R.O. Chalmers, Commemorative Papers (Mineralogy, Meteoritics, Geology)

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Australian Meteorites

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Abstract. Meteorites are an unique source of information about the earliest history of the Solar System. Since the first recorded discovery of a meteorite in 1854 near Cranbourne, Victoria, a total of 277 distinct and authenticated meteorites have been recorded in Australia. The material, including 13 observed falls, comprises 195 stones (ten achondrites, 183 chondrites and two unclassified stones), 68 irons, 13 stony-irons and one meteorite of unknown class. One hundred and forty one meteorites are known from Western Australia, 50 from South Australia, 47 from New South Wales, 14 from Queensland, 11 from the Northern Territory, ten from Victoria and four from Tasmania. A low ratio of falls to finds (1:20) compared with other countries (e.g., USA 1:7) reflects Australia's sparse population. However, normalised to population density, the rate of recovery of meteorites (falls + finds) in Australia exceeds that of most other countries of similar size and range of climatic conditions. More than 50% of documented meteorites from Australia have been recovered from Western Australia, 28% coming from the Nullarbor Region including many rare types. Excluding Antarctica, the Nullarbor Region has proved to be one of the most prolific areas in the world for meteorite finds. As in Antarctica, the frequency of meteorite types in the population of meteorites so far collected from the Nullarbor Region is depleted in irons, and may differ from that in the rest of the world. The climatic, physiographic and human factors that contribute to the recovery of meteorites in Australia are examined. Terrestrial ages of meteorites from the arid zone of Australia may help to provide a chronology for recent palaeoclimatic events.

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The available evidence suggests that meteorites originate within the Solar System, and most appear to be fragments of asteroids that are in solar orbits between Mars and Jupiter (Wasson & Wetherill, 1979). Meteorites have extremely old formation ages (4.55 Ga) and many have remained essentially unaltered since their formation. As samples from minor planets, meteorites are an unique source of information about a wide variety of events that occurred very early in the history of the solar system.

Twenty five years ago there were, in total, specimens of about 2100 distinct meteorites known throughout the world, representing approximately ten new recoveries per year over the two centuries that meteorites have been recognised as important and collected. Approximately 40% of these were observed falls: the remainder were chance recoveries, or 'finds'. Since 1969, the remarkable discovery of major caches of meteorites preserved in the ice-fields of Antarctica (Whillans & Cassidy, 1983), and the recognition that the hot deserts of the world may also contain concentrations of meteorites that have accumulated with time, has led to the recovery of an abundance of new material and opened up many new lines of research. High on the list of those countries of the world with large tracts of arid land likely to yield great numbers of meteorite finds is Australia.

The earliest well-documented recoveries of meteorites in Australia were two large masses of iron weighing 3.5 and 1.5 tons found in 1854 near Cranbourne in Victoria. An even earlier discovery may have been the Barratta stony meteorite, reported to have been found in 1845 in Townsend County, New South Wales (Liversidge, 1872), but Mason (1974) suggests that the evidence concerning the date of find is not conclusive. The description of the Cranbourne meteorites by Haidinger (1861) effectively marked the beginning of research on Australian meteorites. Subsequently, during the period 1854 to 1928, eight additional masses of the same meteorite shower were recovered from an area between Beaconsfield and Langwarrin bringing the total weight recovered to more than ten tons. Walcott (1915) demonstrated that the find-sites of the five individuals then known lay along a line trending S.30°W. Extensive literature on the Cranbourne irons has been summarised by Edwards & Baker (1944) and, more recently, by Graham *et al.* (1985).

Australian meteorites have been reviewed, or listed, on numerous occasions in the past (Cooksey, 1897; Anderson, 1913; Prior, 1923; Hodge-Smith, 1939; Prior & Hey, 1953; Hey, 1966; Mason, 1974; Gibbons, 1977; Graham *et al.*, 1985). Figure 1 shows the total numbers of meteorites known from Australia at various times during the period 1897 to 1990. Save for a period of stagnation in the years around the First World War (1913-1923), Mason (1974) also noted a small, but uniform growth in the number of recoveries for the period 1897 to 1966 averaging 16 new meteorites per decade. Further, Mason (1974) documented the large increase in the number (57) of recoveries (notably stony meteorites) between 1960 and 1974. The majority of these new meteorites were found in the Nullarbor Region of Western Australia (see McCall & Cleverly, 1970; de Laeter, 1983) and were partly the result of a program of search and recovery in the area undertaken by personnel from the Western Australian School of Mines in Kalgoorlie. However, many of the earliest discoveries in the Nullarbor Region were made by rabbit trappers, the largest contribution (24) by Mr John Carlisle, a professional bushman from Kalgoorlie, and members of his family.

Mason (1974) documented a total of 184 distinct meteorites from Australia. Since 1974, data have been published on 93 new Australian meteorites and many additional recoveries remain to be described (Bevan & Binns, 1989c; M. Duggan, personal communication). Although meteorites continue to be found throughout Australia, following the trend noted by Mason (1974), the rapid increase in the number of new recoveries (Fig.1) is largely due to discoveries in the Western Australian Nullarbor. For climatic and geological reasons the Nullarbor Region has proved to be one of the most prolific areas of the world for meteorite recoveries outside of Antarctica (Bevan & Binns, 1989a, 1989b, 1989c). Recoveries from the region currently account for more than 28% of all meteorites known from Australia.

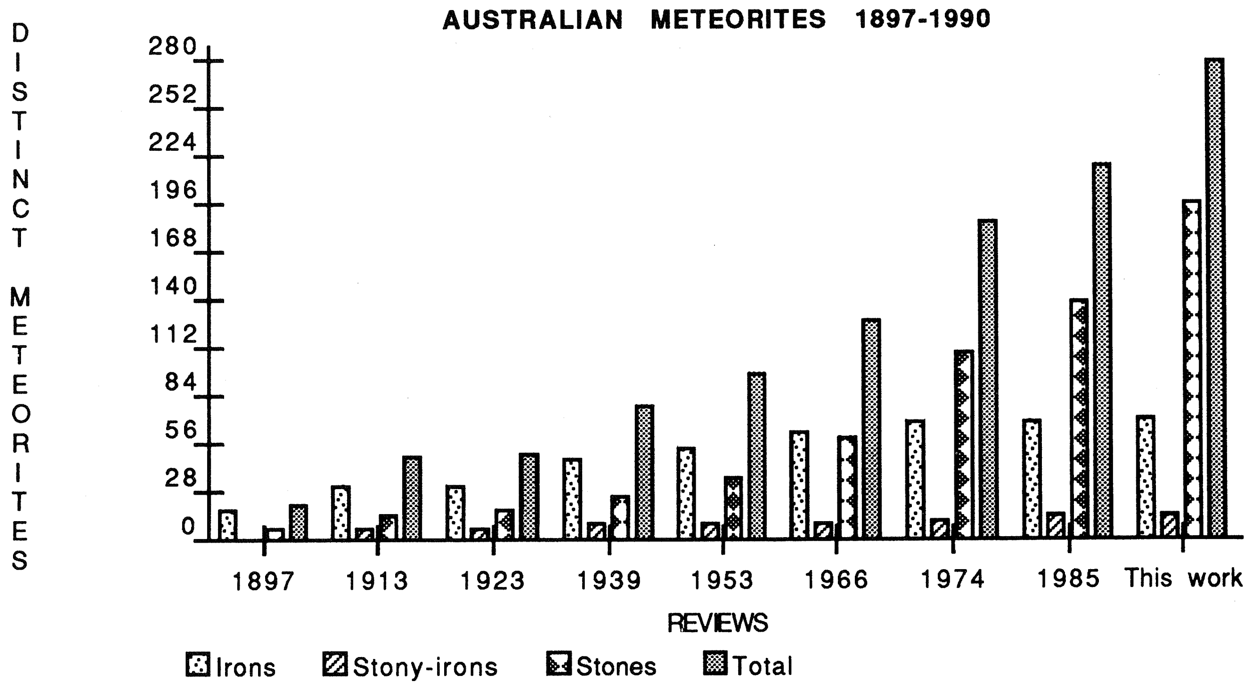

Fig.1. Meteorites (stones, irons, stony-irons) known from Australia during the period 1897-1990.

The purpose of this paper is two-fold. Firstly, to review Australian meteorites and, with special reference to the unique conditions in the Nullarbor Region and by comparison with other areas of the world, to examine some of the climatic, physiographic and human factors that contribute to the recovery of meteorites in Australia. Secondly, to provide an up-to-date index of Australian meteorites for those involved in meteorite research. Graham *et al.* (1985) have catalogued the literature on Australian meteorites to 1984, and it is not intended to provide a comprehensive bibliography in this work. However, references to the description of meteorites recovered or recognised since 1984, or otherwise not included in Graham *et al.* (1985), are quoted (see Appendix II).

All tables referred to throughout the text are listed in Appendix I.

Meteorite Classification and Origin

The present understanding of meteorites is based on many lines of evidence, most of which are beyond the scope of this paper. The modern classification of meteorites is outlined briefly here as a means of illustrating current theories on the origin and evolution of meteorites.

Meteoritic materials are dominated by ferro-magnesian silicates and metallic iron-nickel. Historically, meteorites have been divided into three broad categories on their contents of these two components. *Irons* are composed principally of metal, *stones* consist predominantly of silicates but with varying amounts of accessory metal; and *stony-irons* comprise metal, and silicates in roughly equal proportions. Detailed chemical, mineralogical and structural studies of meteorites have identified numerous subdivisions within these three categories, and recognised that the overall classification of meteorites obscures relationships between certain types of meteorite and implies other relationships where none appear to exist (Wasson, 1974; Dodd, 1981; McSween, 1987). One of the aims of modern meteorite research is to group together genetically-related meteorites and to seek inter-group relationships. To this end, the classification of meteorites has been refined considerably over the last twenty years.

The principal classes of meteorite are listed in Table 1. Of the two types of stony meteorite, the *chondrites* are most numerous accounting for approximately 86% of observed falls. Chondritic meteorites have bulk, non-volatile element compositions close to that of the Sun (Anders, 1971) and are characterised by rounded, mm-sized bodies of silicate material called 'chondrules' from whence their name derives. The *achondrites* include those stony meteorites that differ chemically from the chondrites and lack chondrules. Many achondrites have textures and chemistries resembling terrestrial and lunar igneous rocks, or their impact derived debris.

Chondrites

With the exception of volatile elements (notably H,C,N and S), chondrites have remarkably similar chemistries, the elements Fe, Mg, Si and O constituting over 90% by weight. However, there are systematic variations in their major element compositions, mineralogy and texture that serve to distinguish a number of groups. The abundance of Fe in chondrites and the distribution of this element between reduced (metal + sulphide) and oxidised (silicates + oxides) phases distinguishes five main groups (E, H, L, LL, and C). The same groups can also be distinguished on ratios of their refractory element (Mg, Al, Ti, Ca) contents to Si (Ahrens, 1970), and oxygen isotopic compositions (Clayton *et al.*, 1976).

The highly reduced enstatite chondrites (E) contain abundant metal, have Mg/Si atomic ratios of less than 0.85 and, as their name suggests, possess virtually iron-free silicates. Enstatite chondrites comprise two groups: high-iron EH and low-iron EL chondrites (Sears *et al.*, 1982). At the other extreme, carbonaceous chondrites (C) are highly oxidised materials rich in refractory elements (Mg/Si atomic greater than 1.05) and containing little or no metallic iron. The carbonaceous chondrites are divided into four groups (see note in proof), CI, CM, CO and CV (Kallemeyn & Wasson, 1981). The H- (high-iron), L- (low-iron) and LL- (low-total iron, low-metallic iron) groups are intermediate in oxidation state and are collectively known as the ordinary chondrites (OC). Ordinary chondrites are depleted in refractory elements (Mg/Si atomic = 0.95) relative to carbonaceous chondrites, contain significant amounts of both metallic and oxidised iron and are the most abundant extra-terrestrial materials available for study. A few chondrites defy classification into any of the known groups and have been termed anomalous (CHANOM).

Within each of the chondritic groups, meteorites show the effects of varying degrees of solid-state recrystallisation that has progressively erased their chondritic textures. Van Schmus & Wood (1967) recognised four main types of ordinary chondrite to which they assigned petrologic labels on a numbered scale from least (type 3) to most (type 6) crystallised. Types 4 and 5 are intermediate between these extremes. Petrologic types 1 (now CI) and 2 (now CM) refer to the rare carbonaceous chondrites often containing free carbon and water-bearing minerals indicative of low temperature environments. Type 3 chondrites (Fig.2b) display prominent chondrules with glassy mesostases set in a fine-grained matrix, and consist of highly disequilibrated mineral assemblages. In type 6 chondrites (Fig.2c), solid-state recrystallisation of matrix and chondrule mesostases has all but erased their chondritic textures, and they contain more or less equilibrated minerals (Van Schmus & Wood, 1967). An additional petrologic type 7 has been proposed for those chondrites that have been severely recrystallised and/or partially melted (Dodd *et al.*, 1975).

Achondrites

The achondrites are a heterogeneous group of essentially igneous stony meteorites (Fig.3a,b). Five classes of achondrites are either cumulates, or breccias of rock and mineral fragments of igneous origin. These are sub-divided into calcium-poor (aubrites, diogenites and ureilites) and calcium-rich (eucrites and howardites) types (Table 1). In addition to these five main classes, there are a number of achondritic stones that have been assigned group names in the past (e.g., nakhlites, angrites and chassignites), but are now generally considered anomalous (ACANOM) or have been assigned to other groups (Graham *et al.*, 1985). Six meteorites, representing four distinct falls, from Antarctica have been identified as lunar anorthositic breccias (Marvin, 1983; Eugster, 1988), and it has been suggested that another eight achondrites with young crystallisation ages in the range 1.3 x 10^9 to 0.2 x 10^9 yrs (the SNC-group - named after the stones Shergotty, Nakhla and Chassigny) - are planetary in origin and may have been derived from Mars (e.g., see Wood & Ashwal, 1981; McSween, 1985; Laul, 1986).

Stony-irons

The stony-irons comprise two main groups. The *pallasites* are composed of roughly equal proportions of metal and olivine (Mason, 1963; Scott, 1977), whereas the *mesosiderites* are heterogeneous mixtures of metal, angular fragments of achondritic rock composed of plagioclase and Ca-pyroxene, and rounded masses of olivine. In mesosiderites, metal often occurs as large rounded nuggets, as veins, and may also occur as small grains intimately intermingled with silicates. Based on the composition of metal, Scott (1977) has divided the pallasites into two sub-groups. The *Main Group* accounts for 75% of all known pallasites. However, Scott (1977) recognised three chemically distinct pallasites (Eagle Station, Itzawisis and Cold Bay) that he named the *Eagle Station Group* after the type meteorite.

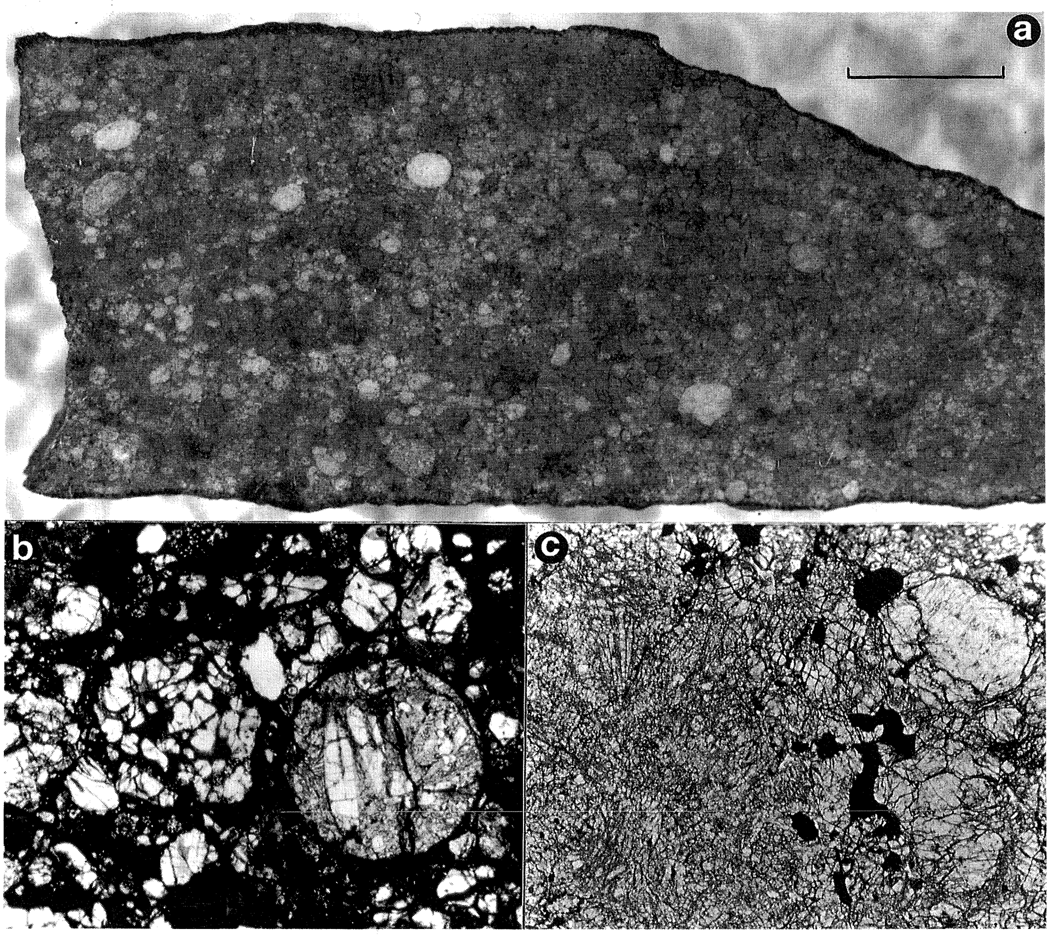

Fig.2. a. Slice of the Barrata (L4) chondrite showing numerous rounded chondrules (scale bar 2 cm) and photomicrographs in PPL of **b.** the H3 chondrite Nyanga Lake 001 showing prominent chondrules and **c.** the crystalline L6 chondrite, Forrest 008 (width of field 3 mm) showing almost complete integration of chondrules and matrix.

Irons

Iron meteorites essentially comprise large crystals of Fe-Ni metal. Bulk Ni contents vary from 4-60 wt%, but most irons have compositions in the range 5-12 wt% Ni. Etched sections of iron meteorites with Ni contents in the range about 7-11 wt% display macroscopic octahedral arrangements of plates called Widmanstätten patterns (Fig.4a). The structure comprises two cubic Fe-Ni alloys: body centred cubic α-Fe,Ni (kamacite) with a maximum Ni solubility of about 7.5 wt%, and face-centred cubic Ni-rich γ-Fe,Ni (taenite) which is often strongly compositionally zoned with respect to Ni. An ordered, tetragonal γ-phase (tetrataenite) containing greater than 45 wt% Ni has been identified as an additional component of the structure (Peterson *et al.*, 1977; Scott & Clarke, 1979).

Iron and nickel, together with small amounts of Co (0.3-1.0 wt%), usually make up greater than 98 wt% of bulk iron meteorites. However, minor elements such as sulphur, carbon, phosphorus and chromium and many other elements at trace levels are also present in non-metallic minerals such as troilite FeS, cohenite $(FeNi)_3C$, schreibersite $(FeNi)_3P$, graphite and chromite, and also in solid solution in metallic Fe-Ni.

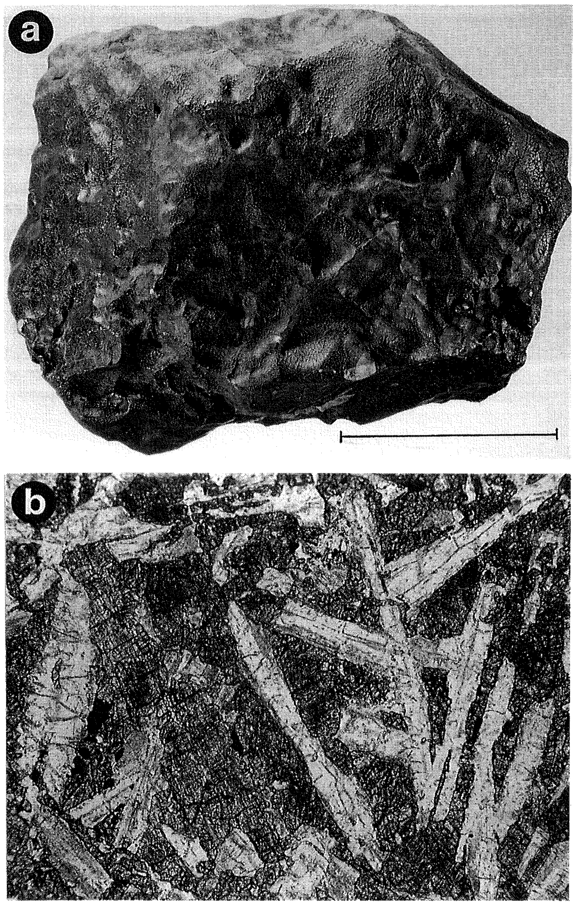

Fig.3. a. Main mass (20 kg) of the Millbillillie eucrite (scale bar 10 cm): **b.** Photomicrograph (PPL) of a doleritic clast in Millbillillie showing ophitic texture of laths of plagioclase feldspar (light) enclosed in grains of pyroxene (dark) (width of field 3 mm).

Historically, irons have been grouped on the basis of their metallographic structures (Buchwald, 1975). As the result of pioneering analytical work by Goldberg *et al.* (1951), Lovering *et al.* (1957) and later by Wasson (1967) and others, systematic chemical variations at the trace element level were discovered between irons. The data have provided genetic information on the origin of iron meteorites and serve to distinguish a number of discrete chemical groups. Plots of Ga, Ge or Ir (and other trace elements) versus Ni distinguish thirteen well-defined groups of irons (Fig.4b) and form the basis of a modern chemical classification (Scott & Wasson, 1975, 1976; Scott, 1979; Kracher *et al.*, 1980). The chemical groups are designated by Roman numerals and letters (Table 1). Eleven groups (IC, IIAB, IIC, IID, IIE, IIF, IIIAB, IIIE, IIIF, IVA, IVB) have narrow ranges of compositions, two groups (IAB and IIICD) have much wider compositional ranges and evolved differently. Approximately 10% of all analysed irons do not plot within any of the resolved chemical groups and are designated anomalous (IRANOM).

Variations between groups of irons were probably established in chemically distinct environments (Scott, 1979), whereas the regular chemical variations within groups of irons are attributed to the separation and fractional crystallisation of molten metal during planetary differentiation (Lovering *et al.*, 1957: Scott 1972, 1979; Kelly & Larimer, 1977).

Origin

Models for the origin of the Solar System invoke a dense initial cloud of gas and dust, the 'solar nebula', from which the Sun formed, with the materials that formed the planets condensing and accreting at approximately the same time and by a complementary process. The approximately 'solar' bulk compositions of chondritic stones are taken to indicate that they have not undergone extensive planetary differentiation either before or after their formation. Chondrites are essentially undifferentiated aggregates of materials that retain a physical and chemical record of some of the earliest events in the history of the Solar System. In broad terms, iron, stony-iron and achondritic stony meteorites mainly represent the products of extensive early differentiation and mixing on small planetesimals.

Although the nature of inter-relationships between chondrites and other meteorite types remains uncertain (Hutchison, 1982), differentiated meteorites may have formed in a number of planetesimals by the melting of chondrite-like materials and the gravitational separation of molten metal and silicates the irons representing solidified and slowly-cooled segregations of once molten metal, and the achondrites more or less recycled samples of the silicate residue. The stony-irons may have formed by the mechanical mixing of both solid and liquid metal and silicate at various depths within their parent planetesimals. The pallasites probably formed at metal/silicate boundary regions deep within differentiated planetary bodies (Scott, 1977), whereas mesosiderites may represent near planetary surface mixtures of metal and achondritic silicates of diverse origins (Floran, 1978; Prinz *et al.,* 1980; Hassanzadeh *et al.*, 1990).

Geographical Distribution and Classification of Australian Meteorites

To date, a total of 277 authenticated and distinct meteorites have been recorded from Australia. The material comprises 195 stones (ten achondrites, 183 chondrites and two unclassified stones), 68 irons, 13 stony-irons and one meteorite, the type of which is unknown. These are listed alphabetically with classifications, co-ordinates and state of origin in the Appendix II. The list includes only those meteorites for which published information is available and the names of which have either appeared in Graham *et al.* (1985), or have been approved subsequently by the Meteorite Nomenclature Committee of the Meteoritical Society. For three meteorites (Rockhampton, Johnny's Donga and Korrelocking) no material is known to be preserved. Currently, there are 141 distinct meteorites known from Western Australia, 47 from New South Wales, 50 from South Australia, 14 from Queensland, 11 from the Northern Territory, ten from Victoria and four from Tasmania.

Falls

Thirteen observed falls have been recovered in Australia. The earliest well-documented meteorite fall

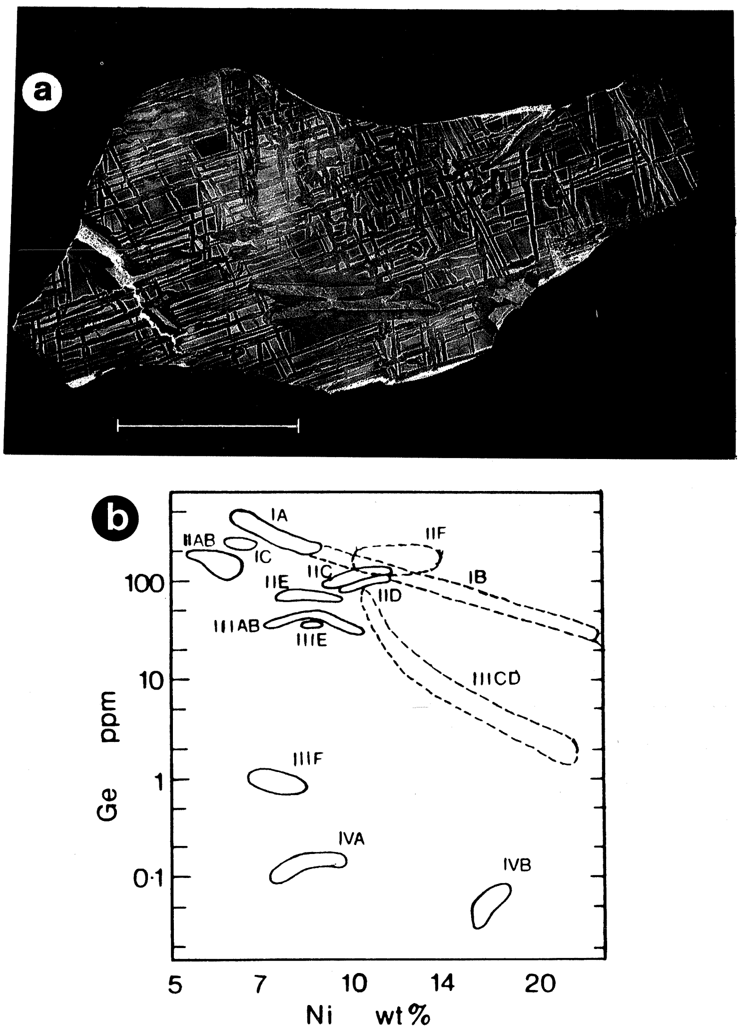

Fig.4. a. A polished and etched slice of the Tieraco Creek (IIIB) iron meteorite showing octahedral arrangement of interlocking plates of kamacite and taenite, called a Widmanstätten pattern, and several laths of schreibersite (scale bar 2.5 cm): **b.** Logarithmic plot of Ge versus Ni showing the 13 known chemical groups of irons (after Scott, 1979).

occurred in 1879 near Tenham pastoral station in Queensland from which hundreds of stones were collected (Spencer, 1937). The most recently recovered fall, a single stone weighing 488.1 grams, occurred on 30 September, 1984 at Binningup in Western Australia (Bevan *et al.*, 1988). Australian falls are listed in Table 2 and their geographical distribution is shown in Figure 5. A number of other fresh meteorite recoveries in Australia have been linked to witnessed fireballs (e.g., see Lovering, 1975). In most cases, these meteorites were found or recognised some time after the reported events and their dates of fall have to be considered doubtful. One of these, Barratta, is possibly the first recorded meteorite fall in Australia (Mason, 1974).

The authenticated observed falls comprise seven ordinary chondrites (Tenham [L6], Narellan [L6], Moorleah [L6], Forest Vale [H4], Woolgorong [L6], Wiluna [H5] and Binningup [H5]), two carbonaceous chondrites (Karoonda [C4] and Murchison [CM2]), three basaltic achondrites (Emmaville [eucrite], Binda [howardite] and Millbillillie [eucrite]) and one unclassified stone (Rockhampton). Three stones were reported to have fallen near Rockhampton in Queensland during the spring of 1895 (Tryon, 1910), but Spencer (1937) noted that the material was lost.

Finds

The geographical distribution of meteorite finds in Australia is shown in Figure 6. Excluding the anomalously large number of meteorites recovered from the Nullarbor Region in Western Australia (Fig.6), the distribution of meteorite recoveries is generally concentrated around centres of population, or in areas of intense agricultural/pastoral and mining activity. Few meteorites have been recorded from central Australia, or tropical regions north of latitude 23°S. Mason (1974) noted that there have been few recoveries from Queensland. While several additional discoveries have been made in recent years, curiously, the total number of documented meteorites from Queensland still stands at only 14. The most recent of these was an H5 chondrite weighing 2.6 kg found at Lake Machattie in May, 1988 (Graham, 1990).

The largest single meteorite recovery in Australia is an 11.5 tonne mass of the Mundrabilla iron found in 1966 on the Nullarbor Plain in Western Australia (Wilson & Cooney, 1967). Fragments of five meteorites (4 irons and 1 stony-iron) are associated with explosion craters (Dalgaranga [mesosiderite], Veevers [IIB iron], Wolf Creek [IIIB iron], Boxhole [IIIA iron] and Henbury [IIIA iron]) (see Fig.6). In addition, another crater at Mount Darwin in Tasmania is undoubtedly of meteorite impact origin (Fudali & Ford, 1979), but there are no

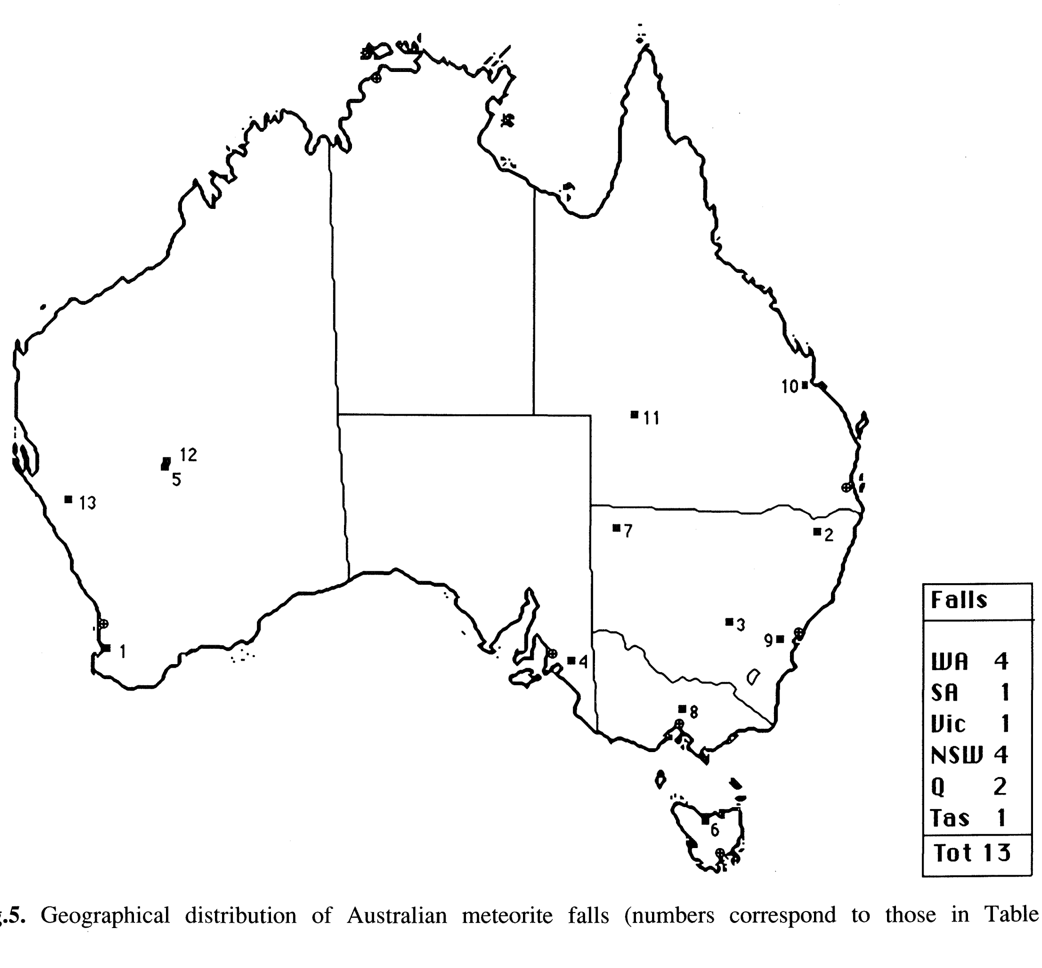

Fig.5. Geographical distribution of Australian meteorite falls (numbers correspond to those in Table 2).

associated meteorites. Throughout Australia another 15 large structures have been identified, to varying degrees of certainty, as the deeply eroded remnants of ancient impact structures, but no meteoritic material survives at these sites (Shoemaker & Shoemaker, 1988).

Classification

Out of the main groups or sub-types of meteorites known (Table 1), only ten are not represented among the meteorites recovered from Australia. These include LL3-4 and petrologic type 7 ordinary chondrites, groups CI, CO3 and C5 carbonaceous chondrites, and EH3-4 enstatite chondrites. The carbonaceous chondrite Karoonda was classified by Van Schmus & Hayes (1974) as C5, but Scott & Taylor (1985) suggest that it is C4 (see Appendix II). Chemical analysis of two type 3 chondrites Moorabie and Starvation Lake indicate that they may be LL3 (Sears *et al.*, 1990) although their oxygen isotopic compositions fall within the field of both unequilibrated L and LL chondrites. Pending further studies they are listed in Appendix II as L (LL?)3 chondrites. In the achondrites, there are no known Australian aubrites and diogenites. One previously ungrouped iron, Corowa, now forms part of the IIF chemical group of irons (Kracher *et al.*, 1980). Two meteorites, Pennyweight and Murchison Downs, have been shown by Wasson *et al.* (1989) to be irons with silicate inclusions closely related to the mesosiderites and they are listed as such in Appendix II.

Nomenclature and 'Pairing' of Meteorites

Conventionally, meteorites take the name of the geographical locality where they fell or were found. 'Paired' meteorite falls are those pairs, or groups, of meteorites for which it has been suggested, because of geographical proximity and classification, belong to a single fall (Hey, 1966). When two or more meteorites, found at different times and allocated different names, are proved to be from the same fall they are said to be 'synonymous' and the name of the meteorite first recovered usually takes precedence. Conversely, meteorites thought to be from the same fall are sometimes found on further examination to be distinct. For these reasons, the number of distinct meteorites known from Australia has fluctuated in the past without the addition of new material. For example, four masses of iron found in Murchison County, New South Wales and thought to represent three distinct falls (Bingera, Barraba and Warialda - see Liversidge, 1882; Mingaye, 1904, 1921; White, 1925) have been shown to be synonymous (see Hodge-Smith, 1939; Mason, 1974;

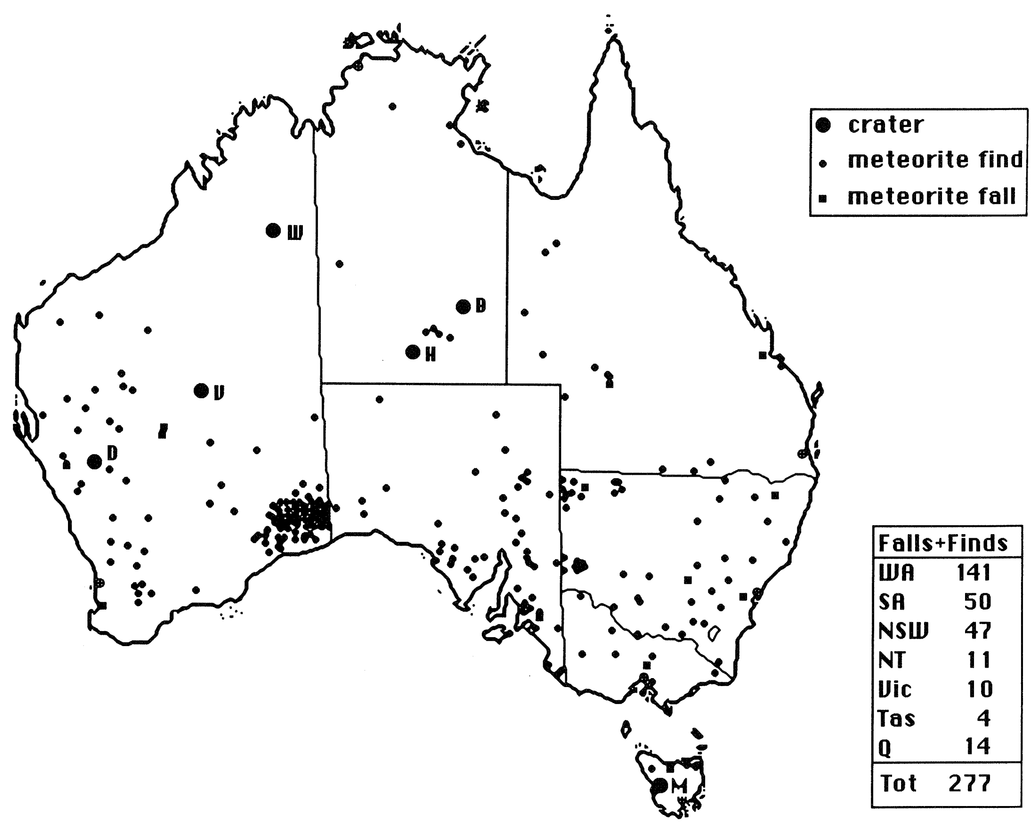

Fig.6. Geographical distribution of Australian meteorite falls and finds including the sites of five meteorite impact craters, Wolf Creek (W), Dalgaranga (D), Veevers (V), Henbury (H), Boxhole (B), Mount Darwin (M).

Buchwald, 1975) and are now listed under Bingera (Graham *et al.*, 1985). More recently, a chondritic stone (Hammond Downs) found close to the strewnfield of the Tenham meteorite in Queensland and originally thought to be from that fall has been shown by Mason (1973) to be distinct. Similarly, two L (LL?)3 chondrites found near the border between New South Wales and South Australia (Moorabie, Quinyambie) are considered synonymous, and are listed under Moorabie by Graham *et al.* (1985). An additional L (LL?)3 find, Starvation Lake, may also be from the same fall (Sears *et al.*, 1990) but is listed separately in this work. However, on the basis of mineral chemistry, Mason (personal communication) considers that Moorabie, Quinyambie and Starvation Lake are three distinct meteorites. Synonyms that have been used for some Australian meteorites are listed in Appendix II.

Meteorite Preservation and Recovery

At this point, it is pertinent to examine the principal factors that contribute to the recovery of meteorite falls and finds throughout the world. With only a slight decrease in the rate of infall near the poles, meteorites appear to fall randomly over the Earth (Hughes, 1981). On average, only five to six meteorites have been seen to fall annually and recovered over the two centuries or so that accurate records have been kept (Graham *et al.*, 1985). Based on photographic data of fireballs from a network of 60 cameras operational in western Canada for nine years, Halliday *et al.* (1984) calculated that some 5800 meteorites with masses of at least 100 grams may be deposited annually on the Earth's land surface. From their study of historical falls, Wickman & Palmer (1979) noted that, in the majority of cases, those freshly fallen meteorites that were quickly recovered inflicted damage on man-made structures such as buildings and cars, or landed within a few tens of metres of a human being. A classic recent example is the Binningup fall that landed within 4 to 5 metres of two women sunbaking on a beach in Western Australia (Bevan *et al.*, 1988). Clearly, in the absence of camera networks, population density is paramount in governing the rate of recovery of fresh falls. However, by rationalising recovered falls to area and population density for a number of countries throughout the world, Dodd (1986) has demonstrated that the trend is not strictly linear. In addition to population density, Dodd (1986) recognised that historical and educational factors have also contributed to the recovery of meteorites. For example, the most successful country in terms of recovery of meteorite falls is France which is less densely populated than other European countries such as the United Kingdom or Germany. Moreover, countries with large, moderately to densely populated catchment areas, such as the north east of USA, the Ukrainian USSR and India, have not matched the recovery rate in France. Dodd (1986) noted that France was the country in which the scientific importance of meteorites was first recognised around 1800. Consequently, during the period 1800 to 1850, 27 observed falls were recovered in France, a rate of recovery unsurpassed by any other country.

For those meteorites that fall unobserved on to land, preservation depends mainly on climate. Because meteorites are generally rich in metallic iron, in temperate and tropical climates they are destroyed on a time scale that is rapid compared to their influx. In dry climates, meteorites may be preserved for thousands of years after their fall (Boeckl, 1972). Whether or not these are recovered depends, ultimately, on recognition.

Over the last twenty years a number of areas of the world have proved to be prolific sources of meteorite finds. The most outstanding case is Antarctica (Whillans & Cassidy, 1983). To date, more than 9800 fragments of meteorite have been recovered from a number of blue ice areas throughout Antarctica (Graham & Annexstad, 1989). More recently, 'bad lands' subject to wind deflation in Roosevelt County, New Mexico, USA have yielded large numbers of meteorite finds (Scott *et al.*, 1986; Sipiera *et al.*, 1987) and many meteorites are also being found in the deserts of North Africa (Wlotzka, 1989; Jull *et al.*, 1990). From the terrestrial ages of finds, mainly from the western United States, Boeckl (1972) estimates that the 'half-life' of an ordinary chondritic meteorite before destruction by weathering in that climate is about 3600 years.

Australia

The ratio of falls to finds in Australia (1:20) is much lower than in most other countries (e.g., USA 1:7) and is undoubtedly a function of the country's sparse and unevenly distributed population. The lack of meteorite finds from tropical Australia (Fig.6) is probably due to the combination of dense vegetation and a wet climate that are not conducive to the preservation or discovery of meteorites. However, the lack of recoveries from arid central Australia is more difficult to explain and may be the result of factors such as education and recognition. Nevertheless, rationalised to population, the rate of recovery of meteorites (falls + finds) in Australia exceeds that of most other countries of similar size and range of climatic conditions (Fig.7).

In Australia, palaeoclimatic studies indicate that the onset of aridity dates from the Late Tertiary following a period when subtropical, humid environments predominated. However, in the southern regions of the continent, Bowler (1976) suggests that desiccation was probably well advanced 2.5 mya. Progressively drier conditions developed during the Quaternary reaching a peak of intensity about 18,000 to 16,000 years ago in the Pleistocene and have persisted up to the present day (Bowler, 1976). To date, only two areas containing concentrations of meteorites that may have accumulated over long periods have been recognised in the arid zone of Australia. McCall & Cleverly (1970), Mason (1974) and, more recently, Bevan & Binns (1989a,b,c) have documented large numbers of meteorite finds from the Nullarbor Region of Western Australia. Additionally, Fitzgerald (1979) has described a number of chondritic meteorites from Menindee Lakes in western New South Wales, and many more recoveries from near this locality remain to be described (M. Duggan and D.H. McColl, personal communication). Currently, more than 50% (141) of the total number of documented Australian meteorites have been recovered from Western Australia, the bulk (78) of these coming from the Nullarbor Region.

The Nullarbor Region

The Nullarbor is a region of generally treeless limestone plains in the south of the continent straddling the border between Western Australia and South Australia (Beard, 1975) (Fig.6). The Nullarbor is coincident with a geological structure, the Eucla Basin, consisting of flat-lying limestones of Early Miocene age that outcrop over a total area of approximately 240,000 sq km (Lowry, 1970). The semi-arid to arid climate of the region, combined with a lack of vegetation and pale limestone country rock, makes the Nullarbor ideal for the preservation and recognition of meteorites (Fig.8). Several thousand specimens from more than one hundred possibly distinct meteorites have been recovered from the Western Australian Nullarbor and greater than 500 specimens of potentially new meteorites remain to be described (Bevan & Binns, 1989a,b,c). Excluding Antarctica, the current density of meteorite finds from the Nullarbor (about one meteorite per 391 km^2) is two orders of magnitude greater than the average (one meteorite per 68 x 10^3 km^2) for the rest of the world's land surface (Bevan & Binns, 1989b).

To deal with the large numbers of recent recoveries, Bevan & Binns (1989a) have devised a new system of nomenclature. The system currently defines a network of 47 named areas in the Western Australian Nullarbor. Distinct meteorites take the name of the area in which they are found, and a three digit number (e.g., Deakin 001) in chronological order of discovery within each area.

Fall and Find Frequency

Meticulous documentation of meteorite recoveries from throughout the world has allowed statistical studies of the temporal and spatial distribution of falls (Hughes, 1981). Well documented meteorite falls provide the best available measure of the relative abundances of the different types of meteorite that survive their fall to Earth. The aim of statistical studies is to obtain reliable values for the influx of meteorite falls and their mass, and the constitution of the meteoritic flux (Brown, 1960). Wickman & Palmer (1979) have shown that statistics based on witnessed falls and chance recoveries are fraught with difficulties, and generally rely on *ad hoc* assumptions about how the distribution of human populations around the world, and their varying levels of education, affect the probability of meteorite recognition and recovery. Networks of cameras covering large areas (10^6 km^2) of the Earth's surface have provided more reliable estimates of the annual influx of meteorites. In recent years, as the result of advances in the understanding of luminous phenomena associated with the fall of meteorites, it has become possible to identify those fireballs with the potential to yield meteorites even if none are recovered subsequently (Halliday *et al.*, 1984). As yet, however, camera techniques are not sufficiently sophisticated to

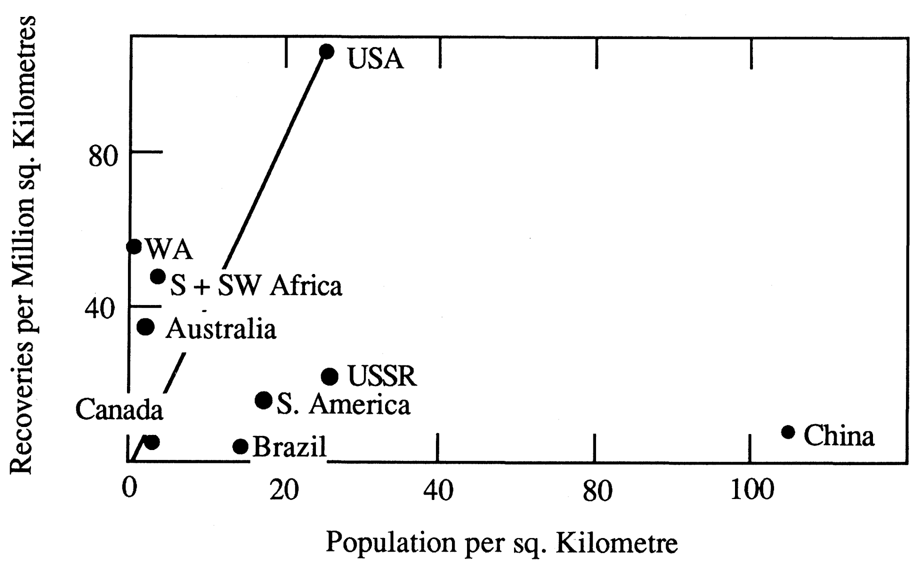

Fig.7. Meteorite recoveries rationalised to population density for Australia, Western Australia (WA) and selected countries. The tie-line indicates the country (USA) with the greatest number of meteorite (fall + find) recoveries.

distinguish with confidence actual meteorite types from observations of fireballs.

Using modern observed falls as a sample, Wasson (1974), Dohnanyi (1972) and, more recently, Harvey & Cassidy (1989) have calculated the relative abundances of different compositional types of meteorite. The 'fall frequency' is the number of each type of meteorite seen to fall expressed as a percentage of the total number of observed falls (Table 3). A sample (835) of well-documented falls (this work) taken from Graham *et al.* (1985) (Table 3), shows that, collectively, the chondritic meteorites (particularly the ordinary chondrites) are the most abundant types, accounting for 86.2% of observed falls. Irons and stony-irons are the rarest types seen to fall, accounting for 4.8% and 1.1% of the population, respectively. When the data are recalculated to include all meteorites in collections throughout the world (falls + finds - Table 3), while the proportions of chondrites (enstatite, carbonaceous/anomalous, and ordinary) and achondrites correspond well with those predicted by their fall frequency, the irons and, to a lesser extent, the stony-irons, appear to be over-represented. Reasons for the disproportionately high numbers of iron and stony-iron meteorite finds are that the metallic meteorites often survive longer in the terrestrial environment and, significantly, are more easily recognised as meteoritic. This bias in the recognition and collection of 'metallic' meteorites extends back to prehistoric times. Throughout the world there is evidence that many ancient civilisations found, utilised and even revered meteoritic iron (Buchwald, 1975).

By comparison, the constitution of the total population of meteorites (falls + finds) recorded from Australia matches closely that for the rest of the world (Table 3), and shows the usual abundance (25%) of irons. However, taken as a discrete sample, the constitution of the population of meteorites so far recovered from the Nullarbor Region appears anomalous.

Comparison of the Nullarbor, Antarctic and World Meteorite Populations

The discovery of populations of meteorites that have accumulated over long periods has provided an opportunity to study the constitution of the meteoritic flux with time. On the basis of trace element studies of the most common types of chondrites from Antarctica, Dennison *et al.* (1986) have suggested that Antarctic meteorites and modern falls are chemically distinct, and may reflect changes in the sampling of meteorite parent bodies with time. Terrestrial ages of Antarctic meteorites are very much greater than most finds from other parts of the world. Nishiizumi (1990) and others report terrestrial ages for Antarctic meteorites ranging up to 0.95 Ma., though most Antarctic meteorites have terrestrial ages between 1-2 x 10^5 years (Schultz, 1986). Recently, Harvey & Cassidy (1989) have compared the constitution of meteorite finds from Antarctica with the modern fall frequency. On the basis of non-parametric statistical analysis, they suggest that modern falls and several populations of Antarctic meteorites are probably not good samples of a single steady-state meteoritic complex. The conclusions of Harvey & Cassidy (1989) appear to support the view that the flux of meteoritic material to Earth may have been variable over the last 400,000 years. While there is a general consensus that differences do exist between Antarctic and non-Antarctic meteorites, the reasons for these differences are poorly understood (Koeberl & Cassidy, 1991) and may relate either to pre-terrestrial processes (Lipschutz & Samuels, 1991), or to terrestrial weathering and sampling bias (Cassidy & Harvey, 1991; Huss, 1991).

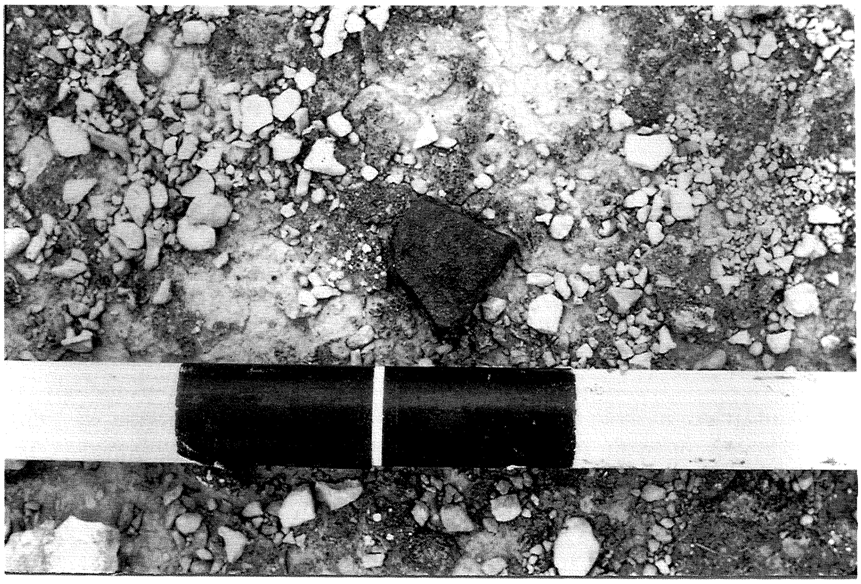

Fig.8. A weathered chondritic meteorite lying on the Nullarbor Plain, Western Australia (ranging pole divided in 5 cm units).

Comparison between the constitution of the sample of meteorites found in the Nullarbor and those in Antarctica (Table 3) shows that the two populations are remarkably similar. Graham & Annexstad (1989) note that in the Antarctic population the percentage (2%) of irons is lower than that predicted by the modern fall frequency (about 5%). The percentage of iron meteorite finds from the Nullarbor (2.8%) is similarly low. In addition, in the Nullarbor population, there is a relatively high proportion (4.6%) of rare, or anomalous types of chondrites. However, it should be noted that two irons from the Nullarbor (Mundrabilla and Haig) account for more than 99% of the total mass of all meteorites recovered from the region to date.

The sample of probably distinct meteorites from the Nullarbor (107) for which classification data are available is an order of magnitude smaller than that from Antarctica (greater than 1000) and may not be statistically significant. However, a major problem with the Antarctic meteorite population is determining the actual number of falls that are represented (Scott, 1984). Using the ratio of irons to stony-irons in the Antarctic population, Graham & Annexstad (1989) suggest that the material collected from Antarctica represents an upper limit of approximately 1000 individual falls, i.e., 10% of the number of specimens collected. While the number of different falls represented in the Antarctic population is uncertain, in the case of the Nullarbor the lack of transportation processes in the region and documentation of the distribution of finds has allowed 'pairing' of meteorites to at least 90% level of confidence and most paired meteorites should have been detected (Bevan & Binns, 1989a).

In the Nullarbor population three irons (Mundrabilla, Haig and Sleeper Camp 002) and one stony-iron (Rawlinna 001) are known. Applying the same analysis to the Nullarbor meteorite population as used by Graham & Annexstad (1989) for Antarctica, the ratio of irons to stony-irons from the Nullarbor (3:1) is close to that for Antarctica (28:11) and the rest of the world (5:2). From the modern fall frequency, assuming that three irons represent about 5% and one stony-iron represents about 2% of the total number of falls, then the expected number of distinct meteorites in the Nullarbor population works out at 60 from the irons and 50 from the stony-irons. Both of these figures are well below the currently recorded population (107) and indicate that these types of meteorites may be under-represented in the population by a factor of two. The alternative that the total population of distinct meteorite finds in the Nullarbor has been over-estimated by a factor of two seems unlikely.

The low percentages of irons in both the Antarctic and Nullarbor populations are difficult to explain. In Antarctica, meteorites have been collected by experienced personnel, thus eliminating the possibility of any human bias in the collection. Graham & Annexstad (1989) suggest that, in Antarctica, the operation of some terrestrial process may have reduced the number of irons available for collection. Another possibility is that irons are rarer as falls in Antarctica than in other parts of the world. In the Nullarbor, many meteorites have been found by inexperienced personnel and it would be expected that any bias would be towards more, rather than less, iron meteorites. A complicating factor is that the Nullarbor has been periodically populated by aboriginal people over at least the last 20,000 years, and by itinerant prospectors and rabbiters within the last 100 years. To date, there is no evidence anywhere in Australia to suggest that early aborigines collected or utilised meteoritic iron, but the possibility of human interference with the population of meteorites from the Nullarbor cannot be ruled out. This problem may only be resolved when a much larger sample of meteorites has been collected from the Nullarbor.

Terrestrial ages of meteorites from the Nullarbor Region are not yet available. However, recent data on the natural thermoluminescence of two chondritic meteorites (Moorabie and Starvation Lake) found on similarly arid land near the South Australian/New South Wales border (Sears *et al.*, 1990) indicate terrestrial ages of 10,000 to 20,000 years. Significantly, these ages are within the range of the majority of Antarctic meteorites.

Rare Meteorites from Australia

Many rare, and some hitherto unknown, types of meteorite have been recovered from Australia and research on these has played an important role in extending our understanding of the early Solar System. Of these, the fall of more than 100 kg of stones at Murchison in Victoria on September 28, 1969 is probably the most significant (Lovering *et al.*, 1971; Fuchs *et al.*, 1973). Prior to the fall of the Murchison CM2 carbonaceous chondrite, only small quantities of this type of meteorite were known worldwide. The abundance of material from the Murchison fall allowed extensive research that has been summarised by Graham *et al.* (1985). Notably, analysis of Murchison confirmed the existence of extra-terrestrial organic compounds, including amino acids (Kvenvolden *et al.*, 1970). These compounds are abiotic and their origin is still a matter for debate; however, there is general consensus that they may have been the precursors of life on Earth (e.g., see Shock & Schulte, 1990 and references therein). Recently, Lewis *et al.* (1987) reported the presence of nm-sized primary interstellar diamonds in Murchison and other chondrites that are extending our knowledge of nucleosynthesis, and the pre-history of the Solar System.

The fall of the Karoonda meteorite in Buccleuch County, South Australia in 1930 was the first recorded example of an equilibrated (C4) carbonaceous chondrite and, to date, the only observed fall of this type of meteorite. Later, in 1971, the discovery of the Mulga (west) meteorite on the Nullarbor Plain in Western Australia provided another even more crystalline (type 5/6) example of a carbonaceous chondrite (Binns *et al.*, 1977; Scott & Taylor, 1985). Several other crystalline carbonaceous, or otherwise anomalous, chondrites have since been discovered in Australia including the anomalous type 3-4 chondrite, Carlisle Lakes (Binns & Pooley, 1979; Rubin & Kallemeyn, 1989), the C4 chondrite Maralinga (Kallemeyn *et al.*, 1991), an as yet undescribed C4 chondrite from the Nullarbor Region (Bevan, in preparation) and an ungrouped chondrite, Deakin 001 (Bevan & Binns, 1989b). A few meteorites similar to Karoonda and Mulga (west) have also been recovered from Antarctica (Scott & Taylor, 1985). Two other meteorites from Antarctica, Allan Hills 85151 and Yamato 75302, are similar to Carlisle Lakes and may belong to an entirely new group of chondrites (Rubin & Kallemeyn, 1989). Interestingly, only one C4 chondrite, Coolidge, from Kansas, USA, is known currently from the northern hemisphere. The remaining non-Antarctic examples of C4-6, or Carlisle Lakes-like, chondrites are all from southern Australia, including three from the Nullarbor Region. The significance, if any, of this concentration of rare meteorite types has yet to be investigated, but may be related to the time-span of the population of meteorites sampled in Antarctica and the Nullarbor.

One of the most remarkable meteorites known is the Bencubbin meteorite found in 1930 in Western Australia (Simpson & Murray, 1932). Bencubbin is listed in Appendix II as an anomalous stony-iron (SIANOM) although it is not related to any of the major stony-iron groups. Essentially, Bencubbin is a complex breccia of primitive metal and silicate components, including a variety of chondritic xenoliths (Lovering, 1962; McCall, 1968; Kallemeyn *et al.*, 1978; Newsom & Drake, 1979; Hutchison, 1986; Weisberg *et al.*, 1990). Bencubbin is unique, although components of the meteorite share some chemical and isotopic characteristics with Renazzo, an anomalous carbonaceous chondrite that fell in Italy in 1824, a unique Antarctic chondrite, Allan Hills 85085 (Grady & Pillinger, 1989; Weisberg *et al.*, 1990), and another anomalous stony-iron, Weatherford, from Oklahoma, USA (Mason & Nelen, 1968).

No lunar meteorites are known from Australia (see note in proof). However, it has been suggested by Johnson *et al.* (1977) that one olivine-rich achondrite, Brachina, found in South Australia may belong to the SNC-group of martian meteorites. Compositionally, Brachina is similar to the SNC meteorite Chassigny, but oxygen isotopes show that they are not related (Clayton & Mayeda, 1983). Brachina has no immediate relatives, though it may be genetically related to the L or LL group chondrites (Johnson *et al.*, 1977).

Australian Meteorite Collections

Most Australian meteorites that remain in the country are held in a few main institutional collections. The largest collections of Australian meteorites are held by the Western Australian Museum in Perth, and the Australian Museum in Sydney. Additionally, moderate collections are held by the South Australian Museum in Adelaide, the Museum of Victoria in Melbourne, the Bureau of Mineral Resources and the Australian National University in Canberra, and many Departments of Geology in Universities throughout Australia. Meteorites are protected by law in Western Australia, South Australia, Northern Territory and Tasmania, and their respective State Museums have a statutory obligation to maintain meteorite collections.

Summary and Conclusions

More than 50% of the Australian continent (3.8 x 10^6 km^2) comprises deserts or semi-arid land providing conditions for the prolonged preservation of meteorites. From the concentration of meteorites in the Nullarbor Region of Western Australia, it is reasonable to assume that similar concentrations exist throughout the arid zone of Australia. The recorded number of distinct meteorites (277) from Australia, more than 70% of which have been found in the arid zone, is probably only a small fraction of those available for collection. The low number (about 15) of meteorite finds recorded from central Australia is probably a function of physiographic and human factors that exclude the recognition of meteorites. These may include burial of meteorites in sand or their occurrence in deeply lateritised terrains, and human factors such as sparse population and lack of knowledge.

In the Nullarbor Region, the concentration of meteorites appears to be solely a function of prolonged aridity and may not have involved additional physical concentration processes as in Roosevelt County, USA. Important data missing from the analysis of Australian meteorite finds are their ages of terrestrial residence. Ultimately, terrestrial ages of meteorites from areas such as the Nullarbor may help to constrain the age range of the surfaces on which they are found and the onset of dry conditions in the region. In addition to providing information on the flux of meteorites with time, these data may have important implications for palaeoclimatic and palaeoecological studies in Australia. The continued recovery of meteorites from the arid regions of Australia will provide not only an important resource for the study of the early Solar System, but may also give new insights into palaeoclimatic-related research.

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APPENDIX I

Table 1. The classification of meteorites and abundance known from Australia

STONES	No.	Frequency %
Class unknown	2	0.7
Chondrites		
Class unknown	2	0.7
H-group		
H3	7	2.5
H4	16	5.7
H5	41	14.8
H6	15	5.4
petrologic type unknown	1	0.4
L-group		
L3	4	1.4
L4	8	2.9
L5	12	4.3
L6	55	19.9
L7*	0	0.0
petrologic type unknown	3	1.1
LL-group		
LL3*	0	0.0
LL4*	0	0.0
LL5	3	1.1
LL6	3	1.1
petrologic type unknown	1	0.4
Carbonaceous		
CI*	0	0.0
CM2	3	1.1
CO3*	0	0.0
CV3	1	0.4
C4	2	0.7
C5	0	0.0
C6	1	0.4
Enstatite		
EH3*	0	0.0
EH4*	0	0.0
EH5	1	0.4
EL5*	0	0.0
EL6	1	0.4
Anomalous		
CHANOM	3	1.1
Achondrites		
Ca-poor		
Aubrites (enstatite achondrites)*	0	0.0
Diogenites (hypersthene achondrites)*	0	0.0
Ureilites (olivine-pigeonite achondrites)	3	1.1
Ca-rich		
Eucrites (plagioclase-pigeonite achondrites)	4	1.4
Howardites (plagioclase-hypersthene achondrites)	2	0.7
Anomalous		
ACANOM	1	0.4

STONY-IRONS		
Pallasites (PAL)	5	1.8
Mesosiderites (MES)	7	2.5
Anomalous		
SIANOM	1	0.4
IRONS		
IAB	8	2.8
IC	3	1.1
IIAB	4	1.4
IIC	2	0.7
IID	1	0.4
IIE	1	0.4
IIF	1	0.4
IIIAB	25	9.0
IIICD	3	1.1
IIIE	1	0.4
IIIF	1	0.4
IVA	2	0.7
IVB	2	0.7
chemical class unknown	7	2.5
Anomalous		
IRANOM	7	2.5
Meteorite (type unknown)	1	0.4
TOTAL	277	100

*denotes meteorite types not recorded from Australia

Table 2. Australian observed meteorite falls.

	Name	Date of fall	Class	State	Co-ordinates
1	Binningup	30 Sept. 1984	H5	WA	33°09'23"S 115°40'35"E
2	Emmaville	1900	Eucrite	NSW	29°28'S 151°37'E
3	Forest Vale	7 Aug. 1942	H4	NSW	33°21'S 146°51'30"E
4	Karoonda	25 Nov. 1930	C4	SA	35°05'S 139°55'E
5	Millbillillie	Oct. 1960	Eucrite	WA	26°27'S 120°22'E
6	Moorleah	Oct. 1930	L6	Tas	40°58.5'S 145°36'E
7	Mount Browne	17 July 1902	H6	NSW	29°48'S 141°42'E
8	Murchison	28 Sept. 1969	CM2	Vic	36°37'S 145°12'E
9	Narellan	8 Apr. 1928	L6	NSW	34°03'S 150°41'20"E
10	Rockhampton*	(spring) 1895	stone	Qld	23°23'S 150°31'E
11	Tenham	(spring) 1879	L6	Qld	25°44'S 142°57'E
12	Wiluna	2 Sept. 1967	H5	WA	26°35'34"S 120°19'42"E
13	Woolgorong	20 Dec. 1960	L6	WA	27°45'S 115°50'E

*specimen lost

Numbers correspond to those shown in Figure 5

Table 3. Frequency of meteorite types in the Nullarbor Region, Antarctica, Australia and the World.

	Nullarbor Region (finds)	Antarctic (finds)	Australia (falls+finds)	World (falls+finds)	World (falls)
Sample	(107)*	(1100)#	(272)	(2474)	(835)
	Frequency%	Frequency%	Frequency%	Frequency%	Frequency%
Chondrites	93.4	91.3	66.5	62.3	86.2
Ordinary	87.9	87.9	62.1	58.5	80.0
Carbonaceous+anom	4.6	2.7	3.7	2.9	4.6
Enstatite	0.9	0.7	0.7	0.9	1.6
Achondrites	2.9	5.8	3.7	5.4	7.9
Stony-irons	0.9	0.7	4.8	2.9	1.1
Irons	2.8	2.2	25.0	29.4	4.8
	100.0	100.0	100.0	100.0	100.0

* includes data on 29 distinct meteorites for which classification data are available but are not listed in this paper (see Bevan & Binns, 1989c)

estimated number of falls represented (data from Scott, 1984)

N.B. One unclassified meteorite, two unclassified stones and two unclassified chondrites not included in the calculation for Australian (falls+finds).

APPENDIX II

Names, co-ordinates, classifications and synonyms of Australian meteorites. (References are given only for those meteorites not included in Graham *et al.* (1985). n.c.c.= no chemical class; n.f.c.= no further class

Meteorite name	classification	fall or find/year	Latitude	Longitude	State	*Synonyms* (references)
Adelaide	CM2	Find 1972	unknown		SA	
Alikatnima	IRANOM	Find 1931	23°20'S	134°07'E	NT	
Answer	IR ataxite (n.c.c.)	Find 1970	21°39'35"S	140°54'25"E	Qld	
Arltunga	IID-ANOM	Find 1908	23°20'S	134°40'E	NT	
Arrabury	H6	Find c 1960	26°30'S	141°05'E	Qld	
Artracoona	L6	Find 1914	29°04'S	139°55'E	SA	
Avoca (Western Australia)	IIIA	Find 1966	30°51'S	122°19'E	WA	
Baandee	H5	Find 1967	31°37'S	118°02'E	WA	(Bevan *et al.*, 1990)
Balfour Downs	IA	Find 1962	22°45'S	120°50'E	WA	
Ballinoo	IIC	Find 1892	27°42'S	115°46'E	WA	*Ballinee, Ballinos, Mount Erin*
Barratta	L4	Find 1845	35°18'S	144°34'E	NSW	*Baratta, Deniliquin*
Bealiba	L6	Find 1950	36°48'S	143°33'E	Vic.	(Birch, 1991; Wlotzka, 1990)
Bencubbin	SIANOM	Find 1930	30°45'S	117°47'E	WA	*Mandiga, North Mandiga*
Bendock	PAL	Find 1898	37°09'S	148°55'E	Vic.	*Bendoc*
Billygoat Donga	L6	Find 1962	30°08'S	126°22'E	WA	
Binda	AHOW	Find 1912	34°19'S	149°23'E	NSW	
Bingera	IIA	Find 1880	29°53'S	150°34'E	NSW	*Barraba, Bingara, Warialda*
Binningup	H5	Fall 1984	33°09'23"S	115°40'35"E	WA	(Bevan *et al.*, 1987)
Blue Tier	IR (n.c.c)	Find 1890	41°11'S	148°02'E	Tas.	*Tasmania*
Bond Springs	H6	Find 1898	23°30'S	133°50'E	NT	
Boogaldi	IVA	Find 1900	31°09'S	149°07'E	NSW	*Bugaldi*
Boolka	chondrite	Find 1968	30°04'S	141°04'E	NSW	
Boxhole	IIIA	Find 1937	22°37'S	135°12'E	NT	*Hart Range*
Brachina	ACANOM	Find 1974	31°18'S	138°23'E	SA	
Buckleboo	H6	Find c 1963	32°57'20"S	136°08'15"E	SA	
Burnabbie	H5	Find 1965	32°03'S	126°10'E	WA	
Burrika	L6	Find 1966	31°58'S	125°50'E	WA	
Cadell	L6	Find 1910	34°04'S	139°45'E	SA	
Camel Donga	AEUC	Find 1984	30°19'S	126°37'E	WA	(Cleverly *et al.*, 1986)
Cardanumbi	L5	Find 1966	32°06'S	125°41'E	WA	
Carlisle Lakes	CHANOM	Find 1977	29°10'S	127°05'E	WA	*Carlisle Lakes (a)* (Bevan & Binns, 1989a)
Caroline	H5	Find c 1941	37°59'S	140°59'E	SA	
Carraweena	L3	Find 1914	29°14'S	139°56'E	SA	*Accalana, Caraweena*
Cartoonkana	L6	Find c 1914	29°45'S	141°02'E	NSW	
Castray River	IR (n.f.c.)	Find 1899	41°30'S	145°25'E	Tas.	
Cockarrow Creek	L6	Find 1970	26°40'S	120°10'E	WA	
Cockburn	L6	Find 1946	32°08'S	141°02'E	SA	
Cocklebiddy	H5	Find 1949	31°56'S	126°13'E	WA	

Meteorite name	classification	fall or find/year		Latitude	Longitude	State	*Synonyms* (references)
Cocunda	L6	Find	1945	32°49'S	134°48'E	SA	
Commodore	H6	Find	1972	31°12'S	138°18'E	SA	(Graham, 1989)
Coolac	IA	Find	1874	34°58'S	148°07'30"E	NSW	
Coolamon	L6	Find	c 1921	34°49'S	147°08'E	NSW	
Coomandook	H6	Find	1939	35°25'S	139°45'E	SA	*Coomandook I, Coomandook II, Ki-Ki*
Coonana	H4	Find	1962	29°51'S	140°42'E	SA	
Coorara	L6	Find	1966	30°27'S	126°06'E	WA	
Corowa	IIF	Find	c 1964	36°00'S	146°22'E	NSW	
Cosmo Newberry	IIA	Find	1980	27°57'S	122°53'E	WA	
Cowell	IIIA	Find	1932	33°18'S	136°01'E	SA	*Caralue*
Cowra	IRANOM	Find	1888	33°51'S	148°41'E	NSW	*Bathurst, Carcoar, Carevar*
Crab Hole	L	Find	1980	30°24'S	127°26'E	WA	
Cranbourne	IA	Find	1854	38°06'S	145°18'E	Vic.	*Abel, Beaconsfield, Bruce, Dandenong, Langwarrin, Melbourne, Pakenham,Victoria, Western Point district, Western Port district, YarraYarra River*
Credo	L6	Find	1967	30°22'S	120°44'E	WA	
Crocker's Well	chondrite	Find	1956	32°01'S	139°47'E	SA	*Crocker Well*
Dalgaranga	MES	Find	1923	27°43'S	117°15'E	WA	
Dalgety Downs	L4	Find	1941	25°20'S	116°11'E	WA	*Ashburton Downs, Dalgetty Downs, Dalgety Doun*
Deakin 001	CHANOM	Find	1978	30°53'S	128°58'E	WA	(Bevan & Binns, 1989b)
Deakin 002	H4	Find	1978	30°53'S	128°58.5'E	WA	(Bevan & Binns, 1989b)
Deakin 003	H5	Find	1986	30°25.9'S	128°40'E	WA	(Bevan & Binns, 1989b)
Deakin 004	H4	Find	1986	30°28.2'S	128°44.7'E	WA	(Bevan & Binns, 1989b)
Delegate	IIIB-ANOM	Find	c 1904	37°00'S	149°02'E	NSW	
Dimboola	H5	Find	1944	36°30'S	142°02'E	Vic.	
Dingo Pup Donga	AURE	Find	1965	30°26'S	126°06'E	WA	
Donnybrook	MES	Find	1918	~33°37'S	~115°55'E	WA	(Graham, 1988)
Doolgunna	L	Find	1967	25°56'S	119°18'E	WA	*Meekatharra*
Dorrigo	IRANOM	Find	c 1948	30°17'S	152°40'E	NSW	
Duketon	IIIA	Find	1948	27°30'S	122°22'E	WA	*Bandhya, Bandya, Duketown*
Edjudina	H4	Find	1969	29°35'11"S	122°10'54"E	WA	*Ejudina*
Eli Elwah	L6	Find	1888	34°30'S	144°43'E	NSW	*Hay*
Ellerslie	L5	Find	1905	28°54'S	146°46'E	Qld	
Elsinora	H5	Find	1922	29°27'S	143°36'E	NSW	
Emmaville	AEUC	Fall	1900	29°28'S	151°37'E	NSW	
Ethiudna	L	Find	1977	31°59'S	139°46'E	SA	
Fenbark	H5	Find	1968	30°26'25"S	121°15'25"E	WA	
Forest Vale	H4	Fall	1942	33°21'S	146°51'30"E	NSW	
Forrest 001	H5	Find	1967	30°49'S	128°13'E	WA	*Forrest (a)* (Bevan & Binns, 1989b)
Forrest 002	L6	Find	1980	30°59'S	127°53'E	WA	*Forrest (b)* (Bevan & Binns, 1989b)
Forrest 003	H3	Find	1970	30°54'S	128°05'E	WA	(Bevan & Binns, 1989b)
Forrest 004	L6	Find	1970	30°28'S	128°12'E	WA	(Bevan & Binns, 1989b)
Forrest 005	H4	Find	1970	30°27.5'S	128°13'E	WA	(Bevan & Binns, 1989b)

Meteorite name	classification	fall or find/year		Latitude	Longitude	State	*Synonyms* (references)
Forrest 006	L6	Find	1977	30°38'S	128°07.5'E	WA	(Bevan & Binns, 1989b)
Forrest 007	H4	Find	1979	30°47.1'S	128°01'E	WA	(Bevan & Binns, 1989b)
Forrest 008	L6	Find	1979	30°45'S	127°59.5'E	WA	(Bevan & Binns, 1989b)
Forrest 009	L6	Find	1979	30°09'S	128°05'E	WA	(Bevan & Binns, 1989b)
Forrest 010	L4	Find	1982	30°07'S	127°52'E	WA	(Bevan & Binns, 1989b)
Forrest 011	H5	Find	1982	30°09'S	128°05'E	WA	(Bevan & Binns, 1989b)
Forrest 012	H5	Find	1982	30°09'S	128°05'E	WA	(Bevan & Binns, 1989b)
Forrest 013	L6	Find	1982	30°09'S	128°05'E	WA	(Bevan & Binns, 1989b)
Forrest Lakes	LL5	Find	c 1948	29°25'S	129°30'E	WA	*Loongana (stone)* (Bevan & Binns, 1989a)
Frenchman Bay	H3	Find	1964	30°36'30"S	115°10'E	WA	
Gilgoin	H5	Find	1889	30°23'S	147°12'E	NSW	*Gilgoin Station*
Gladstone (iron)	IA	Find	1915	23°54'S	151°18'E	Qld	*Queensland, South Queensland*
Glenormiston	IRANOM	Find	1925	22°54'S	138°43'E	Qld	*Boulia*
Gnowangerup	IIIA	Find	1976	34°00'S	118°06'E	WA	
Gundaring	IIIA	Find	1937	33°18'S	117°40'E	WA	
Gunnadorah	H5	Find	1968	31°00'S	125°56'E	WA	(Bevan & Binns, 1989b)
Haig	IIIA	Find	1951	31°23'S	125°38'E	WA	*Rawlinna (iron)*
Hamilton (Queensland)	L6	Find	1966	28°29'S	148°15'E	Qld	*Hamilton*
Hammond Downs	H4	Find	1950	25°28'S	142°48'E	Qld	
Henbury	IIIA	Find	1931	24°34'S	133°10'E	NT	*Basedow Range, Gallipoli, Glen Helen, Hamilton Hotel, Hembury, Nutwood Downs*
Hermitage Plains	L6	Find	1909	31°44'S	146°24'E	NSW	*Hermadale, Hermidale*
Huckitta	PAL	Find	1924	22°22'S	135°46'E	NT	*Alice Springs, Huckitte*
Ingella Station	H5	Find	1987	25°33'S	142°47'E	Qld	(Graham, 1988)
Jeedamya	H4	Find	1971	29°35'S	121°10'E	WA	(Bevan *et al.*, 1990)
Johnny's Donga	Stone (n.f.c.)	Find	c 1965	~30°20'S	~126°22'E	WA	
Kaldoonera Hill	H6	Find	c 1956	32°37'S	134°51'E	SA	
Kappakoola	H6	Find	1929	33°15'S	135°32'E	SA	
Kapunda	IIIA	Find	c 1965	34°19'S	138°56'E	SA	
Karoonda	C4	Fall	1930	35°05'S	139°55'E	SA	*Karoona*
Kielpa	H5	Find	1948	33°36'S	136°06'E	SA	
King Solomon	IR (n.f.c.)	Find	1952	20°41'58"S	139°48'15"E	Qld	
Kittakittaooloo	H4	Find	1970	28°02'S	138°08'E	SA	
Koraleigh	L6	Find	1943	35°06'S	143°24'E	NSW	
Korrelocking	unknown	Find	1937	~26°S	~122°E	WA	
Kulnine	L6	Find	1886	34°09'S	141°47'E	Vic.	
Kumerina	IIC	Find	1937	24°55'S	119°25'E	WA	
Kyancutta	IIIA	Find	1932	33°17'S	136°E	SA	
Kybunga	L5	Find	1956	33°54'S	138°29'E	SA	*Kybunga I, Kybunga II, Kybunga III*
Lake Bonney	L6	Find	1961	37°45'S	140°18'E	SA	
Lake Brown	L6	Find	1919	31°S	118°30'E	WA	*Burracoppin, Lake Moore*
Lake Grace	L6	Find	1956	33°04'S	118°13'E	WA	
Lake Labyrinth	LL6	Find	1924	30°32'S	134°45'E	SA	

Meteorite name	classification	fall or find/year		Latitude	Longitude	State	*Synonyms* (references)
Lake Machattie	H5	Find	1988	24°50'S	139°48'E	Qld	(Graham, 1990)
Lake Torrens	L6	Find	1989	31°02'S	138°04'E	SA	(Wlotzka, 1990)
Landor	IR (n.c.c.)	Find	1931	25°40'S	117°E	WA	
Latham	L6	Find	c 1977	29°45'S	116°26'E	WA	(This work)
Laundry East	H3	Find	1967	31°32'S	127°06'E	WA	
Laundry Rockhole	H5	Find	1967	31°32'S	127°01'E	WA	
Laundry West	L4	Find	1967	31°28'S	126°56'E	WA	
Lefroy	IR (n.c.c.)	Find	1904	40°44'S	146°58'E	Tas.	
Lismore	IIIA?	Find	1959	~35°57'S	~143°20'E	Vic.	
Lookout Hill	CM2	Find	1974	30°05'26"S	128°48'21"E	WA	
Loxton	L5	Find	c 1968	34°27'S	140°34'E	SA	(Wallace & Pring, 1990)
Mangalo	L6	Find	1987	33°34'S	136°39'E	SA	(Wallace & Pring, 1991)
Maralinga	C4	Find	1974	30°18'S	131°16'E	SA	(Wlotzka, 1991)
Mellenbye	LL6	Find	c 1929	28°51'S	116°17'E	WA	*Mallenbye*
Menindee Lakes 001	L6	Find	1969	~33°10'S	~141°45'E	NSW	*Popio*
Menindee Lakes 002	H5	Find	1969	~32°55'S	~141°53'E	NSW	*Twin Wells*
Menindee Lakes 003	L6	Find	1969	~32°55'S	~141°53'E	NSW	*Nine Mile*
Menindee Lakes 004	L6	Find	1969	~33°08'S	~141°43'E	NSW	*Popilta*
Menindee Lakes 005	H5	Find	1969	~32°55'S	~141°53'E	NSW	*Popio Lakes (a)*
Menindee Lakes 006	H6	Find	1969	~32°55'S	~141°53'E	NSW	*Popio Lakes (b)*
Millbillillie	AEUC	Fall	1960	26°27'S	120°22'E	WA	*Nabberu*
Millrose	L6	Find	1984	26°20'S	121°00'E	WA	(Bevan *et al.*, 1990)
Milly Milly	IIIA	Find	1921	26°07'S	116°40'E	WA	
Moama	AEUC	Find	1940	35°57'S	144°31'E	NSW	
Molong	PAL	Find	1912	33°17'S	148°53'E	NSW	
Monte Colina	L3	Find	1963	29°24'S	139°59'E	SA	*Monte Collina* (paired with Carraweena)
Moonbi	IIIF	Find	1892	30°55'S	151°17'E	NSW	
Moorabie	L(LL?)3	Find	c 1965	30°06'S	141°04'E	NSW	*Moorabbie, Quinyambie*
Moorleah	L6	Fall	1930	40°58.5'S	145°36'E	Tas.	
Moorumbunna	IIIA	Find	1943	28°55'S	136°15'E	SA	
Morden	IA	Find	1922	30°30'S	142°20'E	NSW	*Mordan*
Mossgiel	L4	Find	1967	33°19'S	144°47'E	NSW	
Motpena (a)	L6	Find	1968	31°06'S	138°16'E	SA	*Parachilna, Motpena*
Motpena (b)	CHANOM (type 6)	Find	1972	31°12'S	138°18'E	SA	(Graham, 1990)
Mount Browne	H6	Fall	1902	29°48'S	141°42'E	NSW	
Mount Dooling	IC	Find	1909	29°27'S	119°43'E	WA	*Gosnells, Lake Giles*
Mount Dyrring	PAL	Find	1903	32°20'S	151°12'E	NSW	
Mount Edith	IIIB	Find	1913	22°30'S	116°10'E	WA	*Duck Creek*
Mount Egerton	MESANOM	Find	1941	24°46'S	117°42'E	WA	*Siberia*
Mount Magnet	IRANOM	Find	1916	28°02'S	117°58'E	WA	*East Mount Magnet*
Mount Margaret	L5	Find	1972	28°50'S	122°11'E	WA	(Bevan *et al.*, 1990)
Mount Padbury	MES	Find	1964	25°40'S	118°06'E	WA	
Mount Sir Charles	IVA	Find	1942	23°50'S	134°02'E	NT	*Bond Springs*

Meteorite name	classification	fall or find/year		Latitude	Longitude	State	*Synonyms* (references)
Muckera	AHOW	Find	1950	30°05'S	130°02'E	SA	
Mulga (north)	H6	Find	1964	30°11'S	126°22'E	WA	
Mulga (south)	H4	Find	1963	30°12'S	126°22'E	WA	*Billygoat Donga II*
Mulga (west)	C6	Find	1971	30°11'S	126°22'E	WA	
Mundrabilla	IRANOM	Find	1911	30°47'S	127°33'E	WA	*Loongana Station (iron), Loongana Station West, Premier Downs*
Mundrabilla 002	H5	Find	1971	30°53'S	127°33'E	WA	(Bevan & Binns, 1989b)
Mundrabilla 003	H3	Find	1972	30°51'S	127°32'E	WA	(Bevan & Binns, 1989b)
Mundrabilla 004	H5	Find	1975	30°45.5'S	127°31.5'E	WA	(Bevan & Binns, 1989b)
Mundrabilla 005	H5	Find	1977	30°28.5'S	127°31'E	WA	(Bevan & Binns, 1989b)
Mundrabilla 006	H6	Find	1982	30°00.5'S	127°42.5'E	WA	(Bevan & Binns, 1989b)
Mundrabilla 007	L6	Find	1982	30°01'S	127°36.5'E	WA	(Bevan & Binns, 1989b)
Mundrabilla 008	L6	Find	1982	30°48'S	127°37'E	WA	(Bevan & Binns, 1989b)
Mundrabilla 009	L5	Find	1982	30°48'S	127°37'E	WA	(Bevan & Binns, 1989b)
Mundrabilla 010	L6	Find	1982	30°01'S	127°42'E	WA	(Bevan & Binns, 1989b)
Mungindi	IIICD	Find	1897	28°56'S	148°57'E	NSW	
Murchison	CM2	Fall	1969	36°37'S	145°12'E	Vic.	
Murchison Downs	MES	Find	1925	26°40'S	119°E	WA	(Wasson *et al.*, 1989)
Murnpeowie	IC	Find	1909	29°35'S	139°54'E	SA	
Nallah	H	Find	1968	31°58'S	126°15'E	WA	
Nardoo (no. 1)	H5	Find	1944	29°32'S	143°59'E	NSW	
Nardoo (no. 2)	L6	Find	1944	29°30'S	144°04'E	NSW	
Narellan	L6	Fall	1928	34°03'S	150°41'20"E	NSW	
Naretha	L4	Find	1915	31°00'S	124°50'E	WA	*Kingoonya, Kingooya*
Narraburra	IIIB	Find	1855	34°15'S	147°42'E	NSW	*Narrabura, Nurraburra, Temora, Yeo Yeo Creek*
Nilpena	AURE	Find	1975	31°05'S	138°18'E	SA	
Nimberrin	L6	Find	1970	31°31'S	117°58'E	WA	(Bevan *et al.*, 1990)
Nocoleche	IC-ANOM	Find	1895	29°52'S	144°13'E	NSW	
Nora Creina	L4	Find	1962	37°19'S	139°51'E	SA	*Nora Criena*
North East Reid	H5	Find	1969	30°02'S	129°01'E	WA	
North Forrest	H5	Find	1969	30°30'S	128°06'E	WA	(Bevan & Binns, 1989a)
North Haig	AURE	Find	1961	30°13'S	126°13'E	WA	
North Reid	LL5	Find	1969	30°00'S	128°55'E	WA	
North West Forrest (E6)	E6	Find	1971	30°36'S	127°49'E	WA	*North West Forrest (1971)*
North West Forrest (H)	H4	Find	c 1969	30°46'S	128°01'E	WA	*North Forrest, North West Forrest (1969)*
Nuleri	IIIA	Find	1902	27°50'S	123°52'E	WA	
Nullagine	H5	Find	1973	21°52'S	120°07'E	WA	
Nullarbor	H5	Find	1935	~31°S	~132°E	SA	
Nyanga Lake 001	H3	Find	1986	29°46.8'S	126°27.4'E	WA	(This work)
Oak	L5	Find	1968	31°35'S	127°42'E	WA	
Oberon Bay	LL6	Find	c 1962	39°04'S	146°21'E	Vic.	
Oldfield River	H5	Find	1972	33°S	121°E	WA	
Pannikin	L6	Find	1965	32°02'30"S	126°11'E	WA	

Meteorite name	classification	fall or find/year		Latitude	Longitude	State	*Synonyms* (references)
Pennyweight	MES	Find	1982	29°07'S	122°05'E	WA	*Pennyweight Point* (Wasson *et al.*, 1989)
Pevensey	LL5	Find	c 1868	34°47'S	144°40'E	NSW	*Hay*
Pine Dam	L5	Find	1976	30°25'S	138°00'E	SA	(Graham, 1988)
Pinnaroo	MES	Find	1927	35°23'S	140°55'E	SA	
Poonarunna	H5	Find	1970	27°46'S	137°51'E	SA	
Rabbit Flat	H6	Find	1974	20°22'S	130°07'E	NT	
Rawlinna 001	PAL	Find	c 1959	31°10'S	125°16'E	WA	*Rawlinna (pallasite)* (Bevan & Binns, 1989a)
Rawlinna 002	H5	Find	1952	30°22'S	126°05'E	WA	*Rawlinna (stone)* (Bevan & Binns, 1989a)
Redfields	IRANOM	Find	1969	30°43'S	116°30'E	WA	*Redlands, Redlands Farm*
Reid	H5	Find	1969	30°04'S	128°59'E	WA	(Bevan & Binns, 1989b)
Reid 002	L6	Find	1974	30°04'S	128°58'E	WA	(Bevan & Binns, 1989b)
Reid 003	L5	Find	1974	30°04'S	128°58'E	WA	(Bevan & Binns, 1989b)
Reid 004	H5	Find	1977	30°15'S	128°48'E	WA	(Bevan & Binns, 1989b)
Reid 005	L5-6	Find	1977	30°09'S	128°48'E	WA	(Bevan & Binns, 1989b)
Reid 006	H5	Find	1978	30°36'S	128°29'E	WA	(Bevan & Binns, 1989b)
Reid 007	L6	Find	1982	30°39'S	128°24.5'E	WA	(Bevan & Binns, 1989b)
Reid 008	L6	Find	1982	30°05'S	128°49'E	WA	(Bevan & Binns, 1989b)
Reid 009	H4	Find	1986	30°19'S	128°59.1'E	WA	(Bevan & Binns, 1989b)
Reid 010	H6	Find	1986	30°19.3'S	128°51'E	WA	(Bevan & Binns, 1989b)
Reid 011	H3-6	Find	1986	30°13'S	128°18'E	WA	(Bevan & Binns, 1989b)
Rhine Villa	IIIE	Find	1900	34°40'S	139°17'E	SA	*Adelaide, Rhine Valley*
River	L5	Find	1965	30°22'S	126°01'E	WA	
Rockhampton	Stone (n.f.c.)	Fall	1895	23°23'S	150°31'E	Qld	
Roebourne	IIIA	Find	1892	22°20'S	118°E	WA	*Hamersley, Hamersley Range, Hammersley, Hammersley Range*
Roper River	IIIB	Find	c 1953	15°S	135°E	NT	
Rowena	H6	Find	1962	29°48'S	148°38'E	NSW	
Silverton (New SouthWales)	L6	Find	c 1883	31°53'S	141°12'E	NSW	
Sleeper Camp	L6	Find	1962	30°15'S	126°20'E	WA	(Bevan & Binns, 1989a)
Sleeper Camp 002	IR (n.c.c.)	Find	1966	30°29'S	126°15'E	WA	*Un-named* (Bevan & Binns, 1989a)
Snake Bore	H5	Find	1975	31°06'S	138°16'E	SA	(Graham, 1990)
Starvation Lake	L(LL?)3	Find	1975	30°27'S	140°59'E	SA	(Sears *et al.*, 1990)
Streaky Bay	L4	Find	1989	32°52'S	134°17'E	SA	(Wallace & Pring, 1991)
Tabbita	L6	Find	1983	34°03'S	145°50'E	NSW	(This work)
Tawallah Valley	IVB	Find	1939	15°42'S	135°40'E	NT	
Tenham	L6	Fall	1879	25°44'S	142°57'E	Qld	*Warbreccan*
Thackaringa	H5	Find	1974	32°07'S	141°05'E	NSW	
Thompson Brook	IIICD	Find	1918	33°37'S	115°55'E	WA	(Graham, 1988; Wasson *et al.*, 1989)
Thunda	IIIA	Find	1881	25°42'S	143°03'E	Qld	*Diamantina, Windorah*
Tibooburra	CV3	Find	c 1970	29°26'S	142°01'E	NSW	
Tieraco Creek	IIIB	Find	c 1922	26°20'S	118°20'E	WA	*Tiraco Creek*
Ularring	L6	Find	1970	29°58'S	120°36'E	WA	
Veevers	IIB	Find	1988	22°58'6"S	125°22'7"E	WA	(Graham, 1989; Wasson *et al.*, 1989)

Meteorite name	classification	fall or find/year		Latitude	Longitude	State	*Synonyms* (references)
Vincent	L5	Find	1926	35°01'S	139°55'E	SA	*Weekeroo*
Warburton Range	IVB	Find	c 1963-4	26°17'S	126°40'E	WA	
Warden	H5	Find	1989	23°16'S	116°56'E	WA	(Wlotzka, 1990)
Webb	L6	Find	1968	31°41'30"S	127°47'E	WA	
Wedderburn	IIICD	Find	c 1951	36°26'S	143°38'E	Vic.	
Weekeroo Station	IIE	Find	1924	32°16'S	139°52'E	SA	
West Forrest	H5	Find	1971	30°45'S	127°59'E	WA	(Bevan & Binns, 1989a)
West Reid	H6	Find	1969	30°03'S	128°56'E	WA	(Bevan & Binns, 1989a)
Wilbia	H5	Find	1965	26°27'S	131°00'E	SA	
Wildara	H5	Find	1968	28°14'S	120°51'E	WA	
Willaroy	H3	Find	1970	30°06'S	143°12'E	NSW	
Wiluna	H5	Fall	1967	26°35'34"S	120°19'42"E	WA	*Granite Peak*
Wingellina	H4	Find	1958	26°03'S	128°57'E	WA	
Witchelina	H4	Find	1920	~30°S	~138°E	SA	
Wolf Creek	IIIB	Find	1947	19°18'S	127°46'E	WA	
Wonyulgunna	IIIB	Find	1937	24°55'S	120°04'E	WA	
Woolgorong	L6	Fall	1960	27°45'S	115°50'E	WA	
Wooramel	L5	Find	1969	25°39'S	114°13'E	WA	(Bevan *et al.*, 1990)
Wynella	H4	Find	1945	28°57'S	148°08'E	Qld	*Dirranbandi*
Yalgoo	LL	Find	c 1937	28°23'S	116°43'E	WA	
Yandama	L6	Find	c 1914	29°45'S	141°02'E	NSW	
Yardea	IA	Find	1875	32°27'S	135°33'E	SA	*Gawler Range*
Yarri	IIIA	Find	c 1908	29°27'S	121°13'E	WA	
Yarroweyah	IIA	Find	1903	35°59'S	145°35'E	Vic.	
Yayjinna	L6	Find	1965	32°02'S	126°10'30"E	WA	
Yenberrie	IA	Find	1918	14°15'S	132°01'E	NT	
Yilmia	E5	Find	1969	31°11'30"S	121°32'E	WA	
Youanmi	IIIA	Find	1917	28°30'S	118°50'E	WA	*Youanme*
Youndegin	IA	Find	1884	32°06'S	117°43'E	WA	*Joudegin, Mooranoppin, Mount Stirling, Penkarring Rock, Pickarring Rock, Quairading, Youndagin, Yundagin, Yundegin*

Note in Proof

Recently, a 19 gram lunar meteorite was found at Calcalong Creek in Western Australia (Hill *et al.*, 1992). Calcalong Creek is the 12th lunar meteorite recovered and the only one known from outside of Antarctica. Also an additional group of carbonaceous chondrites, the CK group (after Karoonda), has been described (Kallemeyn *et al.*, 1991 - see refs).

HILL, D.H., W.V. BOYNTON & R.A. HAAG (1991). A lunar meteorite found outside the Antarctic. Nature 352: 614-617.

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Bevan, 1992, *Rec. Aust. Mus., Suppl.* 15: 1–27
http://dx.doi.org/10.3853/j.0812-7387.15.1992.80

Inegbenebor et al., 1992, *Rec. Aust. Mus., Suppl.* 15: 29–37
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