The Gove relict iron meteorite from Arnhem Land, Northern Territory, Australia

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Abstract–On February 24, 1979, a deeply oxidized mass of iron meteorite was excavated from bauxite at an open cut mine on the Gove Peninsula, Northern Territory, Australia. The meteorite, measuring 0.75–1 m in diameter and of unknown total weight, was found at coordinates 12°15.8′S, 136°50.3′E. On removal from the ground, the meteorite is reported to have disintegrated rapidly. A preliminary analysis at the mine laboratory reportedly gave 8.5 wt% Ni. A modern analysis of oxidized material gave Ni = 32.9, Co = 3.67 (both mg g^{-1}), Cr = 168, Cu = 195, Ga = 22.5, Ge = <70, As = 4.16, W = 1.35, Ir = 10.5, Pt = 21.2, Au = 0.672 (all μg g^{-1}), Sb = <150, and Re = 844 (both ng g^{-1}). Competent fragments of oxidized material retain a fine to medium Widmanstätten pattern with an apparent average bandwidth of 0.5 mm (range 0.2–0.9 mm in plane section). Primary mineralogy includes rare γ–taenite and daubréelite, and secondary minerals produced by weathering include awaruite (with up to 78.5 wt% Ni) and an, as yet, unnamed Cu-Cr-bearing sulfide with the ideal formula $CuCrS_2$ that is hitherto unknown in nature. Deep weathering has masked many of the features of the meteorite; however, the analysis normalized to the analyses of fresh iron meteorites favors chemical group IIIAB. The terrestrial age of the meteorite is unknown, although it is likely to be in the Neogene (2.5–23 Ma), which is widely accepted as the major period of bauxite formation in the Northern Territory of Australia. Gove is the second authenticated relict meteorite found in Australia.

INTRODUCTION

Few truly fossil meteorites are known, and the antiquity of some of these finds has not been established adequately. Relict chondritic meteorites have been found in limestones of Ordovician age at the Rödbrottet quarry, near Brunflo (approximately 475 Ma) and the Thorsberg quarry, near Österplana (approximately 480 Ma) in Sweden (Thorslund and Wickman 1981; Nyström et al. 1988; Schmitz and Tassinari 2001; and references therein). Remnants of a chondritic meteorite (Hart et al. 2002; Maier et al. 2006) are also preserved in an impact melt-sheet at a depth of 770 m in the Morokweng impact structure in South Africa that has been dated at approximately 145 Ma (Hart et al. 1997; Koeberl et al. 1997; Jourdan et al. 2010).

In recent years, a fragment of deeply altered meteorite (possibly carbonaceous chondrite) has been recovered from a sedimentary core (DSDP Hole 576) in the Pacific Ocean and linked to the Cretaceous–Tertiary (K–T) boundary event at 66.043 ± 0.011/0.043 Ma (Kyte 1998; Renne et al. 2013). Kyte and Brownlee (1985) have described submillimeter- to centimeter-sized fragments of the Eltanin meteorite (mesosiderite) that were recovered from coarse ejecta associated with a late Pliocene (approximately 2.4 Ma) submarine impact
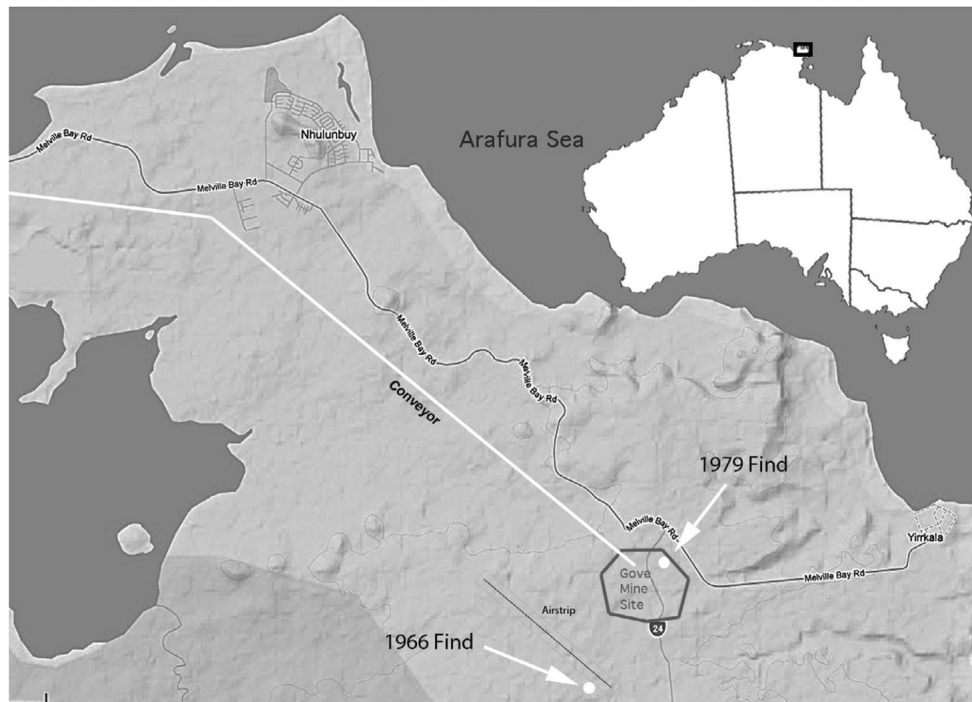
Fig. 1. Locations of the 1979 and 1966 finds of weathered iron meteorite material at the Gove bauxite Mine, Arnhem Land, Northern Territory, Australia.

structure in the Bellingshausen Sea. In addition to whole meteorite fragments, surviving meteoritic components (notably chromite grains) have been recognized at some impact craters and breccia horizons of Ordovician age and linked to the disruption of the L-group chondrite parent body at approximately 470 Ma (e.g., Alwmark and Schmitz 2007; Alwmark et al. 2010; and references therein).

Several iron meteorite finds are reported to be fossil (Buchwald 1975). Two masses of distinct iron meteorites (Gay Gulch and Skookum) were reportedly found in Pliocene gravels in the Klondike, Northwest Territories, Canada (see Grady [2000] and references therein). An iron meteorite was reportedly encountered during drilling in Eocene sediments in Texas, but the recovered material was subsequently lost (Lovering 1959). A small mass (50 g) of oxidized iron meteorite is reported to have been found buried at a depth of 6 m below fossil remains of a megatherium in quaternary deposits at Lujan in Argentina (Kantor 1921; Radice 1959; Buchwald 1975).

In Australia, Birch and Samuels (2003) reported that the Ballarat iron meteorite (group IAB), a small fragment weighing <15 g, was found in a paleoplacer deposit in a gold mine in Victoria. Although the maximum terrestrial age of the Ballarat iron meteorite is poorly constrained, it is reported to be >3 Ma (Birch and Samuels 2003). Here, we report the discovery and

nature of a relict iron meteorite on the Gove Peninsula in the Northern Territory, Australia.

METEORITE DISCOVERY

On February 24, 1979, a deeply weathered mass of iron meteorite reportedly measuring 0.75–1 m in diameter, and of unknown weight, was excavated from bauxite at an open cut bauxite mine then operated by Nabalco Pty. Ltd. (now operated by Alcan Gove Pty. Ltd.) on the Gove Peninsula, Northern Territory, Australia (Fig. 1). The minesite is located approximately 650 km east of Darwin at the western end of the Gove Peninsula in the northeast corner of Arnhem Land. The meteorite was found at coordinates 12°15.8′S, 136°50.3′E near the overland conveyor belt from the mine (Fig. 1). Active mining of the bauxite orebody was in progress at the time of discovery, and it only became apparent later that an "unusual rock" had been uncovered. Unfortunately, mining operations had destroyed the original position of the mass. However, the stratigraphic horizon was known to be situated in loosely cemented pisolitic bauxite, typical of the Gove orebody (Harper, personal communication).

On removal from the ground, the meteorite, which was described as "sheathed in magnetite up to 2 cm thick," is reported to have disintegrated rapidly. No photographs of the recovered mass appear to have been

Fig. 2. A large, deeply weathered sample of the Gove iron meteorite preserved at the Gove Bauxite Mine, Northern Territory, Australia (courtesy of Alcan Gove Pty. Ltd.).

taken at the time of excavation. The main portion of the meteorite was stored at the mine where it remained until, later in 1979, the bulk of the material was taken to Townsville by staff from the Department of Petrology at James Cook University, Queensland. Nabalco Pty. Ltd. retained a specimen (measuring approximately 23 × 15 × 10 cm) that was stored in a glass desiccator at the minesite office (Fig. 2).

A preliminary analysis of the meteorite was performed at the Nabalco Laboratory. A sample was removed from beneath the protective "magnetite" sheath and an analysis (XRF) by D. H. Harper reportedly gave 8.5 wt% Ni, and revealed the presence of abundant Cl. The remainder of the sample is reported to have disintegrated after a few days.

Around 1981, James Cook University passed on the major mass of the find, by that time stored in a drum of kerosene, and two bagged samples of unknown weight, to John Casey (now retired), Director of the then Bureau of Mineral Resources (now Geoscience Australia) in Canberra, where it remains to the present day (Casey, personal communication).

Prior to the discovery of the mass in 1979, small fragments of rusted iron meteorite were reportedly found in 1966 (see Fig. 1) by a construction worker using a metal detector when the airstrip at Gove was being upgraded (Harper, personal communication). Some fragments of this earlier find were reportedly deposited in the Northern Territory Museum in Darwin, although this cannot be verified (Megirian, personal communication). The whereabouts of other fragments of this find are unknown. Moreover, it is not known whether this earlier discovery represents fragments transported from the site of the main mass (only a short distance away—see Fig. 1) to be used in the maintenance of the airstrip, or

fragments from another mass of the same meteorite, or an entirely different occurrence. Currently, the Northern Territory Museum in Darwin holds approximately 590 g of fragments of the 1979 find (NTM 3028) donated in 2004 by Alcan Gove Pty. Ltd., and taken from the large disintegrating specimen retained at the minesite (Fig. 2). The Melbourne Museum in Victoria holds 252 g (E12521) and approximately 346 g (three fragments) and 280 g of finer particles (E18381).

In the early 1980s, R. A. Binns (CSIRO) obtained one of the bagged samples (from the 1979 find) of the meteorite from the Bureau of Mineral Resources (now Geoscience Australia) for microscopic and chemical analysis. Although the sample is deeply oxidized, cut and polished surfaces display a relict Widmanstätten pattern (Binns, personal communication).

In April 1995, samples of the meteorite (1979 find) formerly in the possession of the late Derek H. Harper (former chemist at Nabalco Pty. Ltd.) were passed to the Western Australian Museum by his daughter Mrs. Val Eivers. This material comprises 1164.8 g of deeply weathered fragments and dust (registered WAM 15127), on which this study is based. Other fragments (registered WAM 14219) were acquired from M. Skoss of Alice Springs. Although the original weight of the meteorite is unknown, from the reported approximate dimensions (0.75–1 m in diameter) and assuming a roughly spherical shape and an original average density of 7.7 g cm^{-3}, the weight is likely to have been in the range 2–4 tonnes. The name "Gove" has been officially approved by the Nomenclature Committee of the Meteoritical Society (Weisberg et al. 2012).

CHEMICAL ANALYSIS, CLASSIFICATION, AND MINERALOGY

Analytical Techniques

A subsample of the material (WAM 15127) held at the Western Australian Museum was removed for analysis at the University of California, Los Angeles. Nickel (Ni), cobalt (Co), gallium (Ga), germanium (Ge), and iridium (Ir) along with other trace elements including arsenic (As), tungsten (W), platinum (Pt), and gold (Au) were determined by the methods described in Wasson and Kallemeyn (2002). The analytical results are presented in Table 1. Mineral analyses (Table 2) were performed with a Cameca SX50 WDS electron microprobe analyzer, at an accelerating potential of 15 kV with an operating current of 30 nA. Standards employed included natural minerals and pure metals (Fe, Ni). Powder X-ray diffraction analysis of a small crushed sample showed the presence of a number of secondary minerals.

Table 1. Analysis of an oxidized sample of the Gove iron meteorite.

	Cr $\mu g\ g^{-1}$	Co $mg\ g^{-1}$	Ni $mg\ g^{-1}$	Cu $\mu g\ g^{-1}$	Ga $\mu g\ g^{-1}$	Ge $\mu g\ g^{-1}$	As $\mu g\ g^{-1}$	Ru $\mu g\ g^{-1}$	Sb $ng\ g^{-1}$	W $\mu g\ g^{-1}$	Re $ng\ g^{-1}$	Ir $\mu g\ g^{-1}$	Pt $\mu g\ g^{-1}$	Au $\mu g\ g^{-1}$
Gove	168	3.67	32.9	195	22.5	<70	4.16	16.9	<150	1.35	844	10.5	21.2	0.672

Table 2. Electron microprobe analyses (wt%) of relict daubréelite, and an unnamed sulfide ($CuCrS_2$) produced by weathering in the Gove iron.

	daubréelite (Gove)			$FeCr_2S_4$ ideal	Unnamed sulfide	$CuCrS_2$ ideal
Cr	36.4	36.9	36.2	36.1	29.5	28.9
Fe	18.1	18.2	18.8	19.4	1.22	–
Co	–	0.04	0.3	–	0.81	–
Ni	0.52	0.17	0.3	–	0.31	–
Cu	0.54	–	0.5	–	32.1	35.4
Zn	0.11	0.1	–	–	0.09	–
S	43.5	42.7	42.7	44.5	35.2	35.7
Totals	99.17	98.11	98.8	100.0	99.23	100.0
	Ions on the basis of $4S^{-2}$				$2S^{-2}$	$2S^{-2}$
Cr	2.064	2.131	2.091	2.000	1.034	1.000
Fe	0.955	0.978	1.010	1.000	0.039 ⎫	–
Co	–	0.001	0.014	–	0.025 ⎪	–
Ni	0.025	0.007	0.015	–	0.009 ⎬ 0.995	–
Cu	0.024	–	0.022	–	0.920 ⎪	1.000
Zn	0.004	0.004	–	–	0.002 ⎭	–
Metal/S ratio	0.768	0.780	0.788	0.750	1.014	1.000

– = not detected.
Analyst P. J. Downes.

Classification

Although the samples of the Gove iron meteorite available for the study are completely oxidized, polished sections of competent fragments retain a visible Widmanstätten pattern preserved in palimpsest (Fig. 3).

The bulk composition of the weathered material (Table 1) shows a relatively high fraction of metallic elements. The uncorrected value for Fe in Gove is approximately 700 mg g^{-1}. Together with Ni and Co, this implies that the oxygen content is 250 mg g^{-1}. The measured Ni value is quite low (32.9 mg g^{-1}), and it is likely that, because it is not fully compatible with the oxides produced by weathering, Ni was lost to a greater degree than Fe during the weathering process.

When the data for Gove (Table 1) are normalized to average analyses of fresh group IIIAB and IVA iron meteorites (Fig. 4), the best fit (with the exception of Cr) is obtained with group IIIAB. Chromium in Gove appears to be enriched relative to group IIIAB and other irons.

The analysis by D. H. Harper shortly after the recovery of the meteorite, which gave 8.5 wt% Ni, is also consistent with chemical group IIIAB irons (7.5–10.5 wt% Ni). This is supported by the analysis for Ga (22.5 $\mu g\ g^{-1}$) and Ir (10.5 $\mu g\ g^{-1}$) determined by INAA. Structurally, the octahedral Widmanstätten pattern (approximately 0.5 mm average apparent bandwidth) lies on the structural boundary between groups IIIAB and IVA. Overall, the normalized analysis favors chemical group IIIAB and is not a good fit for group IVA irons (Fig. 4).

Primary and Secondary Mineralogy

While the bulk of the meteorite now comprises predominantly oxides and oxyhydroxides of iron, in the microstructure, there are recognizable vestiges of former structures. Former kamacite lamellae with an average apparent bandwidth of 0.5 mm (range 0.2–0.9 mm) are clearly preserved. Large areas of former net, comb, and spheroidal plessite, up to 5 mm across, are now preserved in iron oxides (Fig. 5a). Several phases appear to be either primary (part of the meteorite's original mineralogy) or secondary (produced by terrestrial weathering) in origin. Highly reflective phases with irregular, spheroidal, and subhedral sections occur rarely throughout the body of the meteorite (Fig. 5a–d).
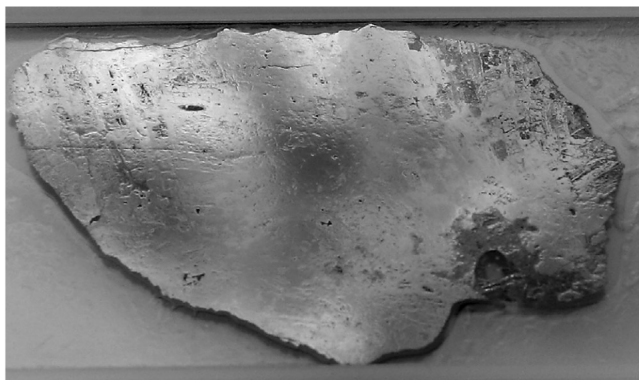
Fig. 3. Polished section of the Gove iron obliquely lit to show the original Widmanstätten pattern now preserved in oxides and oxyhydroxides of iron (maximum length 4 cm).

X-ray diffraction analysis of a crushed bulk sample of Gove indicates the presence of residual kamacite (α–FeNi) (not observed microscopically); corrosion products such as magnetite ($Fe^{+2} Fe_2^{+3}O_4$), goethite (β–$Fe^{+3}O$[OH]), hematite (α–Fe_2O_3), and akaganéite (β–$Fe^{+3}O$[OH,Cl]) as the principal oxides and oxyhydroxides of iron; and other minerals such as siderite ($Fe^{+2}CO_3$) and böhmite (AlO[OH]). Rare, millimeter-sized euhedral cubic crystals of pyrite (FeS_2) were also observed microscopically in the disintegrated Gove material.

A single residual sphere of γ-taenite (10 μm across) containing up to 27 wt% Ni was observed to occur in an area of former plessite. Rounded to subhedral grains of daubréelite are primary and occur in former kamacite lamellae (Fig. 5b). Low Ni group IIIAB irons are known to contain abundant small daubréelite crystals (Kracher and Kurat 1976). Irregular patches of awaruite with up to 78.5 wt% Ni occur in what were former taenite lamellae, often within areas of altered plessite (Fig. 5c).

Spheroidal (30 μm) to subhedral grains of an, as yet, unnamed Cu-Cr-bearing sulfide with the ideal formula $CuCrS_2$ occur in former lamellae of kamacite (Fig. 5d) and are locally seen to be replacing primary grains of daubréelite. Compositions of daubréelite and the Cu-Cr sulfide are given in Table 2. Analyses of grains of the Cu-Cr-bearing sulfide in the Gove meteorite show that some are zoned. Some grains have daubréelite cores and strongly Cu-enriched rims. The outer zones of grains also contain variable, and sometimes considerable, amounts of Fe, Zn, Ni, and Co as well as Cu. Other small grains are composed entirely of the dominantly Cu-bearing Cr-sulfide. A few of the zoned grains are rimmed, partially or completely, by narrow collars (up to 5 μm) of an, as yet, unidentified Ni-rich oxide or oxyhydroxide.

At least three, and possibly four, distinct phases are associated with the progressive alteration of primary grains of daubréelite in Gove. Most have relatively unaltered cores of cuprian/nickeloan/zincian daubréelite, altered outer zones of a Cu-Cr- and other metal-bearing sulfide, and collars of an Ni-rich oxide or oxyhydroxide (Fig. 6). In two grains, however, between the oxide collar and Cu-Cr-bearing sulfide, an additional narrow (approximately 1 μm) rimming phase strongly enriched in Cr was observed.

DISCUSSION

The oxides and oxyhydroxides of iron that now make up the bulk of the Gove meteorite are clearly from the prolonged oxidation of the original Fe-Ni metal. Other less abundant minerals (such as siderite) may have resulted from interaction between the corroding meteorite and percolating carbonate-rich fluids, whereas böhmite appears to have been introduced from the encasing bauxite.

In Gove, awaruite (Ni_3Fe) appears to have formed by the progressive weathering of γ-taenite leading to Fe^{2+} depletion by oxidation (Fe^{3+}) of metal to magnetite or maghemite, and consequent Ni enrichment of the residual phase. Awaruite (from Ni_2Fe to Ni_3Fe) as a terrestrial alteration product in iron meteorites has been identified in Cape York (IIIAB), Sardis (IAB), Wolf Creek (IIIAB), South Dahna (IAB), and Drum Mountain (IIIAB) (White et al. 1967; Pedersen 1999).

In addition to Fe and Cr, daubréelite in the Gove meteorite contains variable, but minor, amounts of Cu, Ni, Co, and Zn (Table 2). One analysis of a grain of daubréelite (lacking Zn) calculated to $4S^{-2}$ gave the structural formula $(Fe_{1.01}Cu_{0.02}Ni_{0.01}Co_{0.01})_{\Sigma1.05}Cr_{2.08}S_4$, another grain (lacking Cu) gave $(Fe_{0.98}Ni_{0.01}Zn_{0.004}Co_{0.002})_{\Sigma0.99}Cr_{2.1}S_4$ suggesting that the grains of primary daubréelite have acquired trace amounts of Cu, Ni, Co, and perhaps Zn from the progressive weathering of the surrounding metallic phases in the meteorite. However, it is possible that the original, unaltered, daubréelite may have contained Zn.

There are two possible explanations for the apparent enrichment of Cr in Gove compared to group IIIAB and other irons (Fig. 4): one is that the sample analyzed contained grains of daubréelite or chromite (not observed microscopically), or that some Cr was also introduced into the meteorite from the surrounding bauxite. In comparison, the normalized Cu and Ga contents of Gove are a good match for IIIAB irons.

The unnamed dichalcogenide compound $CuCrS_2$ has, up until now, been known only as a synthetic (Engelsman et al. 1973) manufactured experimentally by various methods at high temperatures (600–1000 °C) and was first synthesized by Hahn and de Lorent (1957). Crystals are readily grown in the laboratory using the
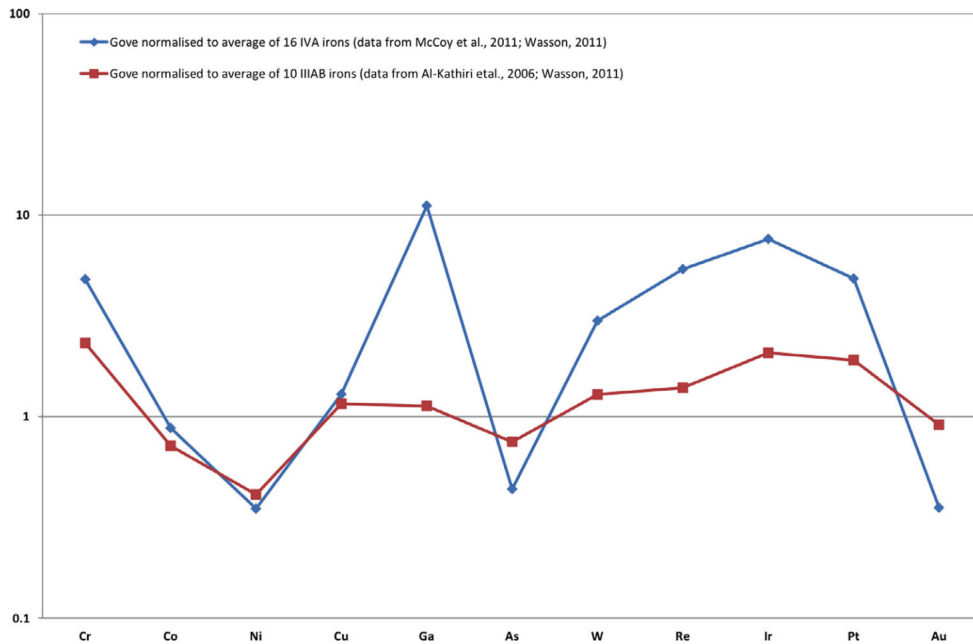
Fig. 4. Elemental data for Gove normalized to the average of 16 group IVA irons and 10 group IIIAB irons.
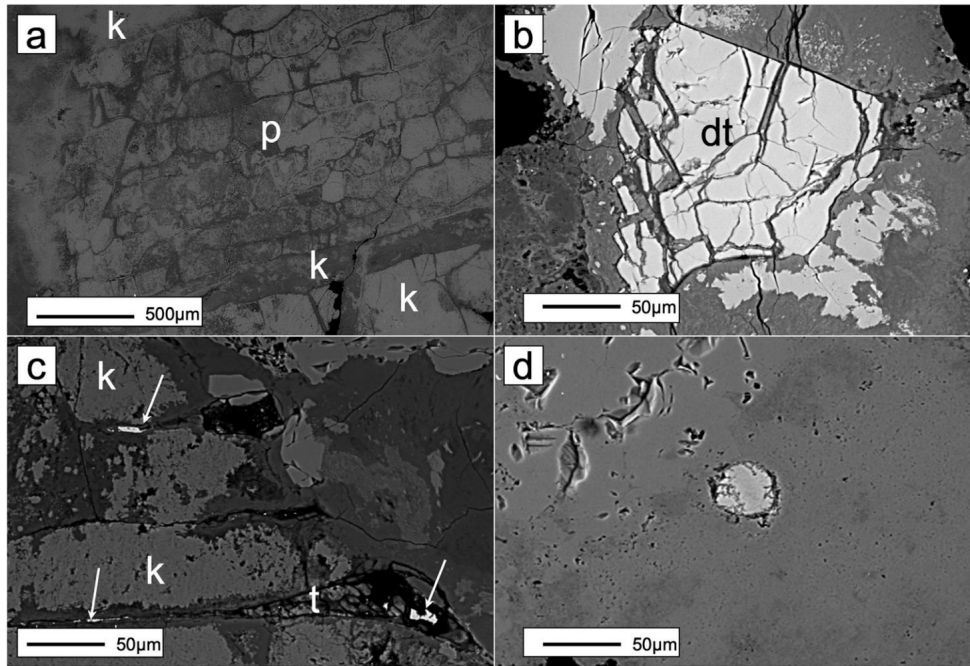

Fig. 5. BSE images of (a) former kamacite bands (k) and net plessite field (p) of the Widmanstätten pattern now preserved in oxyhydroxides of iron. b) Fractured grain of daubréelite (dt) in iron oxide matrix. c) Irregular patches of awaruite (arrowed) in former taenite lamella (t) bounded by former kamacite lamella (k). d) Grain of an, as yet, unnamed Cu-Cr-bearing sulfide (center) set in a former kamacite band.

iodine transport technique (Nitsche et al. 1961), and Fitzgerald and Al-Mukhtar (1980) synthesized $CuCrS_2$ by this method in a sealed quartz tube heated in a furnace to the highest temperature of 900 °C.

The formation of $CuCrS_2$ in the Gove iron meteorite represents a very different set of conditions to those used to synthesize the compound in the laboratory and must have occurred over a very much longer, but unknown,
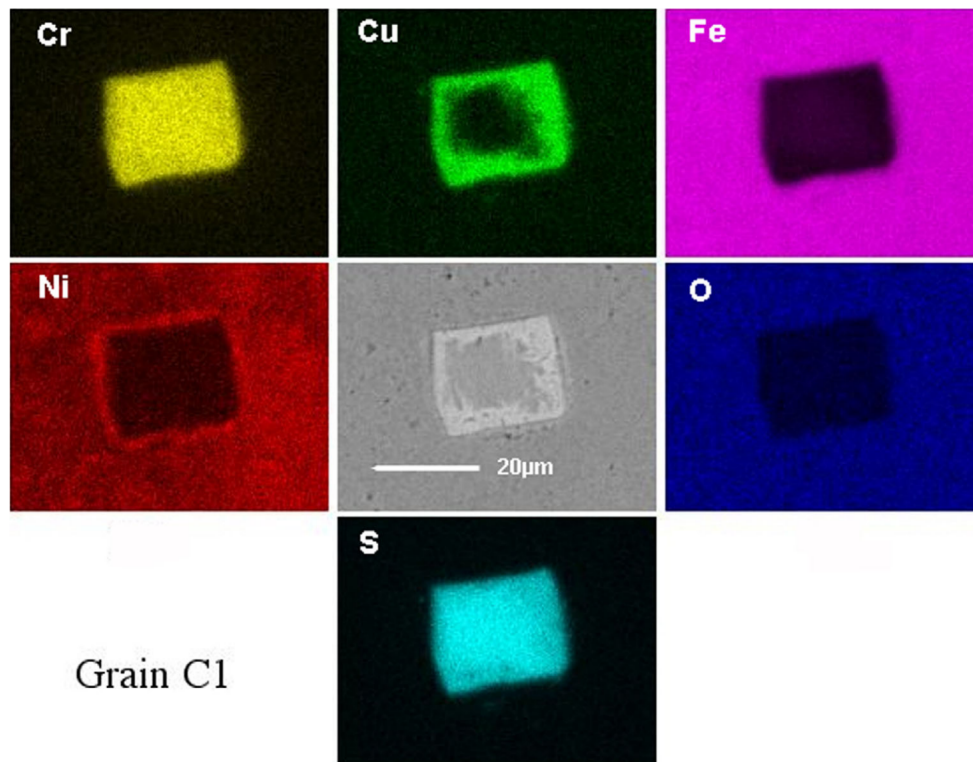
Fig. 6. Elemental maps (Ni, O, S, Cu, Cr, Fe) of a subhedral grain of former daubréelite progressively replaced by the Cu-Cr-bearing sulfide. Note the collar of an Ni-rich phase around the grain. BSE image (center).

period. The progressive weathering of an iron meteorite is analogous to the processes of weathering in the oxide zone of mineral deposits. In terrestrial ore deposits, the uptake of metal ions at the surfaces of sulfide minerals is currently an important area of study (e.g., see Rosso and Vaughan [2006] and references therein). A number of processes have been recognized experimentally, including the replacement of ions at mineral surfaces and diffusion into sulfides in exchange reactions. Additionally, more extensive reactions, possibly redox controlled, may result in precipitation of a new phase at mineral surfaces and/or wholesale replacement of substrates (Rosso and Vaughan 2006).

The bulk Cu contents of iron meteorites vary from 1 to 1000 $\mu g\ g^{-1}$, but the common chemical groups average around 150 $\mu g\ g^{-1}$. Copper in solid solution in metal would appear to be the principal source of Cu for the alteration of daubréelite in Gove (Fig. 6). Copper and other metals (Ni, Co) released by the corrosion of metal, and possibly transported as chloride solutions, were attracted electrochemically to surviving grains of daubréelite and progressively replaced Fe in the outer regions of grains. The gain of Cu at the expense of Fe was also accompanied by a slight loss of Cr and S from the altered regions of former daubréelite crystals. Nickel

was similarly attracted to the grains and formed collars of an Ni-rich oxide or oxyhydroxide. The unnamed compound $CuCrS_2$ appears to have formed as a terrestrial alteration product through prolonged weathering of primary daubréelite.

TERRESTRIAL AGE

Since no sizeable portion of fresh Fe-Ni metal appears to have survived (or has yet to be encountered) in the Gove meteorite, direct methods of terrestrial age measurement (e.g., ^{36}Cl, ^{39}Ar, ^{59}Ni) cannot be applied. An approximate terrestrial age can be constrained from the age of bauxitization on the weathered Gove plateau. The age range of laterite deposits in the northern part of Australia is generally poorly constrained. Deposits are preserved on stable plateaux that allowed deep bauxitization during the Cenozoic. The large Gove bauxite deposit averages 3.7 m in thickness. Profiles through the deposit indicate that some bauxite layers are residual (tubular ore), while others are comprised of loose and cemented pisoliths that are interpreted to be the result of transportation processes (Fig. 7).

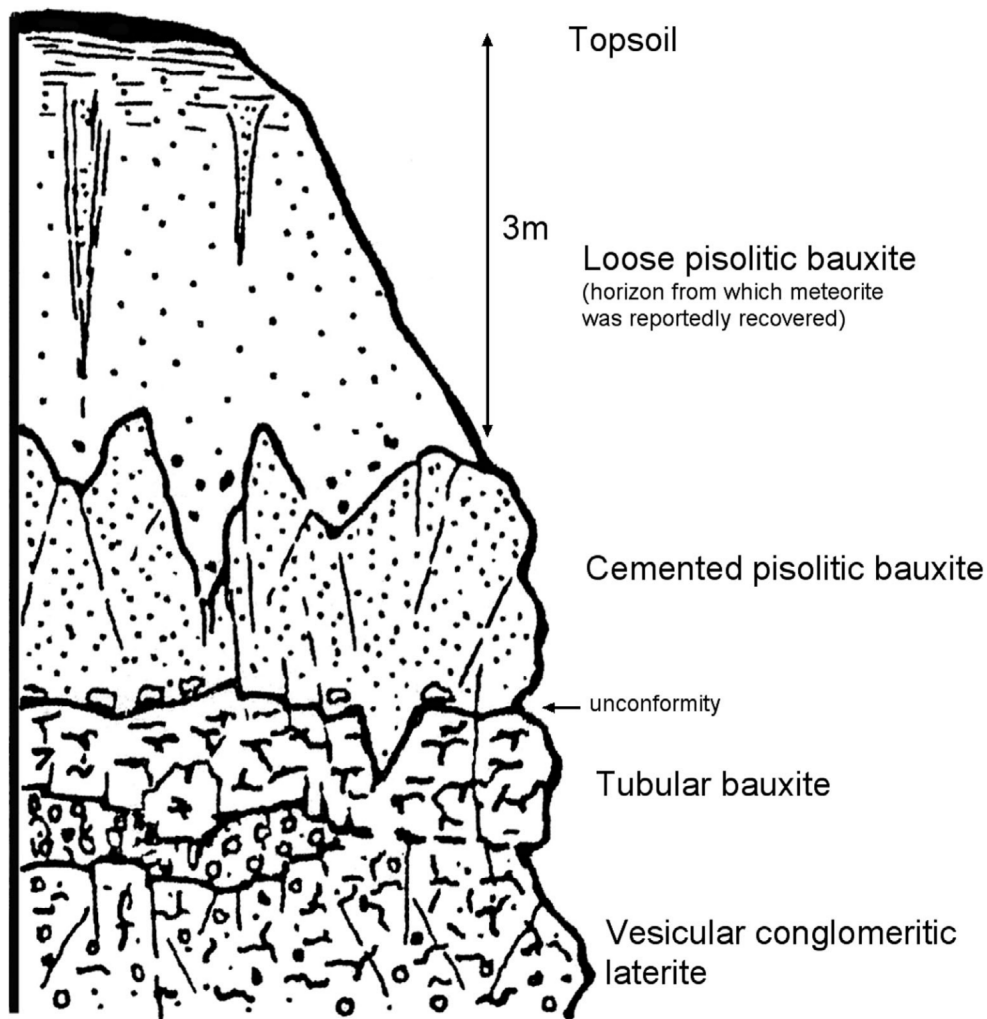Grubb (1970) studied the mineralogy, geochemistry, and genesis of bauxite deposits on the Gove plateau.

Fig. 7. Typical bauxite and laterite profile at the mining areas at Gove. The horizon in which the meteorite was found is indicated (after Somm 1975).

The major period of bauxitization on the Gove plateau is widely thought to be Neogene (2.5–23 Ma) in age (Owen 1954; Grubb 1970; Somm 1975; Ferenczi 2001). Dunnet (1965) suggested that the Gove bauxites are derived from the Mullaman Beds, of early Cretaceous age, and are, therefore, mainly Cenozoic in age. However, Hayes (1967) suggests that it is possible that at least some bauxitization occurred earlier during the Mesozoic. In tropical Australia, it should be noted that the processes of lateritization and bauxitization continue to the present day (Taylor and Eggleton 2008; Retallack 2010).

Somm (1975) suggests that following, or perhaps during, late-stage deposition of the underlying sediments at Gove, there was gradual peneplanation. Lateritization and bauxitization are suggested to be associated with this late-stage development. Subsequent epeirogenic uplift led to renewed erosion and dissection leaving the erosional plateau remnants observed today. Uplift was associated with warping and perhaps local eustatic resubmergence of the surface (Somm 1975). At Gove, bauxite commonly overlies ferruginous–siliceous laterite, and a typical profile showing conspicuous layering in the deposit is shown in Fig. 7.

In the Gove area, the thickness of the bauxite is inversely related to the present surface morphology of the plateau. Bauxite thins over gentle ridges and thickens in swales and low areas except at the plateau edges where it is being eroded (Somm 1975). On prominent hills, bauxite is generally absent and the underlying laterite is exposed. Somm (1975) suggests that this relationship is the result of erosional redistribution of the bauxite and, to a lesser extent, the laterite. Loose pisolitic ore, the horizon from which the Gove meteorite was reportedly recovered, shows the greatest variation in thickness and is interpreted as the main erosional product. The Gove

plateau appears to have undergone late-stage planing after the formation of the bauxite (Somm 1975). Late-stage planing of the plateau surface, predominantly involving the loose pisolitic bauxite horizon, is consistent with the opinion of Grubb (1970) who, on the basis of mineralogy, suggested that some redistribution of bauxite had occurred.

SUMMARY AND CONCLUSIONS

The remnant structure of the Gove iron meteorite suggests that it is a fine to medium octahedrite. The residual primary mineralogy consists of rare areas of taenite, some kamacite, together with the grains of daubréelite that are variably altered. Secondary minerals produced by terrestrial weathering are dominantly oxides and oxyhydroxides of iron and nickel, with rare awaruite and an, as yet, unnamed Cu-Cr-bearing sulfide ($CuCrS_2$) that has progressively replaced original grains of daubréelite as a result of prolonged terrestrial weathering. The normalized analysis of Gove is consistent with group IIIAB.

The Gove iron meteorite is the second confirmed relict meteorite to be recognized in Australia. Although the terrestrial age of the meteorite is poorly constrained, its encasement in bauxite at Gove suggests that its terrestrial age is likely to be >2 Ma. However, as the loose cemented pisolitic bauxite at Gove may represent material transported after formation, it is possible that the fall of the meteorite postdated the major period of bauxitization in the Northern Territory. The meteorite may have landed on an erosional surface later to become encased in loose bauxite pisoliths during subsequent erosion and transportation processes. Nevertheless, the Gove iron meteorite is of considerable terrestrial antiquity.

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