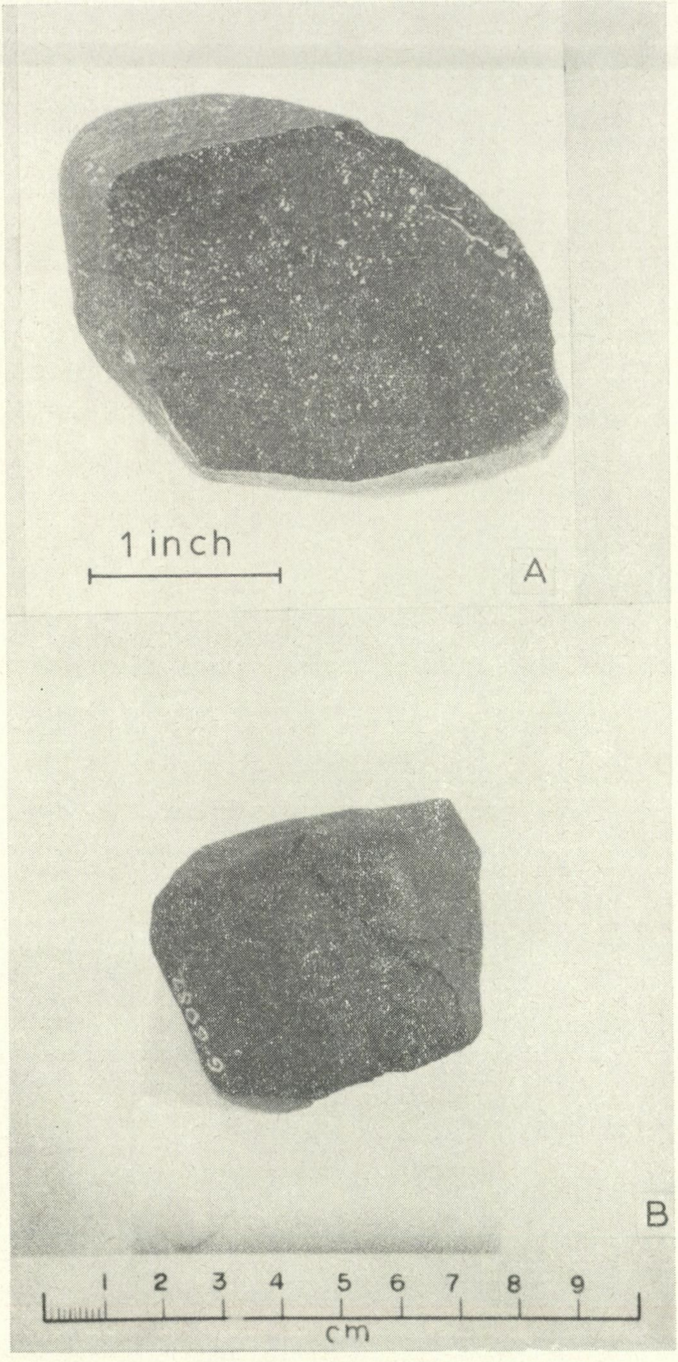

1 inch
A
B
1 2 3 4 5 6 7 8 9
cm

Plate XVIII. (a) The Lake Brown Meteorite (main mass)—showing facetted shape and fusion crust coating.

(b) The Lake Brown Meteorite (main mass)—fairly sparse nickel-iron shows on the cut, polished face and chondrules can be discerned.

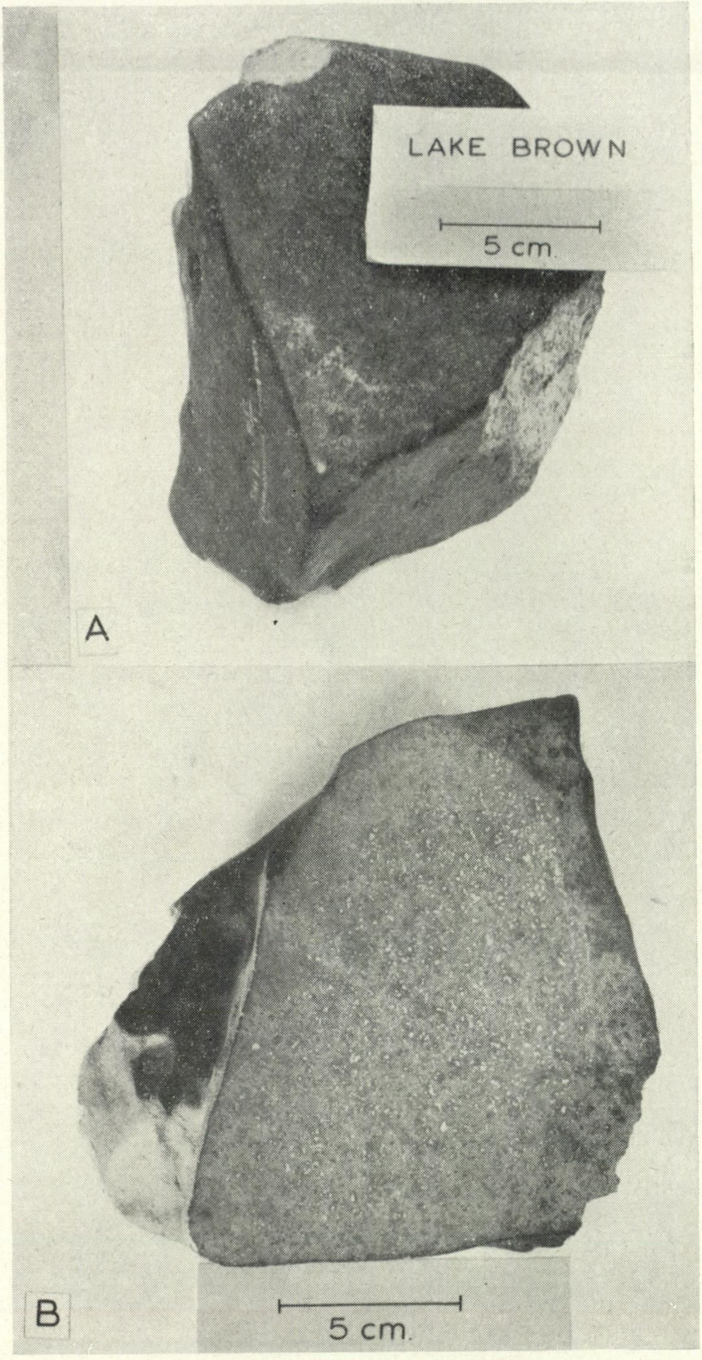
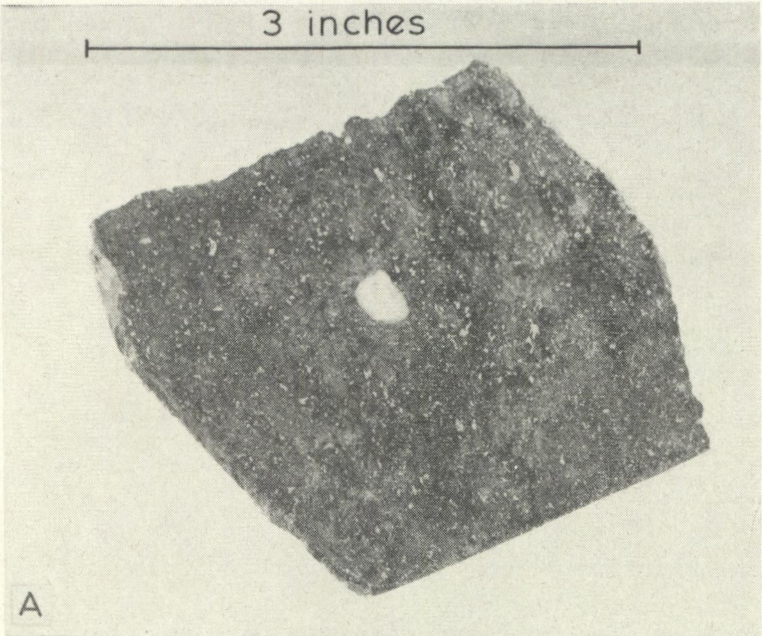

LAKE BROWN
5 cm.
A
B
5 cm.

Plate XIX. (a) The Dalgety Downs Meteorite (erroneously called Ashburton Downs) (fragment)—the peculiar parallelism of nickel-iron flecks is apparent, also a white enclave of some foreign material.

(b) The Dalgety Downs Meteorite (fragment from the recovery by B. H. Mason and E. P. Henderson (1963))—fresher than the above, this fragment shows the same peculiar parallelism of the nickel-iron flecks, but no foreign inclusions.


3 inches
A

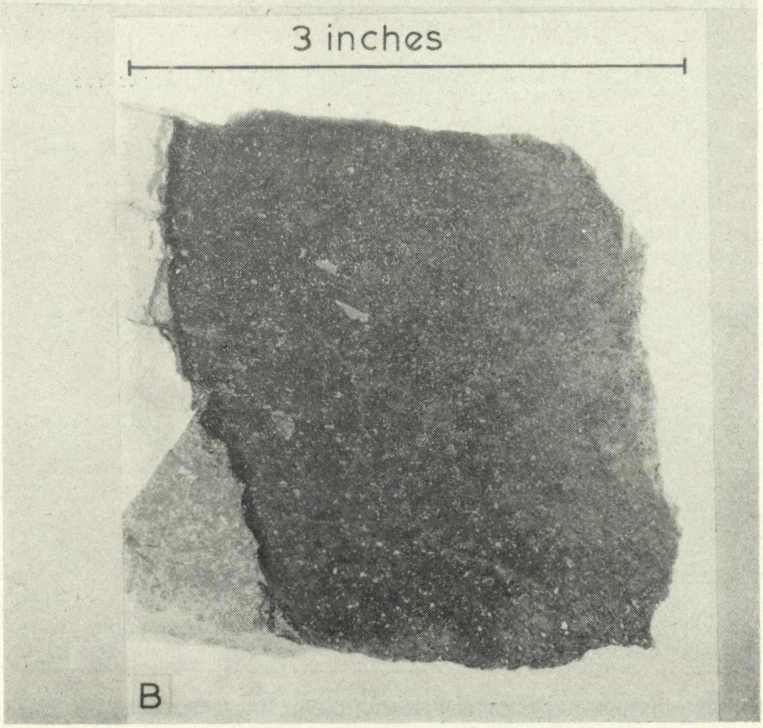

3 inches
B

Plate XX. (a) The Woolgorong Meteorite (fragment)—this is strongly recrystallized and chondrules do not show up well.

(b) The Yalgoo Meteorite (main mass)—chondrules are quite easily discerned on this polished face.

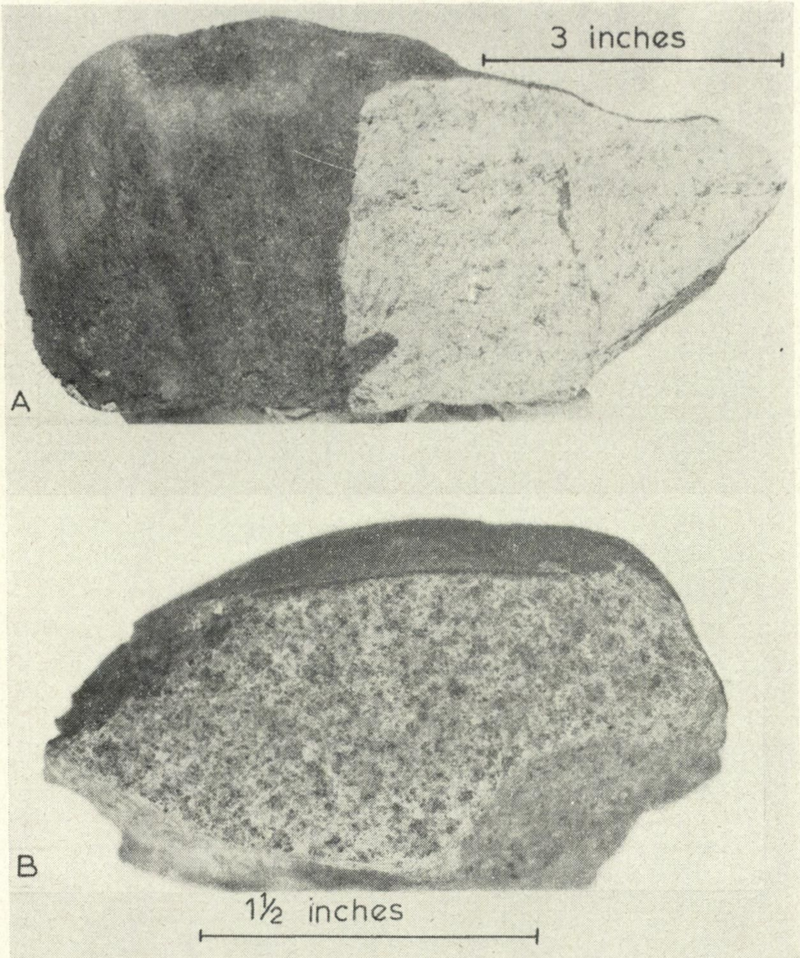
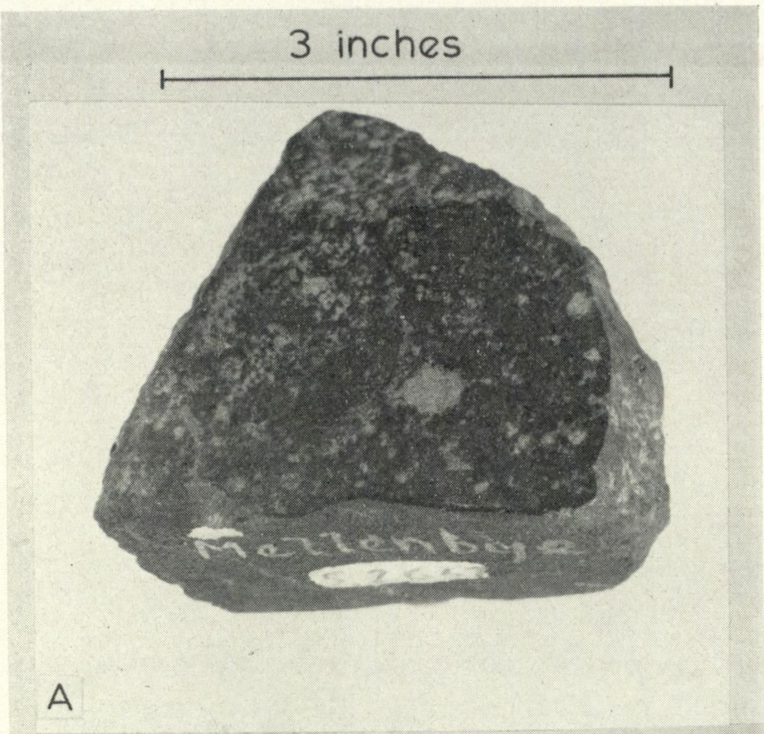

3 inches
A
B
1½ inches

Plate XXI. (a) The Mellenbye Meteorite (main mass)—showing very weathered state, and several large rounded chondrules.

(b) The North Haig Meteorite (main mass).


3 inches
A

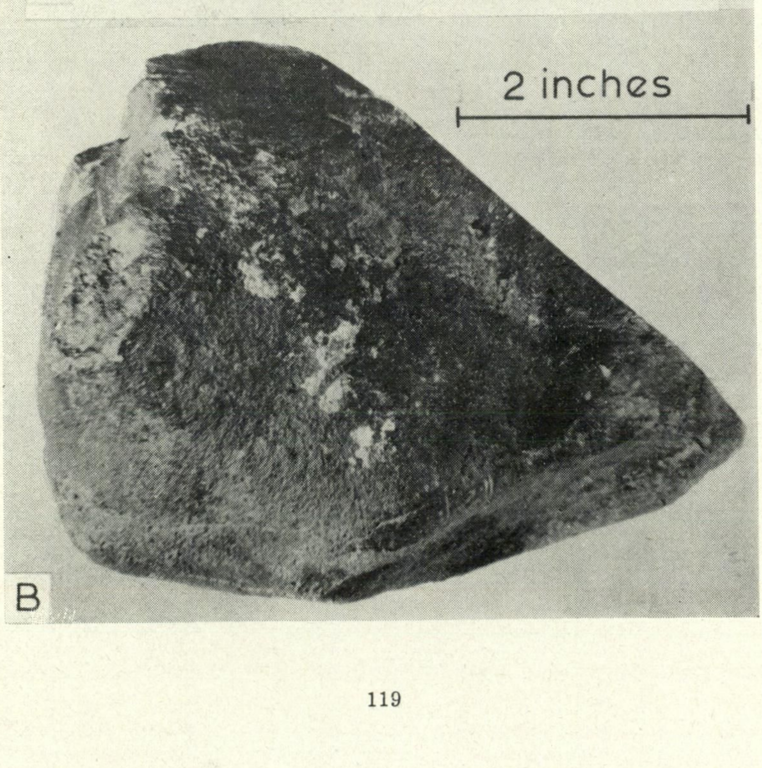

2 inches
B

Plate XXII.

(a) The Sleeper Camp Meteorite (main mass)—a small facetted stone entirely coated with fusion crust.

(b) The Billygoat Donga Meteorite (main mass)—a small polygonal facetted stone entirely covered with fusion crust.

(c) The Billygoat Donga Meteorite (second mass)—a small facetted stone largely covered by fusion crust. Scale shown by centimetre rule.

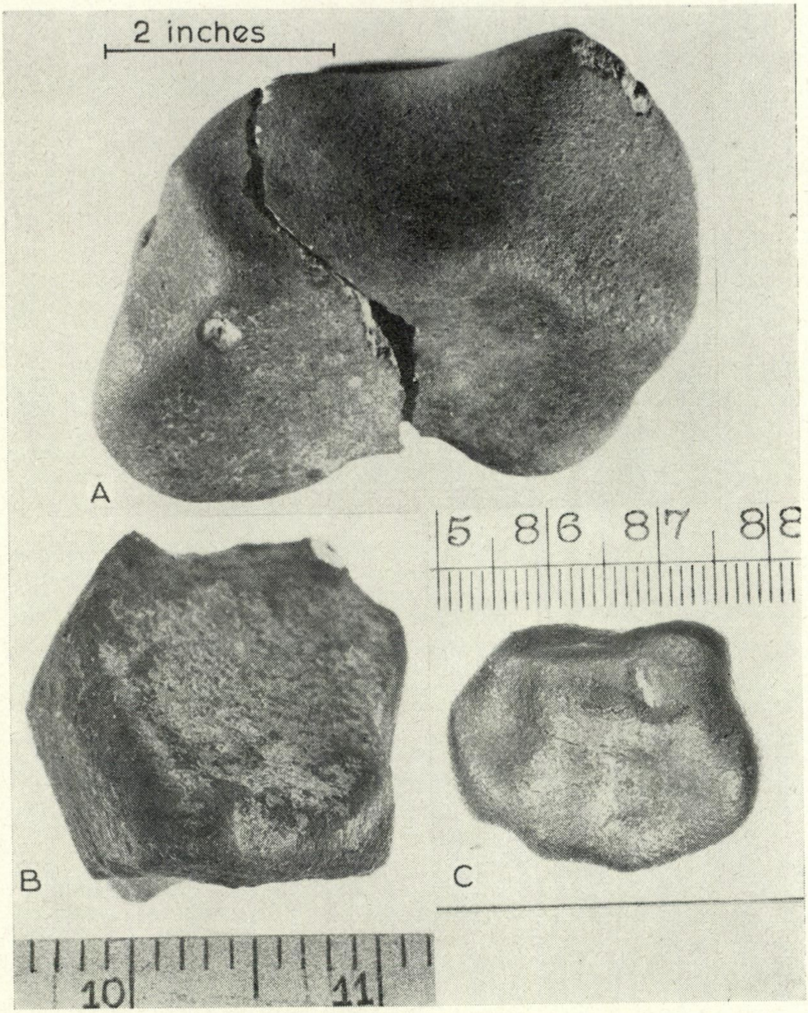

2 inches
A
5 8 6 8 7 8 8
B
C
10
11

Plate XXIII. (a) The Naretha Meteorite (fragment of main mass)—showing similar polygonal facetted shape to Billygoat Donga and identical colour and fusion crust characteristics.

(b) The Naretha Meteorite (polished section)—showing conspicuous chondrules.

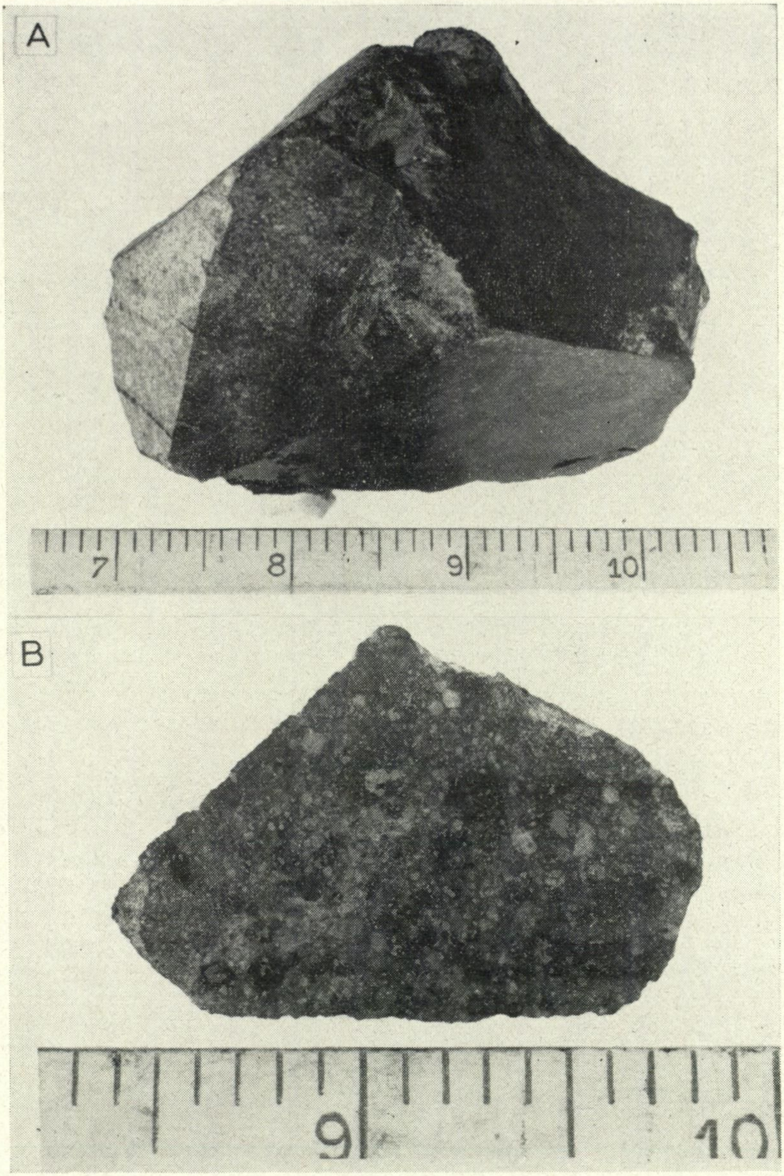

A
7
8
9
10
B
9
10

Plate XXIV. (a) The Forrest Lakes Meteorite (main mass)—showing dark fusion crust covering three sides and thickened at the base. Regmaglypts are apparent and it seems to have formed part of a small oriented stone.

(b) The Forrest Lakes Meteorite (cut, polished section)—showing prominent chondrules, dark glass selvedges and very sparse nickel-iron (white).

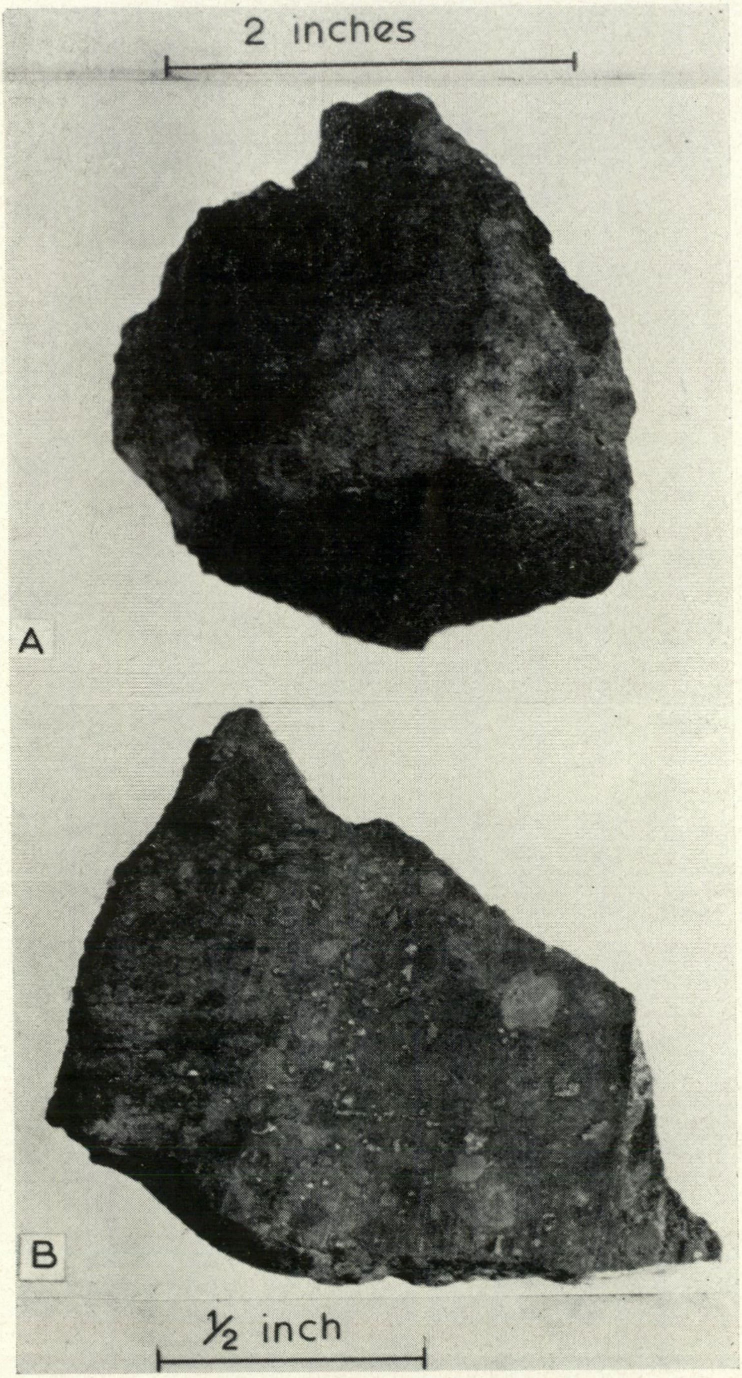

2 inches
A
B
½ inch

Plate XXV. (a) Photomicrograph of the Forrest Lakes Meteorite—showing chondrules and finer granular olivine base. The dark material consists of nickel-iron, troilite and brown glass or crypto-crystalline material. The latter tends to fronge the chondrules. Magnification X10, PPL.

(b) Photomicrograph of the Dalgety Downs Meteorite (I)—showing a large chondrule with grated structure. The granular material in the ground mass is mostly olivine but many of the chondrules are of hypersthene. A chondrule of hypersthene shows extreme left. Like the Forrest Lakes meteorite this meteorite contains glass or crypto-crystalline material and it both fringes the chondrule and forms fine laminae within the grated chondrule. Both glass and nickel-iron with troilite show dark. Magnification X25, PPL.

(c) Photomicrograph of the Cocklebiddy Meteorite—showing large bronzite chondrule and another granular olivine chondrule. The dark material is glass or crypto-crystalline material (apparently carbon stained), nickel-iron and troilite. Magnification X63, PPL.

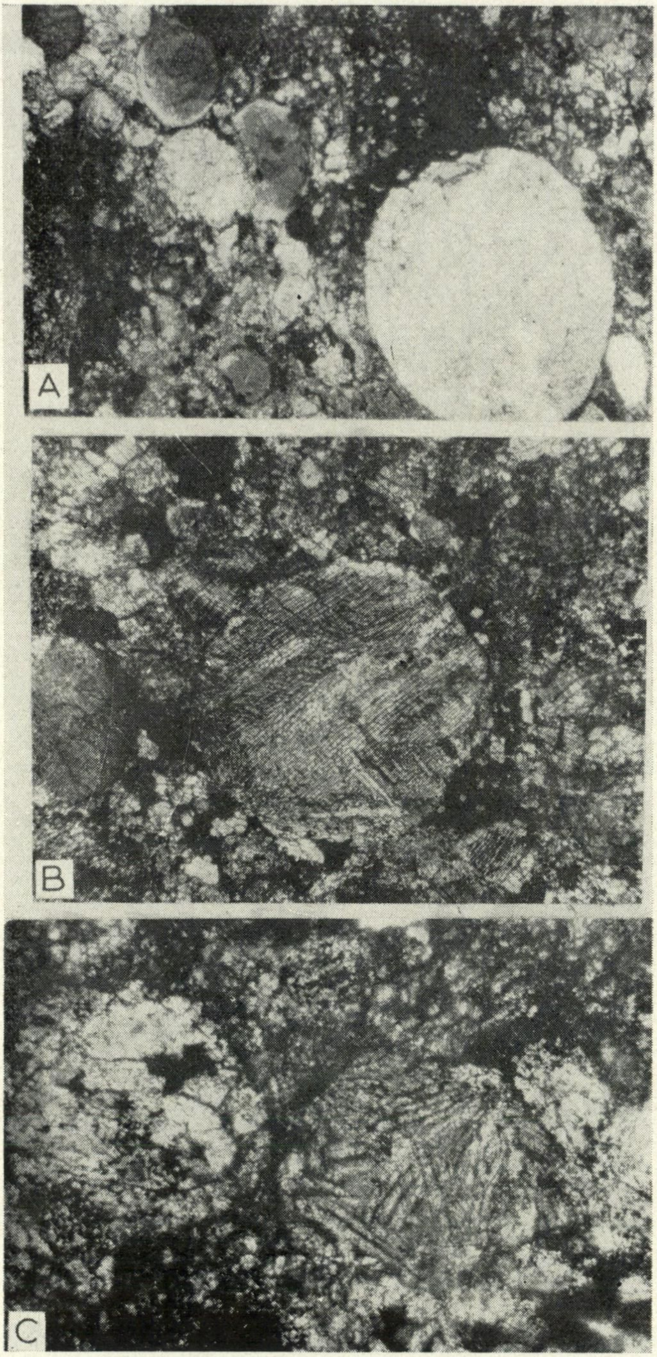

A
B
C

Plate XXVI. (a) Photomicrograph of the Mellenbye Meteorite—showing granular aggregates of olivine and probably some pyroxene, apparently crushed fragments of chondrules or recrystallized chondrules. There is not very much glass evident and the meteorite appears to be brecciated and considerably recrystallized. The dark areas are nickel-iron and troilite and the white areas are cavities in this rather spongy meteorite. Magnification X25, PPL.

(b) Photomicrograph of the Woolgorong Meteorite—showing large excentric-fan type chondrule. The chondrule itself appears to be olivine. There is no glass present and the black material which shows in patches and veins is nickel-iron and troilite. White specks are oligoclase and this tends to fringe the chondrules. Magnification X63, PPL.

(c) Photomicrograph of the Rawlinna Meteorite—showing a large olivine chondrule (a rather sparse occurrence in this meteorite) set in a granular base of olivine and subordinate orthopyroxene (both grey) nickel-iron and sulphide (both black). This meteorite appears to be slightly recrystallized and contains much more nickel-iron than is present in the olivine-hypersthene-chondrites. Magnification X25, PPL.

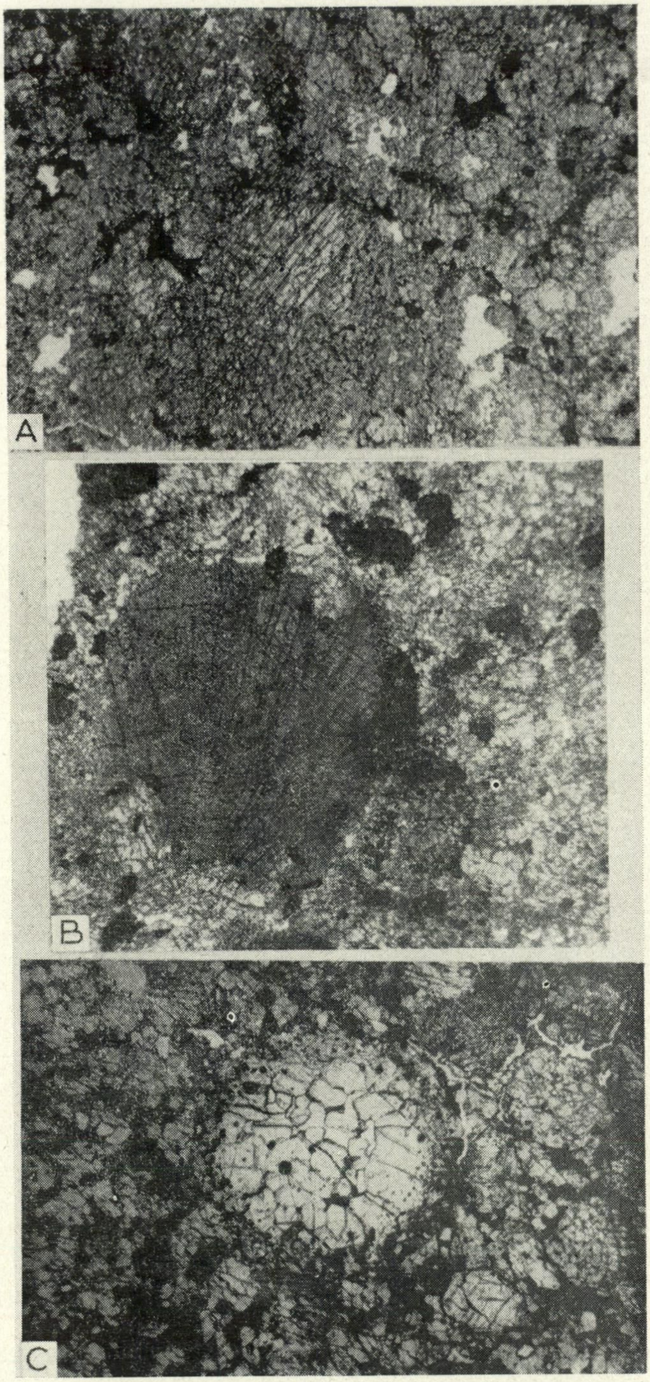

A
B
C

Plate XXVII. (a) Photomicrograph of the Dalgety Downs Meteorite (I)—showing a giant orthopyroxene chondrule (the same one as is shown in Plate XIX (a)). Magnification X10, PPL.

(b) Photomicrograph of the Naretha Meteorite—showing an olivine chondrule enveloped by a thin zone of black glass and a fragment of an orthopyroxene chondrule similarly enveloped, both being set in a brecciated matrix. Magnification X25, PPL.

(c) Photomicrograph of the Billygoat Donga (I) Meteorite—showing a large chondrule of olivine containing much glass along selvedges and interstices. Magnification X25, PPL.

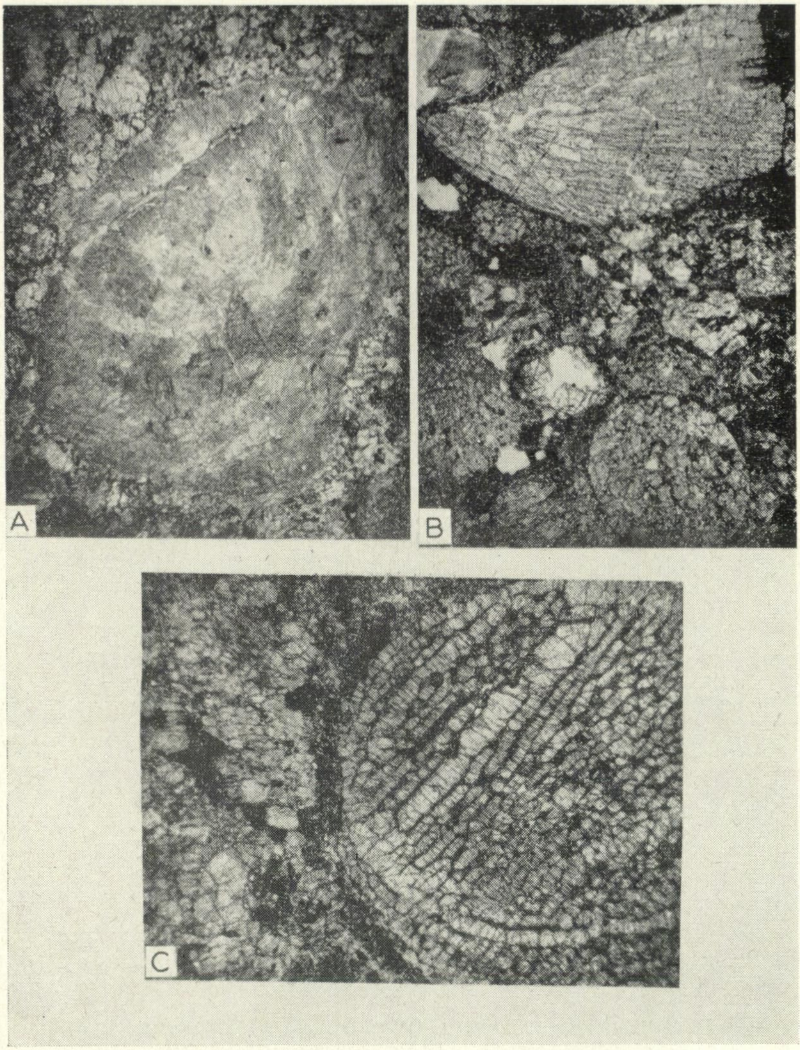
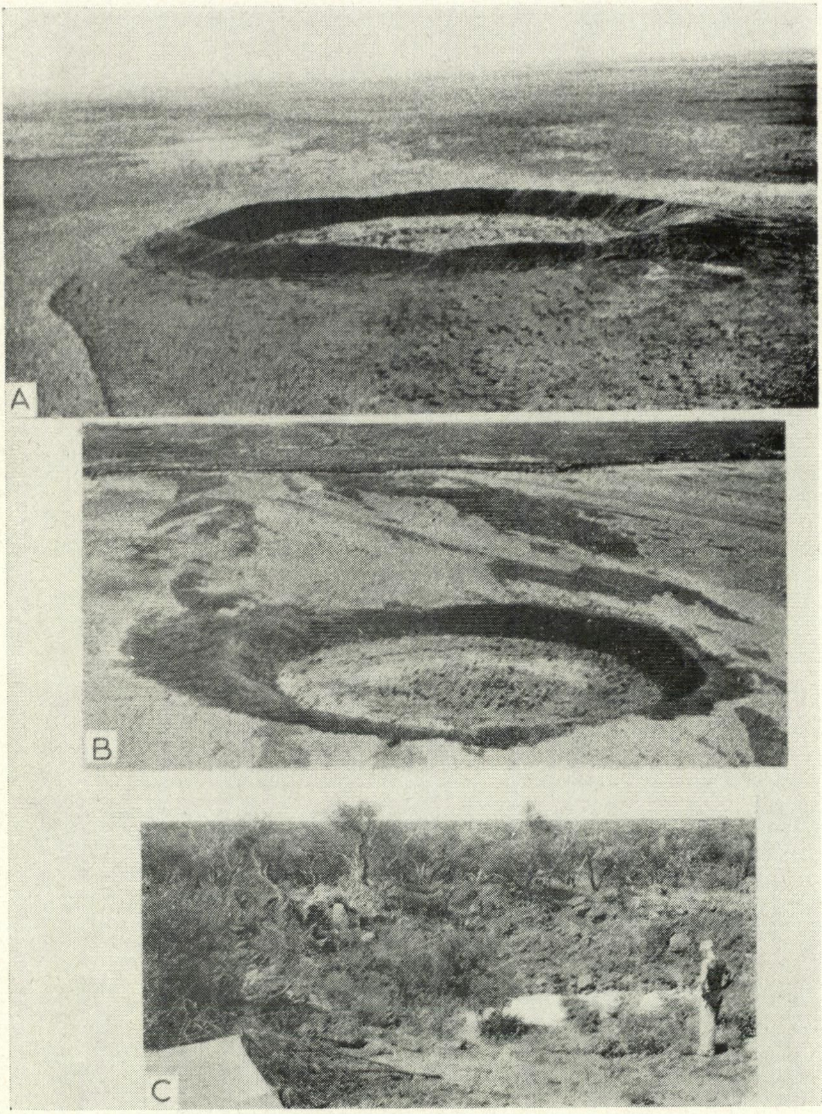

A
B
C

Plate XXVIII. (a) The Wolf Creek Crater—from the west-north-west side (taken from the air by R. M. Elliott). The photograph shows the situation within a narrow annular crater-mound of solid rock outcrop, and amid monotonous sand-plain country traversed by linear dunes (left). The radial " rifts " (fault grooves) are clearly visible, and also the flat floor of the crater, abruptly divided into sand-covered and gypsum covered areas, the latter being centrally situated and clearly demarcated by the vegetation change. The most prolific shale-balls recoveries have been made immediately beyond the two light-coloured patches (lower-middle, right). (Scale : the crater is half a mile in diameter and the crater rim in the foreground lies 100 feet above the sand-plain and 200 feet above the crater floor).

(b) The Wolf Creek Crater—from the east-south-east showing the slightly polygonal outline of the crater and crater mound. The backing up of the dune sand and spill over into the crater on the east side is clearly seen (left foreground).

(c) The Dalgaranga Crater—from the north. Upturned laterite and granite shows (left, crater rim), and broken blocks of laterite are visible beyond. Spoil from excavation shows white on the crater floor. (Scale : the crater is about 70 feet in diameter.)


A
B
C

Index

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