hundred degrees, sufficiently for stress relieving of the metal.

The etched section displays a microscopic Widmanstätten pattern of well-developed, straight ($\frac{L}{W} \sim 15$) kamacite needles with a width of 60±15 μ. The pointed needles or platelets are dispersed as a felt-like meshwork, but do not form continuous, lamellar systems. Neumann bands were probably present previously, but, in the specimens seen by me, the kamacite is now convered to serrated α_2 units due to the atmospheric reheating. The microhardness is 155±10, which is unusually low for an α_2 phase.

In addition to the kamacite lamellae precipitated in the Widmanstätten pattern there is an almost equal amount of kamacite nucleated around the primary schreibersite bodies. This kamacite is bulky and mainly follows the outline of the schreibersite crystals as a 10-150 μ wide zone total amount of kamacite is about 30% by area.

The matrix between the kamacite grid is an easily resolvable, duplex $\alpha + \gamma$ mixture, where the γ component constitutes 1-2 μ wide, winding ribbons. The gross Widmanstätten pattern is repeated in the α and γ directions of the matrix. The microhardness, with a 100 g impression averaging over numerous $\alpha + \gamma$ units, is 155±10 and, thus, identical to that of the kamacite alone.

Schreibersite occurs as scattered crystals, 400 x 30 μ or 200 x 300 μ in size, and there are indications that larger bodies occur locally. It is further rather uniformly distributed as 10-100 μ angular bodies, that occur with a frequency of about 5 per mm^2. The bulk phosphorus content is estimated to be 0.3%. Most of the phosphides precipitated directly from the high temperature austenite phase and later nucleated rims of swathing kamacite that grew to a width of 10-150 μ, before the remaining matrix started to decompose by homogeneous nucleation. Very few kamacite plates grew in a Widmanstätten pattern from the swathing kamacite zones.

The meteorite has a corroded crust. In particular the alpha needles and the alpha part of the duplex matrix are converted to limonite. The micromelted schreibersite and the high-nickel taenite (~ 30% Ni) survive for a long time and serve as a grid that retains the corroded crust for a long time.

Gay Gulch is different from Skookum Gulch in all structural details. Gay Gulch resembles Cowra in many respects, but Gay Gulch has a better equilibrated plessitic matrix of easily resolvable $\alpha + \gamma$. It further resembles the meteorites of group IIC somewhat, such as Kumerina and Wiley, but lacks the frequent chromite inclusions of that group. However, chemically, it is different from all the meteorites mentioned.

Gay Gulch is closely related, both structurally and chemically, to two other small iron meteorites, Kofa and Garden Head. They are all here classified as plessitic octahedrites, with 15-18% Ni and a significant schreibersite content.

Gerzeh, Lower Egypt

29°19′N, 31°17′E

During archaeological excavations of royal graves at Gerzeh, or El Girza, on the western bank of the Nile 70 km sourth of Cairo, a few completely rusted beads were found in 1911 (Petrie et al. 1912; Wainwright 1912). They were fully described, figured and analyzed by these authors, who showed that the material was of predynastic age, i.e., from about 3,000 B.C., and thus were the most ancient iron material ever recorded. Their analysis indicated that all was limonite, and nickel was not reported.

The beads were part of a necklace where metal alternated with precious and semi-precious stones. On a brief visit, in January 1972, to University College, London, the Curator of the Egyptian Collection, Dr. C.M. Dixon, showed me the specimens in question. Evidently, what is presently available is three beads, Nos. 10,738, 10,739 and 10,740, each weighing about 1 gram. The largest piece, a cylinder 15 mm long and 12 mm in diameter, had been the centre of the necklace, while two smaller cylinders 16 mm x 5.5 mm and 16 mm x 3 mm, had been placed on either side at some distance, with other stones in between. All iron beads were strongly oxidized, had a black porous appearance, and were only weakly magnetic; a hand magnet hardly attracted them. Petrie and Wainwright assumed that the beads had originally been produced by flat-hammering and folding to cylinders. Perhaps additional material, now used up in analytical work, was then sufficiently well-preserved for such conclusions to be drawn.

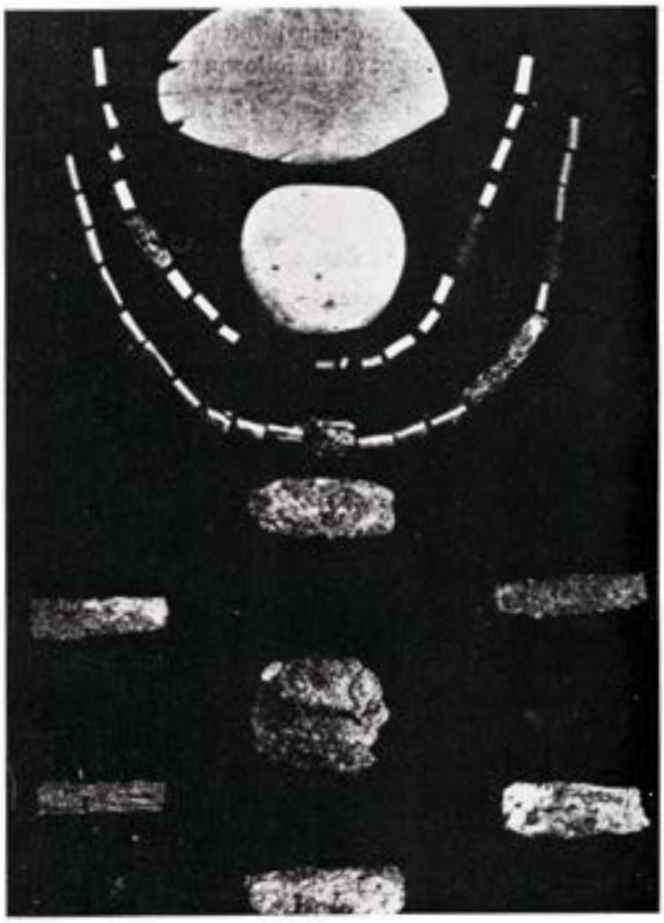

Figure 778. Gerzeh (Brit. Mus.). Two predynastic Egyptian necklaces in which meteoric iron beads (dark) alternate with precious stones (white). Seven of the iron beads are shown at higher magnification below. (From Wainwright 1912.)

Desch (1929), in an often quoted analysis, reported 92.5% Fe and 7.5% Ni on this material. Unfortunately, he neither stated his analytical method, calculation, nor his type of material. It appears that his figures represent some recalculation of an analysis of weathered material, to give the metallic constituents only. In any case, no metallic material was ever found, according to the archaeologists who originally described the material.

If Desch's analysis can be assumed to be correct, it seems to be definitive proof that the beads were produced from some iron meteorite discovered by Egyptian farmers and now lost entirely, perhaps because it was made into (ceremonial ?) tools, implements and ornaments. It appears plausible that a cold-worked meteorite, hammered into small cylinders, should completely transform to limonite over a time span of 5,000 years. If the material was not leached by circulating ground waters or excessive rainfall, it also appears reasonable that iron and nickel should be retained in their original ratios, as reported by Desch. Otherwise, it might be expected that nickel would be selectively removed as easily dissolvable Ni^{++}, and thus leave the material enriched in iron. Iron would not be so easily removed as nickel, because it would be oxidized to Fe^{+++} and precipitate in situ as typical "limonite."

Gibeon, Great Namaqualand. Southwest Africa

Approximately 25°20′S, 18°E; 1,000 m

Polycrystalline, twinned, fine octahedrite, Of. Bandwidth 0.30±0.05 mm. Neumann bands. HV 170±10.

Group IVA. 7.93% Ni, 0.41% Co, 0.04% P, 2.0 ppm Ga, 0.12 ppm Ge, 2.3 ppm Ir.

HISTORY

Large masses of native iron up to two feet square were reported but not actually seen by Captain (later General, Sir) J.E. Alexander (1838) on the east side of the Great Fish River, at a spot three days' journey northeast of the mission station of Bethany. The few chips which Alexander was able to bring back to London were analyzed by Sir John Herschel (1839), who, from the amount of nickel present (4.6%), was able to pronounce the iron to be of meteoric origin.

The first large mass to be investigated was the 81 kg "Lion River," removed from a clay plain where it had been found with other masses too difficult to transport. The irons were known to the Nama natives, who hammered fragments into assagais and other weapons. Shepard (1853a), who acquired the meteorite and cut a few kilograms from one end, described the structure and presented several figures.

In about 1857, another mass of 232 kg was transported by Wild from the vicinity of Bethany to Cape Town (Fletcher 1904a). Slices from this mass were thoroughly examined and analyzed by Cohen and his co-workers (1900d; 1905) under the name "Bethany."

While the exact locality of discovery for the above mentioned masses is uncertain, the following meteorites are generally known to have been recovered from the large cattle farms with which names they are associated. The number of recovered and reported masses is high, about 75, and the average specimen weight is about 280 kg.

A mass of 178 kg from the Mukerop (Mukorob) farm was presented to the Stuttgart Museum by Count von Linden, and here it was cut and distributed. There are 61 kg in Vienna and 16 kg in Stuttgart, but the remainder appears to be in numerous collections, often in the form of full plates. It was by examining these slices that Berwerth (1902), Brezina & Cohen (1902) and Cohen (1905: 335) were able to prove that the meteorite was composed of a number of large, original austenite grains, of which several showed repeated twinning with 5-10 cm wide twins. In their publications and in Brezina & Cohen (1886-1906: plates 19 and 32) are numerous, excellent illustrations and reconstructions of the original, polycrystalline mass. Merrill (1916a: plate 22) presented a photomacrograph of a slice in the Smithsonian Institution. He believed that it was from the 178 kg mass; it is, however, from the 503 kg mass (No. 7), as the dimensions and structure clearly indicate. Mechanical tests were conducted in Krupp's Laboratories (Brezina & Cohen 1902: 302). The material was found to be very ductile; it sustained a 180° bending test without fracturing, and it had a tensile strength of 41.4 kg/mm^2. The good qualities of this material, in reality comparable to an iron-nickel pressure vessel steel, are due to the nickel content, the fine and homogeneous Widmanstätten structure, and above all, to the very low phosphorus content and small number of inclusions. The problem of twinning in Gibeon specimens has recently been taken up again by Frost (1967a), Axon & Faulkner (1967) and Aladag & Gordon (1969), who, from the analogy to hot-rolled, stainless steels, concluded that the twinning is the result of slight plastic deformation at high temperature plus recrystallization and grain growth. This must have taken place on the meteorite parent body.

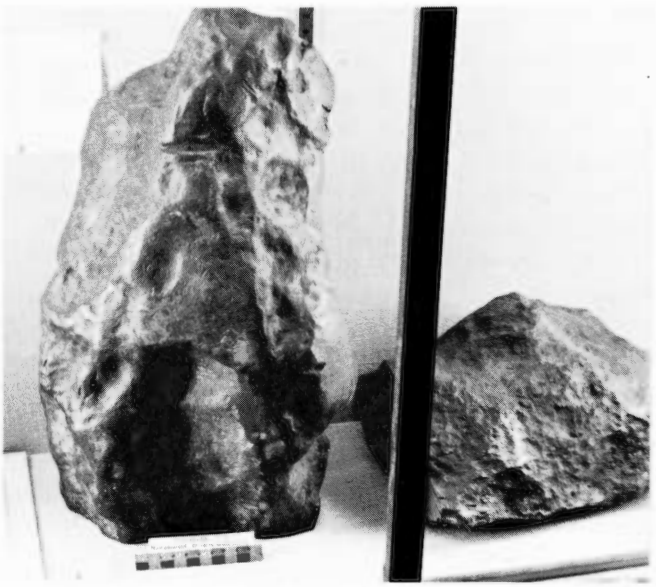

Figure 779. Gibeon. The Lion River mass, of 81 kg, now in Amherst. The natives used fragments of this mass, and possibly other, now lost specimens, for making assagais. To the right the 35.5 kg La Grange main mass. Ruler in centimeters. See also Figure 23, that shows a finger ring forged from Gibeon material in modern times.

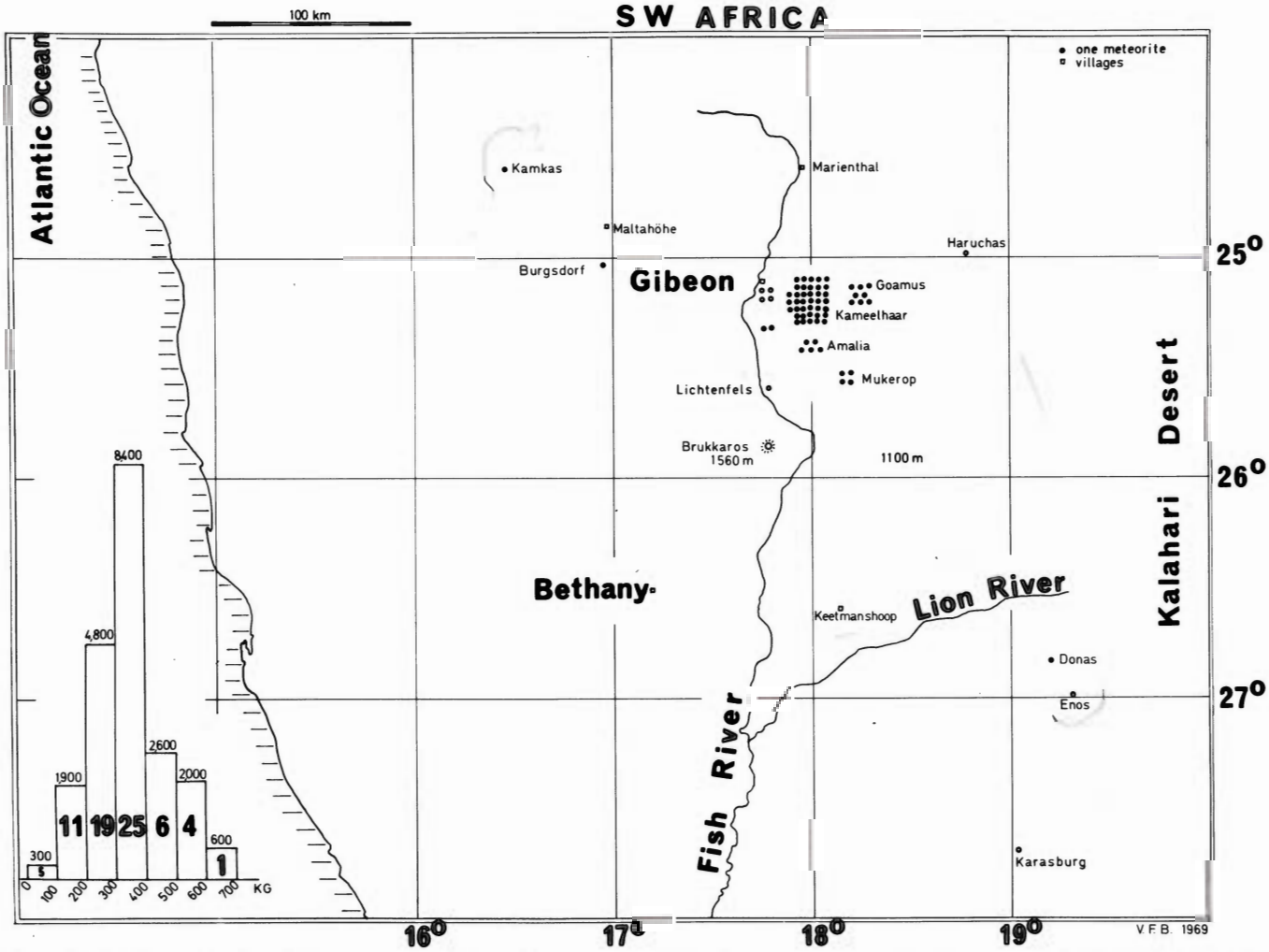

Figure 780. Gibeon. Sketch of the strewn field. Since the precise locality of many masses is unknown, the black dots only indicate the approximate position. The structure and composition of the distant members Kamkas and Enos are similar to the bulk of the Gibeon specimens. Only Karasburg (below) is an independent fall, page 709. To the left, a histogram shows the number and total weight within each mass range. See also the Supplement.

Three other large blocks from Mukerop came to Europe about 1900 (Cohen 1905: 339). Three blocks from the vicinity of Gibeon were mentioned by Cohen (1905: 341) and described and figured by Horn (1912). Horn noted that the numerous pits and thumbprint cavities were the result of the atmospheric flight, and he also identified atmospheric fusion crust on one specimen. Hovey (1909) acquired a full slice and a cast of one of these meteorites for the American Museum of Natural History, and Ussing (1905: 4) acquired a 123 kg endpiece for the Copenhagen Collection.

Experiments with artificial reheating were conducted by Fraenkel & Tammann (1908), who called their piece Damaraland, and by Vogel (1932). Berwerth (1914: 1081) concluded that the Mukerop block in Vienna had been artificially reheated, but this is probably not so.

Dr. Paul Range, Government Geologist of German Southwest Africa, collected 37 specimens, totaling 12,613 kg in the years 1911-13 (Range 1913; 1940). He presented the first map sketch and stated that the masses were found 90-100% embedded in the Karroo formation (Carboniferous) and in the Kalahari chalk (Tertiary), the most common surface rocks of the region. The masses were transported to Windhoek and have since been displayed in the Public Garden, in one large pile. The pile had, by 1967, dwindled to about 27 masses through donations (Citron 1967). Spencer (1930; 1941) described a 136 kg individual from the pile, acquired for the British Museum, and in addition he figured the smallest individual hitherto known, a somewhat corroded fragment of 195 g. The largest individual known appears to be the 650 kg mass from the pile, donated to the South African Museum in Cape Town (Spencer 1930).

Three more masses were collected on the Kameelhaar farm (Zsivny 1932). The smallest, of 132 kg, which was figured, finally went to Budapest (Ravasz 1969: 36). The two others were sold to collectors. It appears that the 189 kg mass was purchased for the Bosch Collection, from where it came to the U.S. National Museum in 1967.

All the masses hitherto mentioned were discovered on farms east and south of Gibeon, covering an approximate area of 30 x 40 km centered around the coordinates 25°15′S, 18°0′E. Spencer (1941), however, reported a mass, believed to be transported from Kamkas farm, 165 km west-northwest of the main field, and quite recently, Citron (1967) has extended considerably the area from which meteorites, associated with Gibeon, are found. In his report he adds six finds, Enos (Kinas Putts), Donas, Hunsrück (Bethani), Lichtenfels, Keetmanshoop and Haruchas; and, while they are not extraordinary in size, they are important because of the well established documentation that they were found in situ by farmers or herd boys. Citron also interviewed the discoverer of Kamkas, who maintained that this mass was actually found on the Kamkas farm and had not been removed from the Gibeon field as believed by Spencer. The following distances will indicate the enormous strewnfield of Gibeon material: Donas (263 kg) is 200 km southeast, Enos (193 kg) is 230 km southeast, and Haruchas (38 kg) is 90 km east-northeast of the main field near Gibeon. The supposition that the outlying masses are part of the Gibeon fall and not independent falls is supported by their structure, morphology and chemical composition, which will be discussed later. Only Karasburg and Bushman Land have proved to be independent falls, and they have been treated separately under these entries.

Citron (1967) has plotted the various Gibeon meteorites on a modern geological map of Southwest Africa. Omitting the oldest meteorites of somewhat obscure origin, it is evident that the masses cover an elliptical area centered around the crater Brukkaros at the western edge of the Kalahari desert. The distribution is very uneven. The heavy concentration of masses occurs southeast of Gibeon about 75 km north of the crater. Kamkas and Enos are the extreme known masses, 190 km northwest and 200 km southeast of the crater, respectively. Spencer (1941) mentioned the crater in a report, but the reaction was to ascribe it to volcanism (Rogers 1915). Citron (1967) reports that South African geologists presently are of divided opinions; evidently more modern field work is needed. It is interesting to note that there is no other volcanism in the area, and there are no volcanic rocks associated with the crater. Explosion breccias formed from the country rock, and a swarm of radiating fissures and small kimberlite pipes are common. The crater is about 2 km in diameter and stands in dominating relief as a cone rising about 400 m above the surrounding plain.

Figure 781A. Gibeon. The 350 kg Lichtenfels mass which is now exhibited in the Max-Planck-Institute, Heidelberg. It is unusually well-preserved, with regmaglypts and fusion crusts over large areas. Length of ruler 15 cm.

Scattered photomacrographs have, in addition to those already mentioned, appeared in publications by Mauroy (1913: plate 3), Foote (1912: plates 5 and 6), Nininger & Nininger (1950: plate 9) and Heide (1957). Massalski et al. (1966) examined the plessite fields with the microprobe and gave photomicrographs; Brett & Henderson (1967) included Gibeon in their discussion of the troilite morphology. El Goresy (1965) examined the troilite inclusions and gave three photomicrographs of a Bethany specimen. Buchwald (1969b) examined a large number of Gibeon specimens and showed Bushman Land and Karasburg to be independent falls. Historical and bibliographical reviews have been prepared by Wülfing (1897), Cohen (1905: 324), Spencer (1941), Hey (1966) and Citron (1967).

Herr et al. (1961) determined by the Os/Ir method the solidification age of Gibeon to be about 4.0 x 10^9 years. Chackett et al. (1953) reported the helium content from seven different fragments, and Ebert & Wänke (1957) examined an Amalia fragment. In continued experiments by Signer & Nier (1962) and Bauer (1963) the helium content was found still lower (about 10^{-8} cm^3 per gram), too small for the determination of a cosmic ray exposure age. The examined specimens apparently came from the interior of a large mass and thus had been well shielded against the bombardment of cosmic rays. Paneth (1954) found from 2 x 10^{-9} to 3.4 x 10^{-6} cm^3 helium per gram, a variation which probably mainly reflects different degrees of shielding.

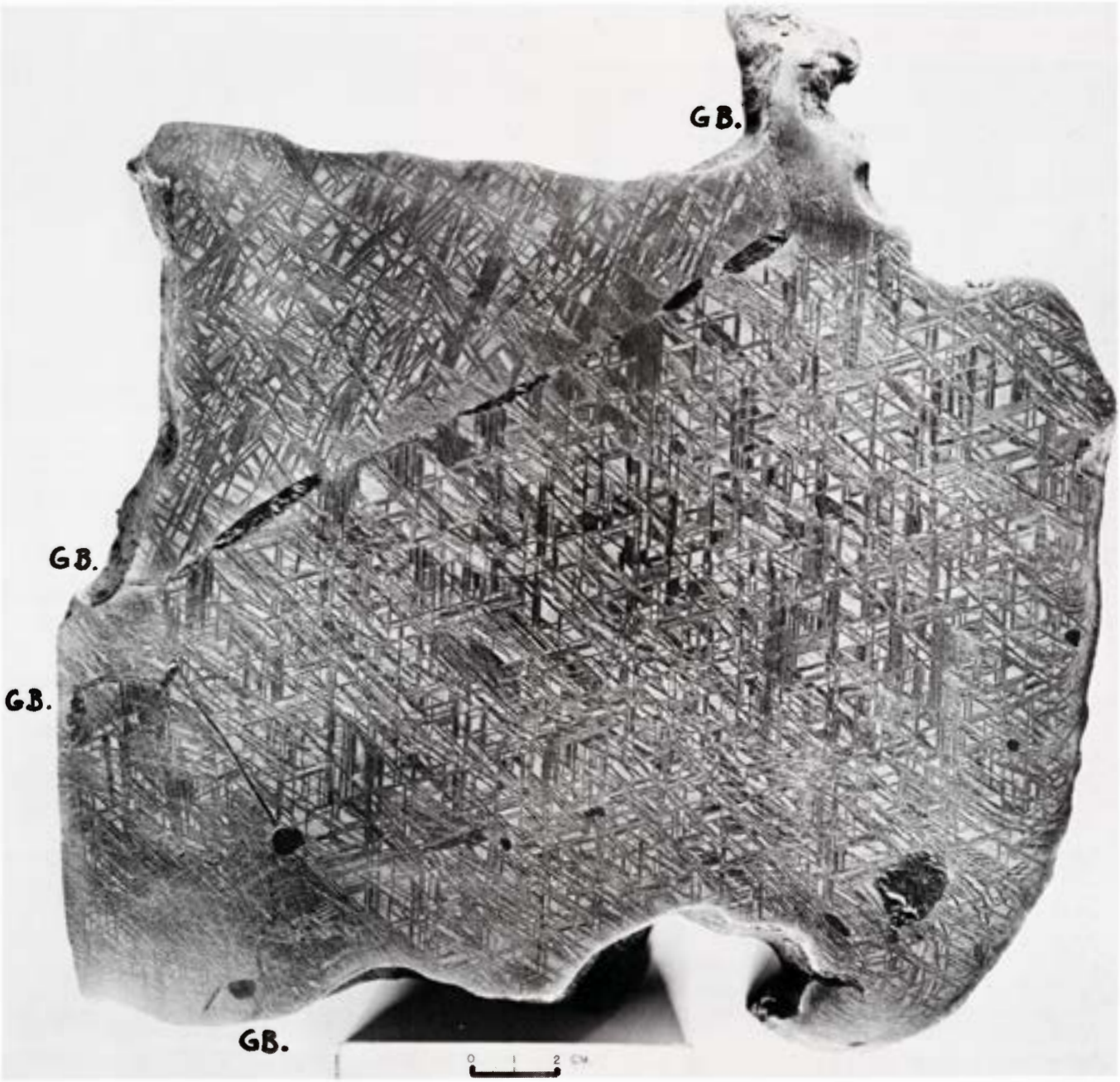

Figure 781B. Gibeon (U.S.N.M.). A full slice showing original taenite grain boundaries (GB) with elongated troilite inclusions. Below right, violent plastic deformation associated with the atmospheric disruption. Deep-etched. Scale bar 2 cm. S.I. neg. M-141. See also Figure 206.

COLLECTIONS

South African Museum, Cape Town (870 kg), New York (559 kg), Frankfurt (556 kg), Hamburg (523 kg), Moscow (327 kg), Berlin (305 kg), Göttingen (262 kg), Bonn (257 kg), Washington (257 kg), Harvard (236 kg), Windhoek Mine Office (200 kg), Vienna (about 185 kg), London (152 kg), Lübeck (unknown weight, Range 1940: 44), Budapest (148 kg), Copenhagen (124.5 kg), Tempe (93.3 kg), Amherst (77 kg), Ottawa (68 kg), Helsinki (about 65 kg), Chicago (53 kg), Braunschweig (26.4 kg), Prague (17.7 kg), Strasbourg (17.5 kg), Bally (13.4 kg), Rio de Janeiro (11.3 kg), City College of New York (8.5 kg), Yale (7.95 kg), Dublin (6 kg), Paris (4.9 kg), Warsaw (4.5 kg), Calcutta (4.2 kg), Breslau (4 kg), Berlin (3.85 kg), Vatican (3.70 kg), Philadelphia (3.45 kg), Utrecht (about 3 kg), Delft (about 3 kg), Rome (2.75 kg), Tübingen (2.67 kg), Oslo (2.56 kg), Mexico City (1.63 kg), Dresden (1.55 kg), Sydney (1 kg). Also slices in numerous other collections and numerous masses in private possession. Gibeon is one of the best distributed meteorites.

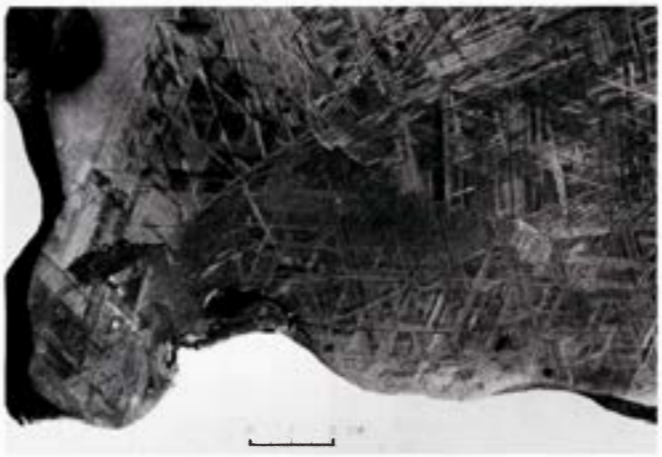

Figure 782. Gibeon (Chicago). The polycrystalline nature is clearly visible. Prø-Widmanstätten kamacite lines the original grain boundaries. Violent plastic deformation above the scale bar. Deep-etched. S.I. neg. M-109B.

DESCRIPTION

The individual specimens, fragments of a large body that probably burst in mid air, range from 195 g to 650 kg in weight. Small specimens are, however, very rare, which is quite different from the case of the crater producing Canyon Diablo and Henbury meteorites. This may be a real

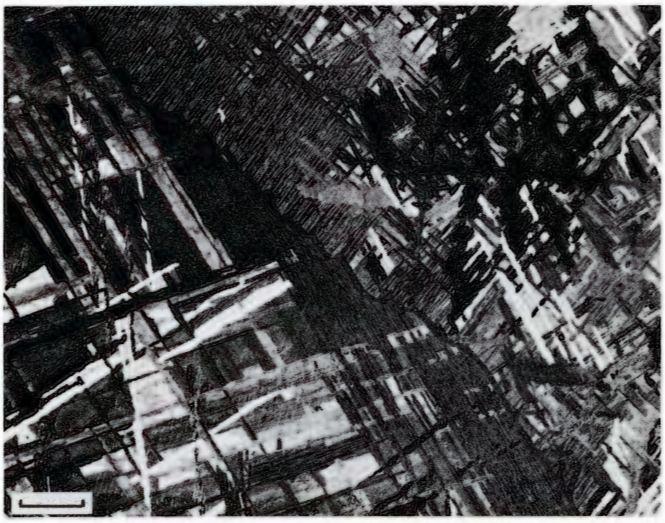

Figure 783. Gibeon (U.S.N.M. no. 3188; Bosch Collection no. 578). A taenite grain boundary runs diagonally across the picture. In the individual grains, more lamella directions than can be accounted for by the Widmanstätten law are developed. Deep-etched. Scale bar 5 mm. S.I. neg. M-1448D.

GIBEON – SELECTED CHEMICAL ANALYSES

Specimen numbers refer to the table on page 592. The essential thing about the analyses is the clustering about 8.0% Ni-0.4% Co-0.04% P, indicating that all individuals were once part of the same rather homogeneous mass.

	percentage			ppm									
References	**Ni**	**Co**	**P**	**C**	**S**	**Cr**	**Cu**	**Zn**	**Ga**	**Ge**	**Ir**	**Pt**	**Specimen**
Fahrenhorst in Cohen 1905	8.18	0.63	0.06	100	400	200	300						No. 3
Krupp in Cohen 1905	7.97	0.50	0.034	500	240	350	160						No. 4
Sjöström in Cohen 1905	7.79	0.69	0.05		1000	100	300						No. 2
Fraenkel & Tammann 1908	7.80	0.40	0.034		100	300	100						
Lovering et al. 1957	7.96	0.39				200	185		2	<1			
Buchwald 1967, unpublished	7.98	0.44	0.02						2	<1			No. 7
Smales et al. 1967						201	157		2.03	0.16			
Wasson 1967	7.82								1.93	0.111	2.4		
Schaudy et al. 1972	7.82								1.99	0.119	2.1		No. 76
Crocket 1972											2.1	8.0	
Rosman 1972								0.08					
Kelly & Moore 1973, pers. comm.								3.5					

difference due to a different mechanism of breakup, or it may be a fictive one due to insufficient knowledge of the Gibeon site. Finally, it might be due to the natives who long ago removed the smaller individuals and worked them into tools.

The exterior morphology ranges from that of a rather smoothly rounded lens like No. 22 (237 kg, 62 x 45 x 22 cm) to that of highly jagged masses with deep, spherical cavities like No. 64 (189 kg, 57 x 33 x 25 cm). An intermediate form is represented by No. 8 (424 kg, 50 x 50 x 40 cm); this is roughly cone-shaped with regmaglypts, 3-5 cm in diameter, on the convex sides and with a flat rear side with unusually large cavities, somewhat resembling what is observed on Goose Lake. Apparently this mass had a long independent flight in a stabilized, oriented fashion after the breakup. As discussed below, it seems that very little has been lost by terrestrial weathering from any of the Gibeon meteorites; heat-affected α_2 zones, 0.5-2 mm thick, are present on some of them studied here and will probably be found on many more, as yet uncut, specimens. Lichtenfels (No. 72) is a particularly beautiful example of a well-preserved mass with regmaglypts over most of the surface. This means that the exterior shapes are in all major respects the result of the rupture and later atmospheric sculpturing, and only to a minor degree modified by terrestrial corrosion.

Etched sections display a fine Widmanstätten structure of straight, long ($\frac{L}{W} \sim 40$) kamacite lamellae with a width of 0.30±0.05 mm. The kamacite shows Neumann bands and subboundaries and has a hardness of 170±10. Some of the Neumann band sets are indistinctly decorated by fine precipitates of γ, less than 0.5 μ across, but otherwise Gibeon belongs to those meteorites which display a very pure metallic matrix.

Taenite and plessite cover 50-60% by area, both as open-meshed comb and net plessite, as cellular plessite and as dense, dark-etching fields of various morphologies. A typical dense field, 2 x 1 mm in size, will have a yellow, narrow taenite border followed by a narrow, martensitic transition zone; then follow duplex, unresolvable $\alpha + \gamma$ structures (HV 225) and then easily resolvable $\alpha + \gamma$ structures ($\sim 1\ \mu$ γ-blebs, HV 200). Finally, in the interior the decomposition to $\alpha + \gamma$ is complete (2-3 μ γ-blebs, HV 165±10). The cellular plessite fields have, within each 100-400 μ cell, uniformly oriented taenite platelets and rods; see Chinautla.

Schreibersite and rhabdite are not present under any form, which is in harmony with the low analytical phosphorus value. Graphite has been reported, but this is probably an error; and it could not be confirmed in this study. Cohenite is absent.

Figure 784. Gibeon (U.S.N.M. no. 1497). Kamacite and plessite development typical for all Gibeon masses: black taenite (above), net plessite (above), cellular plessite (center) and finger plessite (below). Etched. Scale bar 400 μ. See also Figure 70.

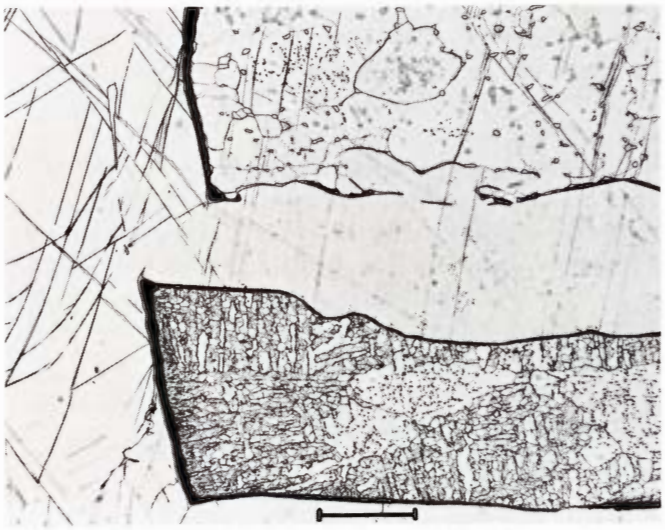

Figure 785. Gibeon. Detail of Figure 784. Cellular and finger plessite. Deformed Neumann bands. Etched. Scale bar 200 μ.

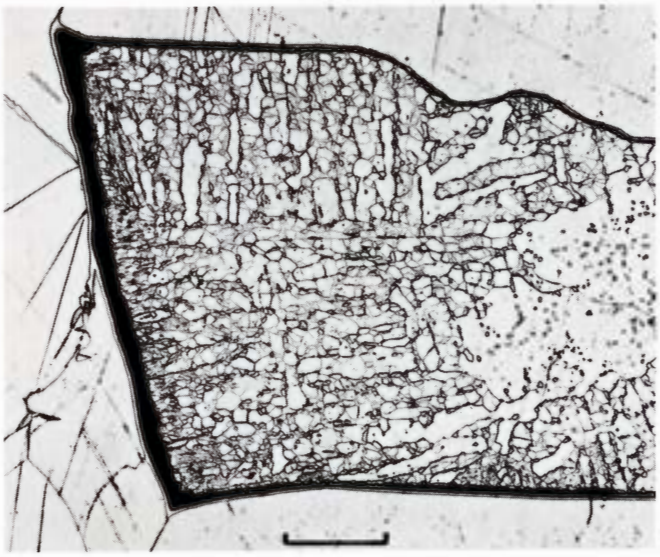

Figure 786. Gibeon. Detail of Figure 784. The finger plessite owes its peculiar morphology to the presence of numerous γ-particles along small elongated kamacite crystals that are themselves subdivided by cell boundaries. Etched. Scale bar 100 μ.

Troilite is ubiquitous as nodules, ranging from 0.5 to 25 mm in diameter, and as elongated lenses typically 10 x 1 mm in size. Frequently the large troilite nodules are surrounded by numerous satellite troilites, only 0.1-1 mm across. All the troilite bodies I have seen, from many different individual masses, have been shock melted. They have dissolved part of the adjacent metallic matrix and now abut irregularly against taenite, plessite and kamacite with spongy, frayed edges. The melts have solidified rapidly to fine-grained eutectics of 1-5 μ sulfide- and metal-grains in which numerous, subangular daubreelite fragments, 2-15 μ across, are embedded. From the troilite, several veinlets of shock-melt may extend for millimeters through the metal. Near-surface nodules show a corroded iron phase, but are otherwise well-preserved. In polished section, some nodules show an intricate change between light and dark patches on a millimeter scale. The light, normal variety is rich in uncorroded, micron-sized metal grains and has a hardness of 210±10; the dark variety appears to contain a dark, well-dispersed phase (phosphates? silica? silicates?) instead of the metal and has a hardness of 245±10.

Chromite occurs sparsely as 0.1-1 mm euhedric crystals, normally associated with troilite. Daubreelite is common in the kamacite as 10-100 μ subangular blebs. Frequently they form sets of parallel platelets separated by 1-5 μ wide, metallic platelets; the explanation for this morphology is not obvious.

Berwerth (1902) reported 3-4 cm^2 large platelets of enstatite in one of the Mukerop blocks. Later studies have occasionally revealed more silicate inclusions, such as tridymite as 1 mm wide and 25 mm long intersecting veins (Schaudy et al. 1972).

Very characteristic for Gibeon is its polycrystallinity. Numerous sections through Lion River (No. 2), Mukerop (Nos. 4 and 7), Amalia (No. 20), Kameelhaar (No. 64), and possibly others, show that Gibeon is composed of many original austenite grains ranging in size from about 10 to 50 cm. Repeated twinning is common, with the individual twin units being 2-10 cm thick. Adjacent twins have one Widmanstätten direction in common, and the twinning plane is also a $\{111\}_\gamma$ plane. The austenite grain boundaries are usually marked by 0.3-0.6 mm wide, continuous kamacite ribbons; and quite locally elongated troilite bodies, 0.5-2 mm wide, have segregated in the grain boundaries (e.g., New York no. 210). Each austenite grain has, in the usual way, formed a fine Widmanstätten pattern, but it is interesting to note that near the boundary the pattern becomes very indistinct, apparently because only one of the four possible Widmanstätten planes has been able to develop. Compare, e.g., Arispe and Savannah.

The features discussed above represent the "normal" Gibeon material, as far as it is known. The structures are due to preatmospheric events.

The breakup in the atmosphere must have been extremely violent, because many specimens show tensile-torsional-shear fractures with extensive necking, faulting and plucking. When No. 64 was cut and divided into two endpieces of 151 and 30.4 kg and a full slice of 4.85 kg, the cold-working immediately became apparent. The section passed through one of the typical, deep holes (13 x 11 cm in aperture, 9 cm deep, and 15 cm in diameter in its widest part) which shows overturned edges and expands significantly below the surface. Two other holes of similar shape are present on the mass, one is hemispherical, 7 cm in diameter and 5 cm deep; and one is an enormous cavity, 13 x 11 cm in aperture, 15 cm deep and 18 cm in diameter in its widest part. The section shows that part of the explanation for the holes is an extensive deformation of the surrounding metal which has been distorted and torn to form the overturned edges. A certain set of Widmanstätten

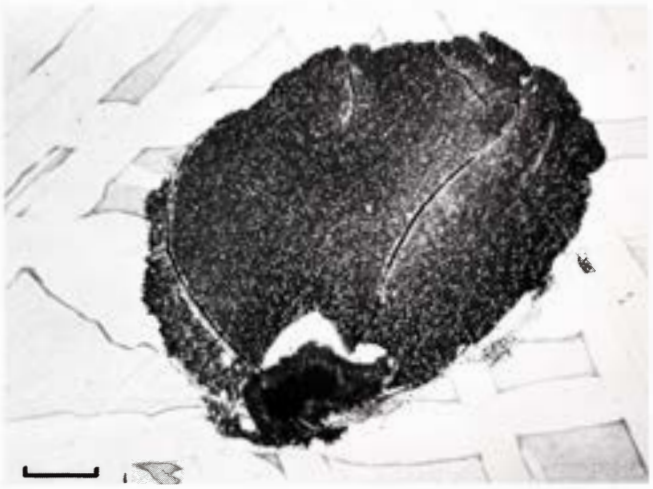

Figure 787. Gibeon (Copenhagen no. 1913, 116). Shock-melted troilite nodule. The interior, softly curved walls are very typical for shock-melted troilite nodules. Etched. Scale bar 500 μ.

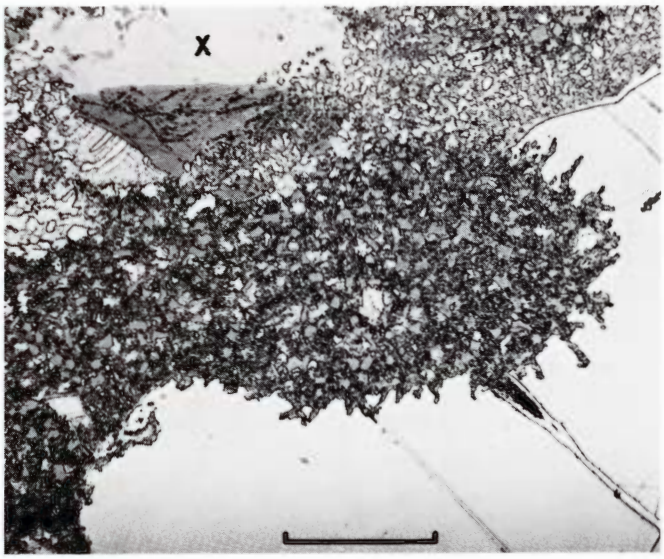

Figure 788. Gibeon (Tempe no. 86b). Edge of a shock-melted troilite-daubreelite nodule. The nodule now displays a eutectic iron-sulfur melt with dispersed daubreelite fragments. A triangular daubreelite crystal is, however, not entirely shattered. X is metallic and yellowish and perhaps a nickel-rich austenite. Etched. Scale bar 100 μ.

lamellae can be seen to change their direction gradually through 180°. The exterior 5-10 mm exhibits an extreme degree of cold-working, so that the original structural elements are no longer distinguishable. It is still widely accepted (see, e.g., Aladag & Gordon 1969, figure 2) that these plastic deformations so common to Gibeon are due to impact with the Earth. This cannot, however, be true since the distortions often occur in numerous places along the periphery and almost always, moreover, display necking and other effects of tensile and shear deformation, rather than compression from impact with the ground. The hardness of the cold-worked kamacite lamellae increases from the normal 170 to about 325 (measured in a specimen of Haruchas No. 73, in a deformed zone 0.2-1.5 mm below the surface). Other specimens which show extreme degrees of cold-working over large areas are Vienna no. J3457, U.S.N.M. nos. 2793 and 2788, and New York no. 210. Similar but smaller deformations may be found near the surface on a large number of specimens.

A few specimens, notably Donas, Enos, Hunsrück, Kamkas and Keetmanshoop, show, in addition to cold-working, extensive reheating effects. While the reheating of the last-mentioned specimen appears to be artificial, due to oxygen-acetylene cutting, the other specimens appear to be undamaged. The kamacite matrix is transformed to serrated α_2 units, 25-50 μ across, and incipient segregation of tiny, 2 x 0.5 μ, rods and platelets of γ has occurred to varying degrees in the kamacite. The taenite and plessite fields exhibit blurred outlines due to beginning diffusion. The structures indicate reheating to above 800° C for a short period, probably as a result of local energy release during the violent atmospheric rupturing. It may be more than a coincidence that the most reheated specimens seem to come from the periphery of the strewnfield and thus represent material thrown 100-200 km away from the central area. Similar effects are known to occur in Campo del Cielo, Canyon Diablo, Henbury and Wabar individuals.

Lion River (No. 2) shows extensive cold-working of the surface, but this is probably due to the natives who knew of the mass and used this and other smaller specimens for the production of spearheads, etc., (Shepard 1853a). The surface is severely battered, and the metal is smoothed and overfolded everywhere. Heavy chisel marks occur and what appears to be a 10 x 10 cm "anvil" face may be identified in one place. "Woman," one of the Cape York specimens, shows a similar surface, artificially smoothed by hammering action when trying to obtain supplies of iron.

Heat-affected rim zones have not previously been reported, except by Buchwald (1969b). It appears now that they are not so rare, but that few sections possess a surface polish that allows a good examination of the edge. I have measured undisputed α_2 zones 0.5-2 mm wide on Lichtenfels (No. 72) and Haruchas (No. 73) and found an α_2 hardness of 195±8 (hardness curve II-III). Many individuals show well-preserved regmaglypts, and, no doubt, a normal but somewhat thin α_2 zone is present under them. Some specimens show a cold-worked surface from rupturing upon which the heat-affected α_2 zone is superimposed, e.g., Kamkas, Hunsrück and Haruchas. Cavities from ablation-melted troilite nodules are present on some specimens. Corrosion is never conspicuous. While 0.1-2 mm thick oxides may be present locally, no deep attacks occur, except along some parent austenite grain boundaries or along fissures created during atmospheric breakup. Near-surface Neumann bands and the metal phase of the shock-melted troilite may be selectively corroded. Due to the dense and pure metallic structure, to the arid climate of the Gibeon region, and possibly, to a not too high terrestrial age, the meteorites are well-preserved. As is usual, the individual specimens are most corroded on those parts well buried in the soil.

Gibeon is a typical fine octahedrite, related to Bodaibo, Bristol, Charlotte, Putnam County and Signal Mountain. It is large enough to exhibit polycrystallinity of the parent mass, a phenomenon which is not noted on the

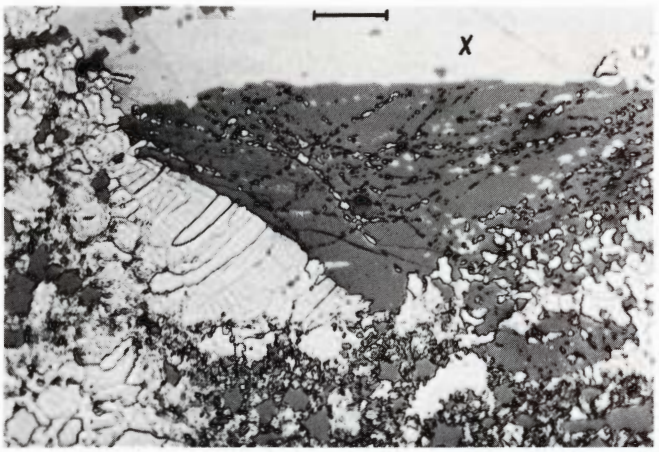

Figure 789. Gibeon. Detail of Figure 788. Granulated kamacite (white) with sulfide (spotted) and daubreelite (dark-gray). Above, an unidentified phase (X), possibly nickel-rich austenite. Etched. Scale bar 20 μ.

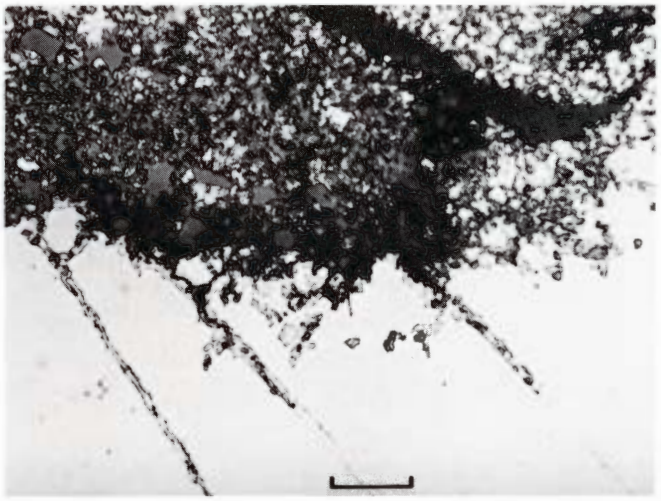

Figure 790. Gibeon (Tempe no. 86b). Edge of shock-melted troilite-daubreelite nodule. The shock-melt was apparently sufficiently mobile to be squeezed out into adjacent kamacite, along what appears to be annealed Neumann bands. Etched. Scale bar 20 μ.

smaller masses mentioned, except on Bodaibo. Gibeon appears to have been a large individual which burst high in the atmosphere and covered an elliptical area, 390 km long and 120 km wide, with fragments. By a coincidence it fell almost symmetrically around the little known volcanic crater Brukkaros. The 77 recovered specimens total about 21,000 kg with an average weight of 280 kg. Another several hundred kilograms in the form of small fragments may have been collected by the natives before the first large specimen was recovered in the mid-nineteenth century. Gibeon is by far the largest strewnfield known of any meteorite, covering about 20,000 km^2. The central, more densely spattered area is about 2,500 km^2 in size. Much more field work is needed, however, before we reach a full understanding of this imported shower. See also the Supplement.

COMMENTS ON THE TABLE

The table has been compiled from various sources, of varying quality. Whenever possible the information as to size, name and present location has been verified by personal inspection of the museum specimens. It is, however, often difficult to follow a certain specimen from its discovery site on the farms in Southwest Africa through the various agents and dealers to the final repository. One such problem is connected with Kamkas which in 1941 was described by Spencer on the basis of a slice, but which later "disappeared." Citron, in a letter of January 22, 1965, noted that the main mass had been sold to a dealer in the United States in 1964; shortly afterwards a mass called "Bethany" appeared in Los Angeles. Since the approximate weight, size and structure are identical, this is probably the Kamkas mass (No. 67). The total weight of the 77

List of Gibeon Specimens

No.	Name	Coordinates, S-E	Weight kg	Remarks	Present Location of Main Mass or Specimens	References, Figures
1	Great Fish River	25°30′ – 18° ?	?	Analyzed by Herschel 1839	A few grams in London	Alexander 1838; Spencer 1930
2	Lion River	27° – 18° ?	81	The Namaquas knew it	Amherst 77 kg; Tempe, London, Vienna	Shepard 1853a: figure
3	Bethany (= Wild)	26°10′ – 17°20′ ?	232		Cape Town no. 45, London, New York	Cohen 1900d: figure
4	Mukerop	25°30′ – 18°10′	178	Graf von Linden 1899 Twins discussed by Berwerth 1902	Vienna 61 kg, Stuttgart 16 kg; 86 kg cut and distributed	Brezina & Cohen 1902: figure; Berwerth 1902: figure
5	Mukerop	25°30′ – 18°10′	232		Harvard no. 466	Cohen 1905: 335
6	Mukerop	25°30′ – 18°10′	297		Krupp Collection, Essen	Cohen 1905: 341
7	Mukerop	25°30′ 18°10′	503	Large slices cut from it	Krupp Collection, Essen; Washington	Richarz 1918: 105; Cohen 1905: 340
8	Gibeon	25°10′ – 17°50′	424	Acquired by Professor Gottsche in 1905	Hamburg	Cohen 1905: 341; Horn 1912: figure
9	Gibeon	25°10′ – 17°50′	281-350	Weights are quoted differently	Hamburg; Copenhagen 123 kg	Horn 1912: figure; Ussing 1905
10	Gibeon	25°10′ – 17°50′	225-255	Deep, spherical cavities	Hamburg; half in Vienna	Hovey 1909: figure; Horn 1912: figure
11	Burgsdorf	25° 0′ – 16°55′	200		Windhoek Mine Office	Range 1913
12	Goamus	25°10′ – 18°15′	242	Nos. 12-17 acquired and distributed by Krantz, Bonn, in 1908-1911	Göttingen	Schauf 1912; Brauns 1926
13	Goamus	25°10′ – 18°15′	253		Bonn	ibid.
14	Goamus	25°10′ – 18°15′	269			
15	Goamus	25°10′ – 18°15′	281			
16	Goamus	25°10′ – 18°15′	328	Deep, spherical cavities	Frankfurt, Senckenberg Natur-Museum	Schauf 1912: figure
17	Goamus	25°10′ – 18°15′	404-407	Tessera-octahedrite	Reported to be in Kiev 1914; now lost?	Rinne 1910; Chirvinsky 1922: figure
18	Goamus	25°10′ – 18°15′	305		Geologische Landesanstalt, Berlin	Schauf 1912
19	Goamus	25°10′ – 18°15′	228		Frankfurt, Senckenberg Natur-Museum	Range 1940: figure; Schauf 1912
20	Amalia	25°25′ – 18° 0′	392	Sliced up about 1910	Well distributed	Foote 1912: 16,25,32,44; figure
21	Amalia	25°25′ – 18° 0′	301	Nos. 20-25, totaling 1,685 kg acquired by Scheibe and distributed, partly through Foote	New York no. 285	Hovey 1912
22	Amalia	25°25′ 18° 0′	237		New York no. 3752	Mason 1964: 14
23-24	Amalia	25°25′ – 18° 0′	about 428 on 2			
25	Amalia, Kameelhaar	25°15′ – 18° 0′	327		Moscow	Schauf 1912; Kvasha 1962: figure
26-62	Amalia, Kameelhaar	25°15′ – 18° 0′	12,613	Total weight of 37 specimens collected 1911-12 by Range	Windhoek Public Gardens	Range 1913; Spencer 1941: figure
59	Gibeon	25°10′ – 17°50′	136	From the Windhoek pile 1930	London no. 1930, 422	Spencer 1930: figure
60	Gibeon	25°10′ – 17°50′	410	From after 1913	Pretoria	Spencer 1930
61	Gibeon	25°10′ 17°50′	320	From after 1913	Pretoria	Hey 1966: 173
62	Gibeon	25°10′ 17°50′	650	From after 1913	Cape Town no. 80	Spencer 1930
63	Kameelhaar	25°10′ – 18° 0′	195	Cut and distributed	1,453 g slice in London	Zsivny 1932; Spencer 1941
64	Kameelhaar	25°10′ - 18° 0′	189	Sold to Bosch probably	Washington no. 3188	Zsivny 1932
65	Kameelhaar	25°10′ 18° 0′	132		Budapest no. 68.21	Zsivny 1932: figure; Ravasz 1969
66	Gibeon	25°10′ – 17°50′	0.195	Only known, small individual	London no. 1929, 1563	Spencer 1941: figure
67	Kamkas	24°40′ - 16°30′	about 150	Transported ?	Purchased by Martin Ehrmann 1964; Presently being distributed by Huss, Denver	Spencer 1941
68	Enos (Kinas Putts)	27° 0′ – 19°20′	193	Found in situ by Hartung before 1923	Johannesburg ?	Citron 1967: figure
69	Keetmanshoop	26°35′ – 18°10′	204	Transported	Keetmanshoop; Stolen 1964	Citron 1967
70	Donas	26°50′ – 19°10′	263	Found in situ 1940 by a boy	Keetmanshoop	Citron 1967; figure
71	Hunsrück (Bethanie)	26°35′ – 17°25′	73		Keetmanshoop	Citron 1967: figure
72	Lichtenfels	25°35′ – 17°45′	350		Max Planck Institut, Heidelberg	Citron 1967: figure; Gentner and Haag, pers. comm. 1974
73	Haruchas	24°55′ – 18°50′	38	Found 1900 by C. Berger. Transported ?	Haruchas	Citron 1967: figure
74	Gibeon	25°10′ – 17°50′	about 35	Used as an anvil	Windhoek State Museum	Citron, letter of January 26, 1965
75	Gibeon	25°10′ – 17°50′	26.4	From Voigt in Windhoek	Technical University Braunschweig	Heide 1919: 62
76	Nico	25°23′ – 17°47′	25.2	Found by natives 1965	Max Planck Institut, Heidelberg	Gentner 1966; Meteoritical Bulletin, No. 36, 1966
77	Railway	26°35′ – 18°10′	47	Found by G.H. Dawson before 1938.	Pretoria 44.7 kg; MPI Heidelberg.	Frick & Hammerbeck 1973; 31

specimens listed in the table is 21,000 kg , giving an average weight of 280 kg. While the total number of specimens known is approximately correct, the relatively unknown pile of large blocks in the Windhoek Public Gardens is a source of error. The pile was collected in 1911-12 by Range who stated (1913; 1940) that it contained 37 individuals, totaling 12,613 kg, and also gave the individual weights: 600, 530, 520, 502, 462, 435, 411, 406, 400, 396, 395, 380, 366, 363, 346, 345, 344, 342, 335, 315, 308, 307, 307, 306, 303, 301, 300, 295, 278, 272, 270, 249, 240, 194, 134 and 86 kg. These show a Gaussian distribution in a histogram of numbers versus various weight categories, and the average weight is 340 kg. The pile has dwindled somewhat since 1940, to 27 masses according to Citron (1967); some of the missing specimens are known to be in collections, notably Nos. 59 through 62 specified in the above table.

Specimens which are still entire, or from which only a small piece has been cut, are underlined and the collection is stated.

Small specimens of the masses Nos. 68-74 were obtained for the U.S. National Museum by Robert Citron (1967) and are here described for the first time. It could be confirmed that they are authentic Gibeon specimens. The Nico iron was originally reported as an independent meteorite (Zähringer in Meteoritical Bulletin, No. 36, 1966); it is, however, a typical Gibeon specimen. Bushman Land and Karasburg were reported by Citron (1967, and letters in the Smithsonian Institution) as possible members of the Gibeon shower, they are, however, independent falls, see pages 353 and 709. Railway, no. 77, is no doubt a typical Gibeon mass, although Frick & Hammerbeck (1973) listed it as an independent meteorite: *South African Railways*.

Gladstone (iron), Queensland, Australia

23°54′S, 151°16′E

Coarse octahedrite, Og. Bandwidth 2.8±0.5 mm. Neumann bands. HV 215±10.

Group I. 6.73% Ni, 0.51% Co, 0.27% P, 1.1% S, 91 ppm Ga, 403 ppm Ge, 2.8 ppm Ir.

The meteorite designated "Queensland" is a fragment of the shower producing Gladstone iron.

HISTORY

Conflicting statements exist regarding the date of discovery, size and history of this meteorite (see Richards 1930; Hodge-Smith 1939: 18, 32). The best information is that of Simmonds (1964) who conducted a field search and interviewed the local people. According to him, a mass (of about 735 kg, see later) was found in 1912 or 1913 by Mr. Tim Lee during the survey and construction of a dam on Tondoon Creek, four miles south of Gladstone. The meteorite was partly buried close to the present site of the retaining wall, the coordinates of which are given above. The meteorite was kept in the Geological Survey of Brisbane until it was sold by Mr. B. Dunstan, chief government geologist, to Ward's Establishment about 1929. A piece had been chiseled off, and a blacksmith had forged a couple of rings from it.

Two other masses of about 5-15 kg had been found about 700 m farther south, but were later lost. A fourth mass of 24.1 kg, that was almost buried on a rocky quartzite ridge, extending north-south (map of localities in Simmonds 1964) was found about 1940, 900 m south of the large mass. The 24 kg mass was for a time used as a doorstop in a hotel, until it was recognized as a meteorite and donated to the Geological Survey of Queensland in 1959, where it was described with photomacrographs and micrographs by Simmonds (1964).

A fifth, rather small specimen was already in the possession of H.A. Ward about 1894. It appears that Ward acquired a few hundred grams, of which a 72 g slab was incorporated in his collection (Catalogs of 1900, 1901a and 1904a) under the heading "Queensland," since he only knew the approximate locality as southern Queensland. The date of discovery was given as 1880 or 1894.

The other part, a 94 g specimen, was sold in 1897 to C.S. Bement, from whose collection it came to the American Museum of Natural History (Wiik & Mason 1965). The "Queensland" pieces have been listed as doubtful meteorites by Prior (1953) and by Hey (1966), but they are – as the history, structure and chemical composition show – quite certainly from an early discovered individual of the Gladstone shower.

The weight of the largest mass was given as 14 1/2 cwt by Richards (1930). This corresponds to either 1,450 pounds (658 kg) or 1,621 pounds (gross, 736 kg). Since the total weight of recorded specimens from this mass constitutes about 725 kg, the latter figure appears to be correct. The dimensions given in the same publication, 33 "x 12 "x 9 ", are erroneous, since they at the most, if calculated as a

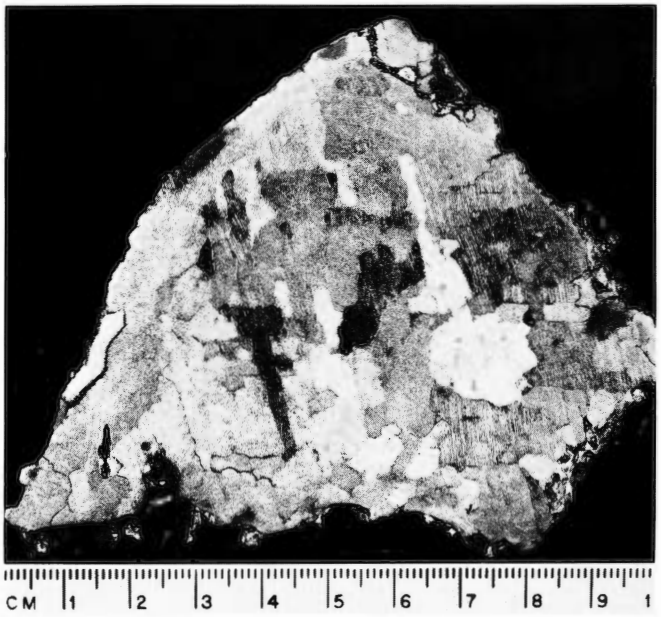

Figure 791. Gladstone (Tempe no. 53a). Coarse octahedrite of group I showing grain growth. Original weathered surface to the left. The other three faces produced by chiseling and breaking. Deep-etched. Scale in centimeters. (Courtesy C.B. Moore.)

rectangular box, would correspond to a volume of 57 liter or a weight of about 450 kg. Inspection of the remaining main mass of 634 kg in Chicago indicates that the original dimensions were approximately 85 x 55 x 25 cm, reduced to 70 x 55 x 25 cm by cutting. Several slices were cut, namely, by Ward's Establishment about 1929, and, while some were sold, the main mass and some slices came to Chicago. Richards (1930) and Nininger & Nininger (1950: plate 5) gave photomacrographs of two of the slices. Voshage (1967) analyzed a specimen but found too little ^{40}K and ^{41}K to determine a cosmic ray exposure age.

COLLECTIONS

Chicago (634 kg main mass; 26 kg slices, etc.), Brisbane (the 24 kg mass from 1940), Washington (20.9 kg), New York (16.1 kg), Sydney (13.1 kg), London (7.4 kg), Harvard (6.1 kg), Tempe (749 g), Ann Arbor (618 g), Moscow (128 g).

DESCRIPTION

The large mass had the approximate dimensions 85 x 55 x 25 cm and weighed 736 kg before cutting. The 24.1 kg mass measured about 23 x 22 x 10 cm. Both masses are severely corroded with 0.1-1 mm adhering oxides and with 0.1-2 mm wide, limonitic veinlets penetrating deep into the interior. Numerous uncorroded rhabdites may be found embedded in the terrestrial corrosion products. On the large slab in the U.S. National Museum two troilite nodules are exposed in the natural surface. Since they are actually projecting a few millimeters above the corroded surface, they must have corroded more slowly than the adjacent metal. The slow corrosion of troilite is at least partly due to its monocrystallinity and the complete absence of finely dispersed iron in it. The nodules are about 20 mm in diameter and must have been below the surface when the meteorite penetrated the atmosphere or else they would have burned out. It is, therefore, estimated that at least 2 cm of the meteorite's exterior skin has corroded away since it fell. The numerous ragged pits, ranging in size from 2-5 cm and resembling regmaglypts somewhat, must be due, mainly, to long-term corrosion.

The heavy general corrosion attack could be confirmed when, in Chicago, I had a chance to briefly examine the main mass. Many kilograms of oxide-shales, some of them 5 cm thick, have spalled off from all parts of the mass. Only a small region, about 30 x 15 cm in size, still appears unattacked, with regmaglypts and cavities from burned out troilite nodules. Probably this small knob was the only part of the meteorite which projected freely above the surface and, therefore, corroded slowly. Compare, e.g., Owens Valley and Drum Mountains. No fusion crust and heat-affected α_2 zones were, however, discovered on the available sections.

Etched sections display a coarse Widmanstätten structure of irregular, bulky, short ($\frac{L}{W} \sim 8$) kamacite lamellae with a width of 2.8±0.5 mm. Grain growth has locally given rise to almost equiaxial kamacite grains 10-20 mm in diameter. While the U.S. National Museum slab of 20.5 kg penetrates only a single, original austenite crystal, the figures given by Richards (1930: plate 8) and Simmonds (1964: figure 2) indicate that the meteorite is, in fact, polycrystalline with original austenite grain sizes from 5 to 40 cm. It is possible that the main mass split in the atmosphere along crystal boundaries, rich in brittle troilite-schreibersite and graphite inclusions. The fracture surfaces are, however, now too corroded to be identified.

The kamacite displays numerous Neumann bands, and subgrain boundaries with 0.5-2 μ rhabdites are conspicuous. The kamacite has a hardness of 215±10, corresponding to slightly work-hardened, unannealed material. Plessite occurs as scattered fields with one or two per cm^2. The fields are either squeezed between kamacite lamellae, or swallowed by a late kamacite grain growth and, therefore, now situated as isolated islands in the kamacite interior. Their size is 0.1-1 mm and they are developed as comb plessite with tarnished taenite rims (HV 400±20), or as pearlitic plessite with 0.5-2 μ wide taenite lamellae (HV 220±20), or as spheroidized plessite with 5-25 μ taenite spherules. Also acicular plessite and martensitic plessite may be found; in short, all the various types so characteristic for the group I irons.

GLADSTONE (IRON) – SELECTED CHEMICAL ANALYSES

Specimen No. 1 is the 736 kg mass; No. 4, the 24 kg mass; No. 5, the small "Queensland" specimen in New York. Simmonds (1964) says, "Lawrencite was not identified but its presence was evidenced by the formation of brownish red droplets of iron chloride on unprotected surfaces. . . . A faint trace of chlorine was detected in the analysis of shavings from the main slice." This is the typical observation upon which most claims relating to lawrencite are based. Since the iron is heavily corroded the major part of the chlorine must be of terrestrial origin, introduced by circulating ground water; the cosmic mineral lawrencite was never present.

	percentage			ppm									
References	Ni	Co	P	C	S	Cr	Cu	Zn	Ga	Ge	Ir	Pt	Specimen
Lovering et al. 1957	6.74	0.51				5.3	148		93	410			No. 1
Deasy in Simmonds 1964	6.70	0.47	0.27	2700	400		200						No. 4
Wiik & Mason 1965	6.92	0.56											No. 5
Smales et al. 1967						29	114	37	68	403			No. 1
Wasson 1970a	6.53								93.7	418	3.0		No. 1
Wasson 1970a	6.78								86.9	380	2.6		No. 5

Trivial amounts of haxonite intergrown with kamacite and taenite occur in some plessite fields. Schreibersite occurs as 12 x 1 or 6 x 2 mm skeleton crystals enveloped in 3-6 mm swathing kamacite. Further as 30-100 μ grain boundary precipitates that are somewhat brecciated, and as 0.2-0.5 mm wide rims around most of the troilite nodules. Rhabdites are numerous as 5-20 μ prisms; near the larger schreibersite crystals their size decreases, as usual, to below 1 μ, and finally they disappear.

Troilite is dominant as 2-50 mm nodules with varying proportions of graphite (0-50%). A point counting of 900 cm^2 indicated that the troilite occupies 5% by volume, corresponding to about 1.1% S in the meteorite as a whole. The troilite is monocrystalline with parallel cleavage planes, and with numerous, parallel precipitates of a light blue, anisotropic mineral, which occurs as 2-10 μ wide, discontinuous spindles and lamellae. The troilite also contains several irregular bodies of an isotropic, grayish mineral. It is normally situated along the periphery of the troilite nodules, attains sizes of 0.1-1 mm and has a hardness (100 g Vickers) of 185±10. It may be sphalerite, (Zn,Fe)S. Daubreelite was not observed.

Cohenite occurs locally in patches. On U.S.N.M. no. 842 it covers 6 x 6 cm^2 in one end, but it is absent on the remaining 850 cm^2. The cohenite bodies, each about 2 x 0.4 mm, are aligned in the kamacite lamellae, which are 20-40% narrower here than in cohenite-free areas. Cohenite was also observed as a thick precipitate upon a 20-50 μ wide schreibersite grain boundary vein. All cohenite is monocrystalline and has apparently not yet started the decomposition to graphite.

Gladstone is a shower-producing, polycrystalline coarse octahedrite with all the characteristics of group I irons. It is closely related to Campo del Cielo, Cranbourne, Cosby's Creek and Youndegin.

Specimens in the U.S. National Museum in Washington:

20.5 kg full slice (no. 842, 53 x 24 x 2.5 cm)
57 g part slices (no. 2360)

Glasgow, Kentucky, U.S.A.

36°57′N, 85°58′W; 200 m

Medium octahedrite, Om. Bandwidth 1.05±0.15 mm. ϵ-structure. HV 280±20.

Group IIIA. 7.60% Ni, 0.1% P, 20.6 ppm Ga, 38.8 ppm Ge, 5.0 ppm Ir.

HISTORY

Two masses of about 25 and 20 pounds (a total of 20 kg) were plowed up about 5 km southwest of Glasgow, in Barren County (Miller 1922). The smaller of the two masses was sent to the U.S. National Museum, where it was briefly described by Merrill (1923b). As received, the iron weighed only 7 kg, but, as it later turned out, it proved impossible to preserve the iron intact. There exists a photomacrograph in the Smithsonian Institution of the polished and etched surface, prepared in 1923. It shows considerable corrosion. Since then, the whole mass has deteriorated and fallen into pieces, from 1-20 mm across.

It appears that a large chunk of the other mass was preserved in the University of Kentucky for many years. When the University Collection was deposited in the Smithsonian Institution in 1966 there was included an unidentified 4,287 g half mass. Due to corrosion, the painted number had spalled off and the label was impossible to read. The mass was tentatively incorporated in the U.S. National Museum Collection with Campbellsville, but there is, in fact, no doubt that it is a piece of the larger of the two Glasgow masses. The macro- and microstructures are identical, the microhardness is identical, the exterior size and state of preservation are the same, and an analysis by Wasson (listed as pseudo-Campbellsville), furthermore, shows that it must be the same material that Merrill worked with in 1923 and which has been reexamined below.

COLLECTIONS

Washington (4.5 kg), New York (3,672 g), Harvard (265 g), London (241 g), Chicago (138 g).

DESCRIPTION

No. 2574 is heavily corroded and covered with a loosely adhering, 0.5-5 mm thick, limonitic crust. All traces of fusion crust and heat-affected α_2 zone are removed, and the iron is slightly opened along the Widmanstätten lamellae. And No. 643 is a collection of millimeter- to centimeter-sized weathered fragments, separated along Widmanstätten planes. The iron must have been exposed to corrosion for uncounted thousands of years.

The etched sections show a medium octahedrite structure of slightly undulating, long ($\frac{L}{W} \sim 25$) kamacite lamellae with a width of 1.05±0.15 mm. The bandwidth determination of 2.25 mm given in Hey (1966: 177)

GLASGOW – SELECTED CHEMICAL ANALYSES

Whitfield worked with strongly oxidized material and reported 19.2% iron-nickel oxides and 0.36% Cl. The analysis by Scott et al. was performed on U.S.N.M. no. 2574, while it was still listed as Campbellsville.

	percentage			ppm								
References	Ni	Co	P	C	S	Cr	Cu	Zn	Ga	Ge	Ir	Pt
Whitfield in Merrill 1923b	7.27	0.62	0.12	600	1100							
Scott et al. 1973	7.60								20.6	38.8	5.0	

appears to be based on inferior material. The kamacite is transformed to a densely hatched ϵ-structure by a shock wave above 130 k bar. The shock-hardened kamacite displays hardnesses of 280±20. Plessite areas are numerous, but they are mostly of the open-meshed comb and net plessite types with rather few and thin taenite lamellae. A 40 μ wide, tarnished taenite ribbon had a hardness of 390±25.

Schreibersite appears as 5-35 μ wide grain boundary veinlets in modest quantities, and 1-3 μ rhabdites are present on many subboundaries and in the grain interiors. The small amount of phosphides is in accordance with the analytical value of 0.12% P.

Troilite occurs with a frequency of one per 20 cm^2 as rounded or rhombic nodules, 1-3 mm across. They are usually monocrystalline and contain 10-30% daubreelite in parallel 0.1-0.5 mm thick platelets. Locally, near phase boundaries, the troilite is polycrystalline, probably due to shock-wave attenuation in these places. Several narrow fissures radiate away from the troilite inclusions. Some of them are partially filled with a breccia of troilite and daubreelite, evidently fragments displaced from nearby troilite nodules. The fissures, typically 30 μ wide and 2 mm long, are now imperfectly recemented by terrestrial limonite, and the troilite is partially weathered to pentlandite.

Several hard, pink, platy particles, typically 20 x 1 μ, are in the α-matrix. They appear to be similar to the chromium nitride mentioned in Cape York, Schwetz and others.

Whitfield found 0.36% Cl which Merrill ascribed to 0.62% lawrencite. As usual, the high chlorine content has been found in a heavily corroded iron with many internal fissures. No doubt, 99% of the chlorine comes from ground water solutions, and lawrencite was never present as a cosmic mineral in the meteorite.

Glasgow is a shock-hardened medium octahedrite with low phosphorus content and few inclusions. It is closely related to Augusta County, Canyon City and San Angelo, and it is a typical group IIIA iron.

Specimens in the U.S. National Museum in Washington:

278 g weathered fragments (no. 643, from a 7 kg mass, now lost)
4,287 g thick slice (no. 2574, 13 x 11 x 5 cm)

Glenormiston, Boulia, Queensland

22°54′S, 138°43′E

Polycrystalline kamacite aggregate with retained taenite. Neumann bands.

Anomalous. 7.24% Ni, 0.52% Co, 0.36% P, 16.9 ppm Ga, 76.8 ppm Ge, 2.7 ppm Ir.

HISTORY

A mass of about 41 kg (90 pounds) was discovered in 1925 by a boy who was tracking a stray horse on property belonging to F.H. Story. The meteorite was lying on the surface of a small plain about five miles west of Glenormiston Station House in the Boulia District. This is 110 km due west of Boulia, corresponding to the coordinates given above. At least two samples totaling 1.5 kg were chiseled off and forwarded to different people in order that the nature of the mass could be ascertained. In 1926 the Queensland Museum purchased the main mass, and Richards (1930) described it, giving three photographs of the exterior anomalous shape and five of the interior anomalous structure. The analysis was, however, inadequate. He classified it as a brecciated medium octahedrite, well knowing that no octahedral structure was present at all. He relied, however, upon the nickel determination which had placed the iron right in the middle of the octahedrites. This viewpoint cannot be sustained today.

COLLECTIONS

Main mass in Queensland Museum, Brisbane.

DESCRIPTION

Since no sample was available for description, I must rely upon the observations made by Richards (1930). The mass was shell- or crescent-shaped, with a distance of 49 cm between the horns and a maximum width of 33 cm in a perpendicular direction. The shell had a maximum thickness of 10 cm, but over much of the area it was rather less, perhaps 5 cm on the average.

The convex side presented a normal weathered surface where remnants of regmaglypts, 3-5 cm across, could be seen indistinctly. The opposite side had a very diverse

GLENORMISTON – SELECTED CHEMICAL ANALYSES

The carbon content is unusually high and difficult to understand considering no carbides or graphite have been reported. A complete modern analysis is needed.

	percentage			ppm								
References	Ni	Co	P	C	S	Cr	Cu	Zn	Ga	Ge	Ir	Pt
Connah in Richards 1930			0.36	2400	3000							
Lovering et al. 1957	7.12	0.52				<1	187		13	73		
Wasson & Kimberlin 1967	7.36								16.9	76.8	2.7	

character. Very concave on the whole, it was, in addition, subdivided by deep marked depressions with sharp ridges in between. The bowls were 5-10 cm in diameter, and from one of them a small hole, about 2 cm across penetrated right through the mass.

From the descriptions it appears that the rough depressions have developed during long exposure to corrosion in an arid climate. Similar features are present on, e.g., some Canyon Diablo and Youndegin specimens, and may also be detected on Gibeon and North Chile specimens. While the upper surfacc – the convex one in the case of Glenormiston – is only little altered, the lower surface has lost many centimeters by dissolution through countless centuries, thereby producing deep inverted bowls.

Etched sections displayed an anomalous array of almost equiaxial kamacite grains in and between which some taenite lamellae and plessite wedges were found. The average size of the kamacite grains was 6 mm, with a range from 2.5 to 13 mm. Neumann bands were well defined and independently oriented in adjacent kamacite grains.

Schreibersite occurred as irregular-shaped nodules, and troilite nodules, 1-2 mm across, were abundant but distributed somewhat unevenly. Compound nodules of troilite and schreibersite were reported, but not further examined.

Graphite, carbides and silicates were not identified.

Glenormiston is clearly a highly anomalous iron, which is perhaps related to Barranca Blanca, Kendall County, and Weekeroo Station. It is, however, not a medium octahedrite, and the term "brecciated" is misleading, too. Such coarse-grained kamacite structures have most likely formed by recrystallization of a more normal Widmanstätten structure, or as in the case of Barranca Blanca, by growth from many nuclei upon sintering. Since I have had no opportunity to examine samples under the microscope, I am not able to form a more precise opinion.

Glen Rose, Texas, U.S.A.

32°15′N, 97°43′W

A mass of about 11 kg was found about 1934 near Glen Rose in Somerwell County and recognized as a meteorite in 1936 (A.D. Nininger 1937: 449; Barnes 1939a: 595). The whole mass was acquired by O.E. Monnig, Fort Worth. It appears to be an octahedrite, but no material was available for the present study. The locality is not far from Cleburne, and the two meteorites should be checked for a possible relationship.

Glorieta Mountain, New Mexico, U.S.A.

35°34′N, 105°49′W; 2,200 m

Medium octahedrite with a few olivine inclusions. Pallasite. Bandwidth 0.85±0.15 mm. Neumann bands. HV 164±8.

Anomalous. 11.92% Ni, 0.54% Co, 0.37% P, 13.2 ppm Ga, 11.0 ppm Ge, 0.014 ppm Ir.

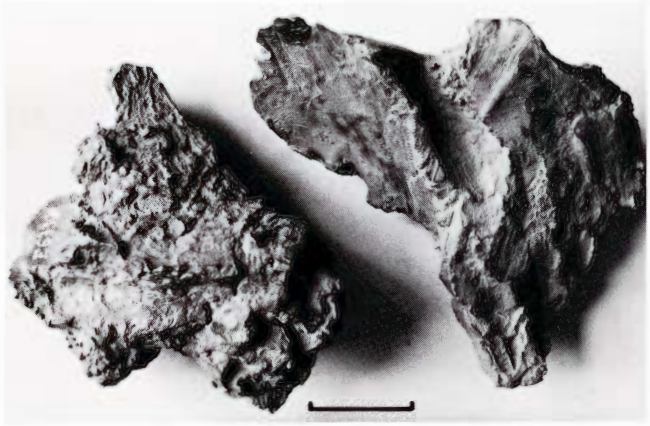

Figure 792. Glorieta Mountain (Vienna nos. F 6339 and F 3681). Two impressive fragments from the atmospheric disruptions. On the right sample, elongated grooves suggest the original position of the finger-shaped fragments. Scale bar 30 mm.

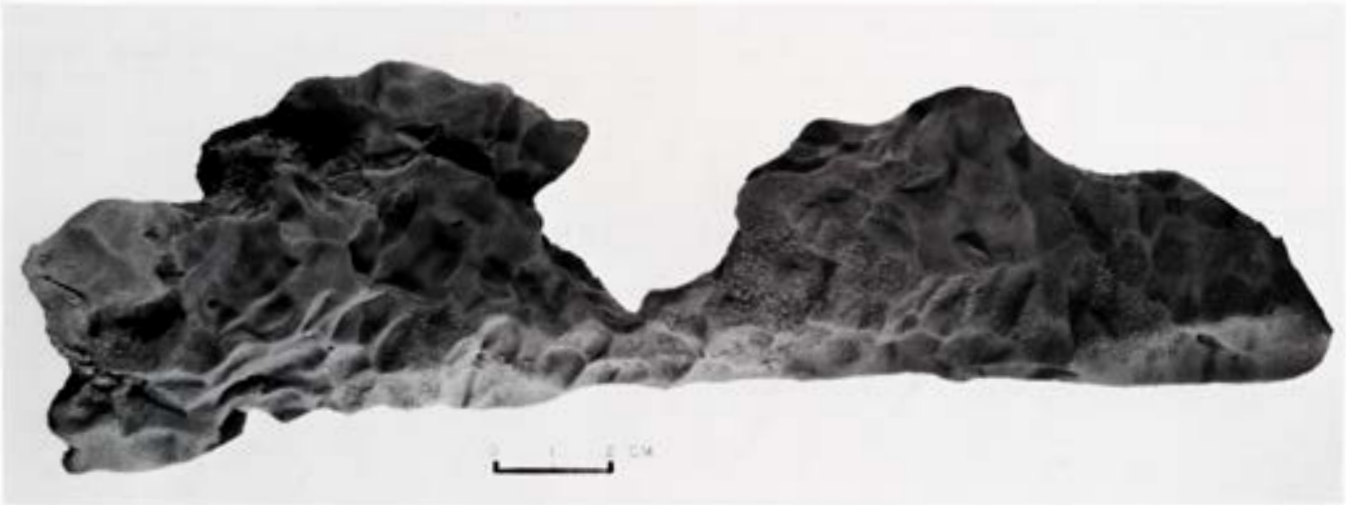

Figure 793. Glorieta Mountain (Chicago no. 997). An irregular fragment with small olivine inclusions. Smoked with NH_4Cl. Scale bar 2 cm. S.I. neg. M-89A.

HISTORY

The first three fragments of this important shower totaling about 190 kg, were found in 1884 by Charles Sponsler on the ranch of Mrs. Roival, near Canonçito, Santa Fé County. The three masses of 67, 52 and 24 kg (see the table) were found within a few meters of each other five miles (south) of Glorieta Mountain and three and one-half miles (west) of the Glorieta Post Office. These, and three additional fragments (Nos. 4-6) found 10-15 m from the larger blocks were thoroughly described with numerous drawings of the exterior shapes by Kunz (1885a,b; 1886a). A mass of 2.5 kg, which turned out to belong to the Glorieta Mountain shower (No. 8) had been independently described by Eakins (1885), and was mentioned by Kunz (1886a). Numerous additional fragments have been recovered by the local population, only some of them having found their way into the larger meteorite collections. The table lists the individual specimens known to the author and gives the references, the dimensions and the present locations. Also mentioned is the exterior shape, since this is often unusual and very characteristic for the Glorieta Mountain fragments.

Nininger (1940a; 1950) who, among others, conducted field work in the area, stated that the 8.2 kg mass (No. 15) was found protruding from the bank of a little arroyo (a dry stream bed) a few rods north of Sandoval's house, about a mile northeast of Canonçito. La Paz (1956) reported the discovery of a sword-to-club-shaped fragment (No. 25) on the Apache Canyon Ridge in a densely brushed area near Canonçito. It appears that most specimens have been found within an area about 4 x 1 km in size, and that the largest fragments came from the northern end (Nininger 1940a).

Two exceptions are the specimens which were described as Pojoaque (Brady 1931; Nininger 1933b) and Sante Fé (Henderson 1934), and which are still listed as separate meteorites by Hey (1966). Pojoaque (No. 12) is a 128 g fragment found in the ancient Indian pueblo of this name. It was found in a pottery bowl, and it has been suggested that its bright, worn exterior may be accounted for by assuming that it had long been carried in the pouch of a medicine man (Brady 1931). The ruin in which it was found is about 50 km northwest of Canonçito, but since the structure and the state of preservation correspond exactly to that of authentic Glorieta Mountain specimens, Pojoaque is, no doubt, a transported fragment.

Santa Fé (No. 13) which was purchased by the U.S. National Museum in 1930 from the finder, Mr. Paytiamo of Glorieta, was described by Henderson (1934) as an independent fall. It is one of the elongated, prismatic fragments so typical for the Glorieta shower. It was suggested by Nininger (1940a) and confirmed by Henderson (1941c) that it was, in fact, a Glorieta Mountain piece, which had been transported. The exterior morphology, the macro- and microstructure, a redetermined analysis and the general place of find all pointed to the same conclusion.

Figure 794. Glorieta Mountain (U.S.N.M. no. 905). Typical finger-shaped fragment from the atmospheric disruption. Well-preserved fusion crust. Smoked. Scale bar 30 mm. S.I. neg. M-67. See also Figure 35.

Figure 795. Glorieta Mountain. Left end of Figure 794. The fusion crust with spilled over metal and fused oxides is clearly seen. Smoked. Scale bar 10 mm. S.I. neg. M-67F.

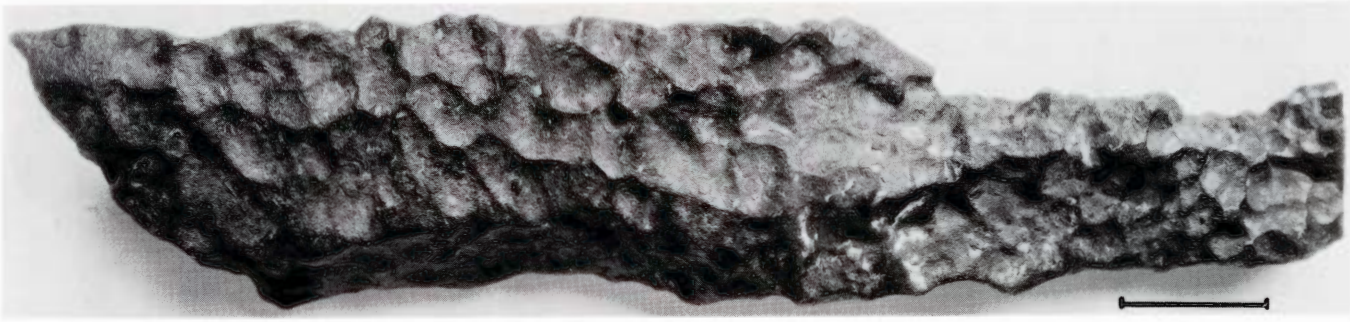

Figure 796. Glorieta Mountain (U.S.N.M. no. 846). Originally described as the independent meteorite Santa Fé, this 10.4 kg specimen is a typical fragment of the Glorieta Mountain shower. Scale bar 5 cm. S.I. neg. 19298-G.

Morphological and structural examinations have appeared in papers by Kunz (1886a: drawings), Brezina (1896: two photographs of the 52 kg mass), Vogel (1932: three photomicrographs), Beck et al. (1951a: 2 figures) and Feller-Kniepmeier & Uhlig (1961: microprobe study and micrographs). Additional photomacrographs and -micrographs will be found in Ward (1904a: plates 1 and 3), Henderson (1934), Nininger (1940a), Nininger & Nininger (1950: plate 17), Nininger (1952: plate 43), and La Paz (1956; 1965: plate 7).

Voshage (1967) found a cosmic ray exposure age of 230±70 million years, while Schultz & Hintenberger (1967) measured the amount of occluded, noble gases.

COLLECTIONS

Vienna (61 kg), New York (29.6 kg), Washington (11.6 kg), Paris (10.8 kg), Amherst (10 kg), Berlin (9.87 kg), Albuquerque (7.85 kg), Chicago (4.70 kg), Yale (3.73 kg), Leningrad (3.10 kg), London (2.67 kg), Dublin (2.1 kg), Harvard (1.23 kg), Vatican (1.00 kg), Tempe (500 g), Bonn (459 g), Sydney (416 g), Ottawa (407 g), Prague (296 g), Los Angeles (290 g), Copenhagen (240 g), Rome (235 g), Greifswald (215 g), Calcutta (204 g), Strasbourg (165 g), Bally (120 g), Sarajevo (117 g), Tübingen (114 g), Ann Arbor (86 g), Delft (30 g).

DESCRIPTION

The weights and dimensions will be found in the table. The three largest blocks are oriented individuals with fusion crust and regmaglypts on the primary faces, but with a hackly morphology and little or no fusion crust on the secondary faces. This is in harmony with a late breakup in the atmosphere, so late that these masses fell close together and relatively slowly in free fall so that no fusion crust could form on the latest formed surfaces. A little spill-over of metallic melts may be observed locally at the intersection of primary and secondary surfaces.

The three 1-kg specimens (Nos. 4-6) in Vienna are beautiful, ragged fragments very similar to the smaller fragments of the Sikhote Alin shower. The smaller fragments found up to a few kilometers away are fully covered with ablation-carved regmaglypts with quite distinct, angular facets and with a 0.1-0.5 mm thick magnetite fusion crust. The finger-shaped fragment (No. 14), which is remarkably well-preserved, was probably originally an elongated, four-sided, prismatic fragment, which was smoothed on the two, long rear sides and grooved on the two other long front sides during flight. On the 24 kg specimen, (No. 3) a finger-shaped depression, 15 cm long, 2.5 cm wide and 2 cm deep, clearly suggests from where

Figure 797. Glorieta Mountain (Nininger no. 52.11). A small fragment with smooth surfaces, fusion crust and cavities after ablated troilite. Smoked. Scale bar 10 mm. S.I. neg. M-87.

Table of Individuals from the Glorieta Mountain Shower

No.	Weight	Dimensions-cm	Remarks	Present Location	References
1	67.35 kg	39x30x22	Olivine present	Cut and distributed	Kunz 1886a; Brezina 1896
2	52.38 kg	41x24x16	Plastic deformation	Vienna	Kunz 1886a; Brezina 1896
3	24.26 kg	30x21x15	Deep fissure	New York no. 680	Kunz 1886a; Brezina 1896
4	1.20 kg	12.5x5x5	Fissure	Vienna	Kunz 1886a; Brezina 1896
5	1.13 kg	10x7.5x4.8		Vienna	Kunz 1886a; Brezina 1896
6	1.05 kg	12.5x8.2x4.5		Vienna	Kunz 1886a; Brezina 1896
7	about 1.5 kg	25x4x3	Finger-shaped	Vienna	Kunz 1886a; Brezina 1896
8	2.5 kg	12x8x4.5		London no. 62,350; Washington	Eakins 1885
9	359 g	12.5x4.7x3		Chicago no. 998	Ward 1900; 1904a
10	1.46 kg	21x6x3	Dumbbell, Olivine present	Chicago no. 997	Farrington 1916
11	2.57 kg	15.5x11.5x7	Olivine present	Denver	Hills 1914
12	128 g*		Pallasitic	Laboratory of Anthropology, Santa Fé	Brady 1931; Nininger 1940a
13	10.4 kg**	47x10x5	Club-shaped 1930	U.S. National Museum no. 846	Henderson 1934
14	290 g	15x2.5x1.5	Finger-shaped	U.S. National Museum no. 905	U.S. National Museum acquisition 1934
15	8.20 kg		Olivine present		Nininger 1940a; 1950
16-18	total 1 kg		Three small pallasites		Nininger 1940a; 1950
19	240 g	12x2.5x2.0	Finger-shaped	Copenhagen no. 1954.4	Nininger 1940a; 1950
20-23	total 1 kg		Four finger-shaped specimens		Nininger 1940a; 1950
24	1.70 kg	23x4x4	Prism	Albuquerque no. 1	Beck et al. 1951a
25	6.24 kg	63x5x5	"Sword"	Albuquerque no. 2	La Paz 1956
26	966 g	16x6x2	Two coherent fingers	New York no. 682	Mason 1964, p. 15
27	about 400 g	8x5x2	Oriented ear	Harvard no. 414c	Frondel 1965, p. 12
28	167 g	7x5x2	0.5-1 mm olivine crystals	Chicago no. 2,365	Horback & Olsen 1965, p. 226

*Originally described as Pojoaque. **Originally described as Santa Fé.

Σ 186.4

Σ N[illegible] 2 145 kg wrong

one such finger-shaped fragment was dislodged during flight. This same block is almost divided in two by a gapping fissure, 13 x 9 cm in area and up to 2 cm wide. The finders evidently attempted to break it completely, but lost two chisels the ends of which are still firmly squeezed in the crack.

While the magnetite crust is thin (0.1 mm), shiny-black and with hairlines on the front side and along the edges where some spill-over may be observed, it is thick (0.4 mm) and rippled-warty on the rear side in the pits. Locally straight grooves, e.g., 30 mm long, 1 mm wide and 1-2 mm deep, may be seen. They resemble chisel marks, but are, in fact, cavities produced by partial ablation-melting of the large schreibersite lamellae.

The large club (No. 13) is an elongated rhombohedron which is evenly pitted on all sides and may have been tumbling during its fall. It is interesting to note that the dimensions of the regmaglypts are roughly proportional to the size of the specimens: 0.3-1 cm in diameter on Nos. 14 and 27, 1.0-2.0 cm on Nos. 11 and 26, 1.2-2.5 cm on No. 13, and 2-5 cm in diameter on Nos. 1-3.

Etched sections display a beautiful Widmanstätten pattern with oriented sheen and with a large contrast between the primary kamacite lamellae (0.85±0.15 mm wide) and the later generations of lamellae and plessitic fields. The lamellae are slightly ragged in outlines and contain scattered 0.2-0.5 mm wide schreibersite bodies along the midline. The lamellae are straight, except near the surface where they may be distorted from the tensile-torsional rupture in the air, e.g., on U.S.N.M. no. 1033 and Vienna no. G 1791. The distorted Widmanstätten structure is quite certainly caused by the violent fragmentation in the air and is not formed, as commonly believed, when the masses hit the ground. The kamacite hardness increases to about 275 in these cold-worked areas.

The primary kamacite lamellae cover about 20% by area. They show Neumann bands and have a hardness of 164±8. Subgrain boundaries decorated with 1-10 μ thick rhabdites are common. The secondary lamellae occur in characteristic bundles, parallel to the primary ones and filling the interstices between them. Other interstices are filled with normal comb and net plessite, but the high proportion of taenite (HV 300±20) to kamacite is conspicuous and gives the plessite its characteristic appearance.

Figure 798. Glorieta Mountain (Harvard no. 414). An ear-shaped fragment with distinct regmaglypts on one side and smooth sculpture on the opposite side (not shown). Scale bar 3 cm.

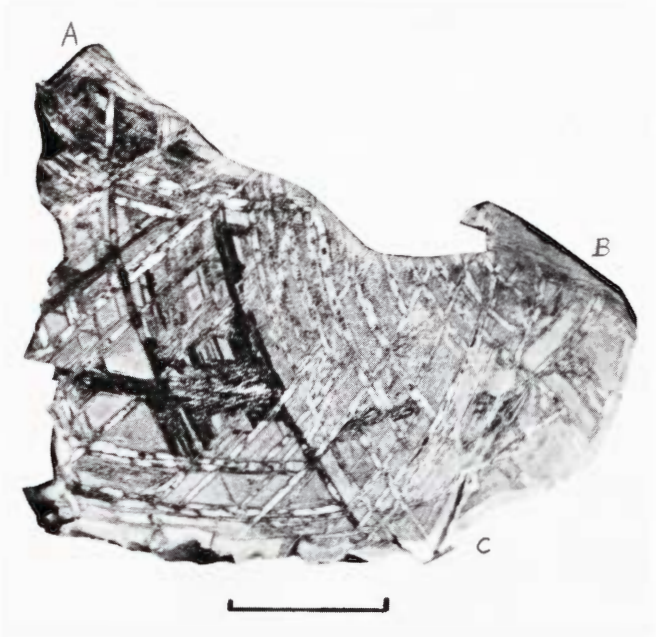

Figure 799. Glorieta Mountain (Vienna no. G 1791). Cross section through a violently deformed fragment. Heat-affected α_2 zone occurs along the edge ABC. The remaining surface is a hackly fracture surface, developed so late that atmospheric ablation was no longer active. Deep-etched. Scale bar 20 mm.

GLORIETA MOUNTAIN – SELECTED CHEMICAL ANALYSES

	percentage			ppm								
References	**Ni**	**Co**	**P**	**C**	**S**	**Cr**	**Cu**	**Zn**	**Ga**	**Ge**	**Ir**	**Pt**
Henderson 1941c	11.79	0.42	0.37		+							
Lovering et al. 1957		0.54				2.7	217		12	18		
Wasson & Kimberlin 1967	12.04								13.4	11.1	0.014	
Smales et al. 1967					<5	6.4	248	<1	14.2	10.9		
Crocket 1972											0.010	

Mason (1963) examined the olivine of Glorieta Mountain and Pojoaque and found them identical, containing 13 mole percent fayalite, Fe_2SiO_4.

Martensitic plessite (HV 400±30) with plates parallel to $(111)_\gamma$ gradually merges with duplex $\alpha + \gamma$ fields of various finenesses, the finest looking as "black taenite." Their hardness range is 225-325.

Schreibersite occurs as large, 10-100 mm long and 1 mm wide lamellae surrounded by 1-2 mm wide rims of swathing kamacite, and as 0.2-0.5 mm wide crystals centrally in the α-lamellae. The schreibersite is monocrystalline and slightly fractured and has a hardness of 890±30. Schreibersite also occurs as 10-50 μ wide grain boundary precipitates and 2-50 μ irregular blebs inside the plessite fields. Rhabdites are numerous as 1-15 μ thick prisms in the wider kamacite lamellae.

Troilite occurs as scattered nodules and elongated bodies 2-20 mm in diameter. The larger ones are enveloped in irregular 1-2 mm wide schreibersite rims which have nucleated 1-2 mm wide rims of swathing kamacite. At least the smaller troilite bodies are shock-melted, polycrystalline mosaics of 2-10 μ wide grains. None of the larger nodules could be examined in polished section.

According to Kunz (1886a), who was a jeweler associated with Tiffany's, the olivines isolated from No. 1 were perfect, transparent crystals of gem quality. Mason (1963) found 13% fayalite. The olivine occurs in small, millimeter-sized clusters associated with troilite, and they are yellowish-green to olive-green. Quite locally, e.g., on New York no. 684, they form large, angular crystals 5-20 mm across. Such metal-olivine parts assume a pallasitic character, but they are apparently rare.

The fusion crust is well-preserved on numerous specimens as a layered zone of varying thickness, e.g., 300 μ dendritic metal (4 laminae) overlain by 50 μ magnetite. The heat-affected α_2 zone stretches 1.7-2.4 mm inwards, and in half this distance micromelted phosphides are present. The hardness is 210±15 (hardness curve type III). Some slight corrosion is present in the surface zones, but, on the whole, Glorieta Mountain is very little altered, and the best specimens still show the black, shiny magnetite crust.

Glorieta Mountain is an anomalous, medium octahedrite with a few olivine inclusions. Specimens of a pallasitic appearance have been reported, but they are rare. The meteorite is related to Brenham and other pallasites. Its low hardness indicates a rather thorough, low temperature cosmic annealing.

Specimens in the U.S. National Museum in Washington

380 g part slice (no. 47, 12 x 6 x 0.7 cm)
56 g endpiece (no. 115, 6.5 x 2.5 x 0.8 cm; from No. 8 Pearce 1888)
9,318 g main mass of "Santa Fé" (no. 846, 36 x 10 x 5 cm)
408 g various slices from "Santa Fé," some heat-treated (no. 846)
293 g complete finger-shaped individual (no. 905, 15 x 2.5 x 1.5 cm)
752 g part slice (no. 1033, 15 x 9 x 0.8 cm)
106 g various small slices and millings (no. 67, 1033, 1443, 2800)
292 g bar, forged in the Smithsonian Institution (no. 846, 12 x 1.8 x 1.8 cm)

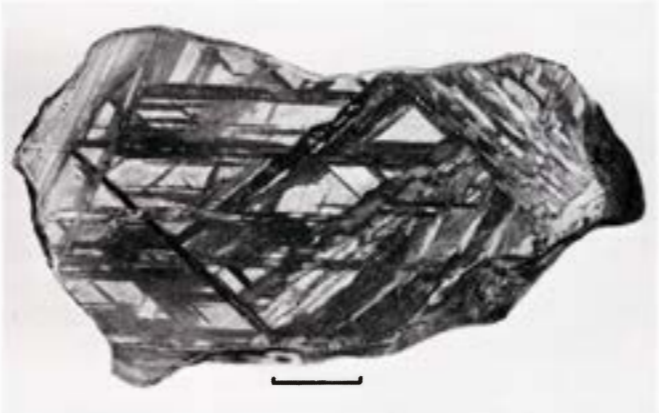

Figure 800. Glorieta Mountain (U.S.N.M. no 846). Cross section of the club, Figure 796. Deep-etched. Scale bar 10 mm. S.I. neg. 43508.

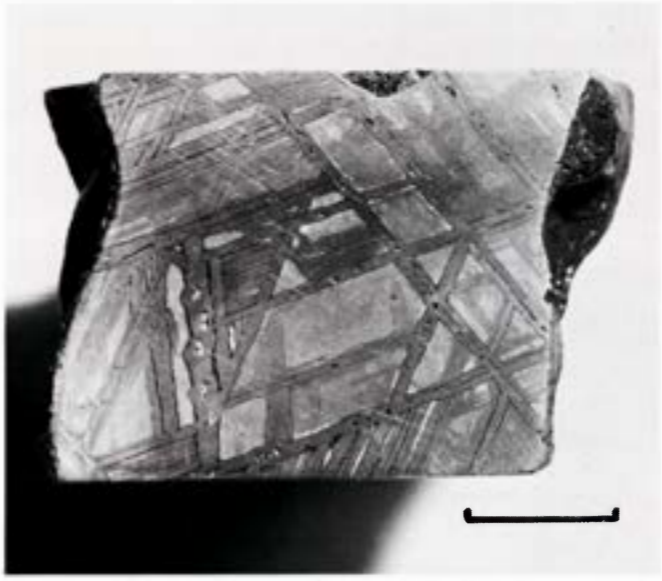

Figure 801. Glorieta Mountain (U.S.N.M. no. 846). Another section through Figure 796. Schreibersite crystals occur as angular blebs centrally in many kamacite lamellae. Deep-etched. Scale bar 10 mm. S.I. neg 43545.

Goose Lake, California, U.S.A.

41°58.6′N, 120°32.5′W; 1,500 m

Medium octahedrite, Om. Bandwidth 1.25±0.15 mm. Neumann bands. HV 155±10.

Anomalous. Group I. 8.28% Ni, 0.47% Co, 0.4% P, 67 ppm Ga, 298 ppm Ge, 2.3 ppm Ir.

HISTORY

A mass of 1,167 kg (2,573 pounds) was found on October 13, 1938, by Joseph Secco, C.A. Schmidt and Ira Iverson, of Oakland, California, while hunting deer west of Goose Lake, in Modoc County only a few kilometers south of the Oregon State Line (Leonard 1939a,b). The meteorite was exposed on the surface of rough lava beds in the Modoc National Forest at an altitude of about 1500 m. The lava