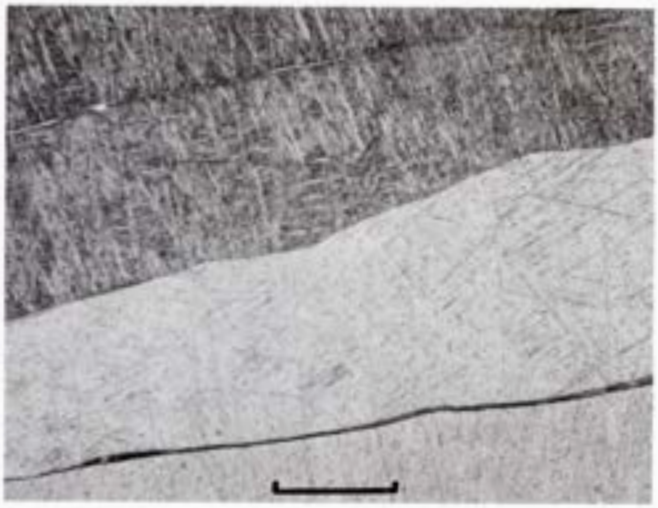

Figure 368. Boxhole (U.S.N.M. no. 1305). Typical kamacite lamellae with shock-hatched structures of varying appearance but similar hardness. Narrow, cloudy taenite lamellae. Etched. Scale bar 300 μ.

plessite and taenite areas, where a 50 μ rim zone is completely transformed to martensitic-bainitic structures. The heat-altered matrix ranges in hardness irregularly from 120 to 180; the structure and the hardness indicate that the slugs were reheated as a whole; there are no regular gradients against the present surfaces. Schreibersite is melted but has not had time to dissolve the surrounding walls and create a smooth, round cavity. The rhabdites are melted and partly resorbed in the matrix. The troilite is melted and injected into centimeter-long narrow cracks, more or less parallel to (111) planes. Upon solidification, fine-grained eutectics and mixtures with iron were created. The structures described here correspond closely to structures described from highly shocked Canyon Diablo specimens and from Henbury specimens, and they were probably caused by the compression and heating when the explosion shock shattered the impacting mass. The residual temperature must for a few seconds have been above 1000° C to create the observed associations of α_2, melted schreibersite and melted troilite.

Summing up, we can thus conclude that about 5,000 years ago a large iron body penetrated the atmosphere with no appreciable loss of speed. At high altitude a minor part of the surface, probably protuberances and other irregularities, were torn off and proceeded as independently falling bodies. The main mass exploded on impact, created the crater and hurled numerous fragments up to a few kilometers away. The major part of the main mass probably vaporized or was disseminated as minute melted globules. It appears that the event was rather similar, on a minor scale, to what occurred at Henbury, Wabar and Canyon Diablo.

The least damaged Boxhole specimens, those that fell as rather normal independent irons, indicate that the preatmospheric structure was a shock-hardened medium octahedrite with ε-structure. The detailed chemical composition, the ε-structure and the somewhat higher phosphide content seem to establish Boxhole as a meteorite different from Henbury. It is, however, related to Henbury, as well as to the smaller meteorites, Red River, San Angelo and Canyon City.

The reheated and distorted slugs are structurally similar to explosion fragments from Canyon Diablo, Henbury and Wabar.

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

2,109 g full slice (no. 1305, 18 x 13 x 1.5 cm)
3,700 g individual (no. 1305, 17 x 17 x 6 cm)
208 g fragments (no. 1305)
53 g individual (no. 1638)
431 g 37 individuals (no. 3227)
373 g 4 shale balls (no. 1306)
472 g 6 shale balls (no. 3228-29) no. 3227-29 collected by E.P. Henderson and Brian Mason 1963 (personal communication).

Braunau, Bohemia, Czechoslovakia
50°36'N, 16°20'E

Hexahedrite, H. Single crystal larger than 25 cm. Neumann bands. HV 155±10.

Group IIA. 5.39% Ni, 0.44% Co, 0.24% P, 0.08% S, 59 ppm Ga, 183 ppm Ge, 12 ppm Ir.

HISTORY

At 3:45 on the morning of July 14, 1847, people were awakened by the sound of loud detonations which roused them out of their houses in several villages in the Sudeten Mountains near the Braunau Benedictine Abbey. The detonations were also heard in Münsterberg 50 km east, and in Breslau, 75 km northeast of Braunau, and probably even farther away. Two fiery masses were observed to fall near the town of Braunau, while a blackish meteoric train slowly dissipated on the northwestern sky. One mass of 23.6 kg was recovered from a vertical hole 0.9 m deep in a meadow, and another of 17.2 kg penetrated the roof of a small cabin where three children were sleeping, about 2,200 m farther south. A detailed account with map and sketches was given by Beinert (1847; 1848). The

Figure 369. Braunau. The endpiece in Tübingen shows the distinct regmaglypts. Scale bar in cm.

Braunau meteorite was only the third iron observed to fall, and because the larger mass was cut and rapidly distributed to leading authorities, it meant a decisive step forward in understanding iron meteorites.

Neumann (1848; 1850) described etched surfaces and measured the traces appearing on the cut faces. He found the traces, which were later named after him, to be twin lamellae in the cubic ferrite. Today we know that the Neumann bands are deformation twins in the α-phase produced by shocks below 130 k bar, and that the twin plane is $\{211\}_{\alpha}$, corresponding to the icositetrahedron (= trapezohedron). Haidinger (1847) observed that the whole mass was one ductile crystal which would easily split along the cubic cleavage planes with a blow from a hammer. Tschermak (1872a; 1874) proposed the term hexahedrites for such irons. Rose (1864a: 48, 138) described and illustrated, with a beautiful technique, the fine tetragonal needles of iron-nickel phosphide and proposed the name rhabdite for them. Reichenbach (1858) observed and described the heated rim zone and compared it to that of the other then-known falls, Charlotte and Hraschina. Cohen (1905) reviewed the literature and appended an analysis.

Böggild (1927) measured the rhabdites on the goniometer, and Perry (1944) and Vogel (1952) gave photomicrographs. Marvin (1963) identified wüstite coexisting with magnetite in the fusion crust. This was surprising, as wüstite was believed to decompose rapidly in a terrestrial environment. El Goresy (1965) observed chromium sulfide in Braunau, and saw in the microcrystalline troilite an indication of cosmic reheating. Reed (1965a, b) determined the composition of the kamacite and phosphide phases with a microprobe. Age determinations have been carried out by Cobb (1966) and Chang & Wänke (1969), who found low cosmic ray exposure ages of the order of 7×10^6 years.

COLLECTIONS

The smaller mass of 17.2 kg, previously in the abbey of Braunau, is now in the National Museum, Prague, which also has 1,085 g samples of the larger mass (Tuček 1966: 21 and plate 3), Vienna (2.45 kg), Berlin (1.48 kg), Tübingen (915 g), Munich (590 g), London (551 g), Chicago (465 g), Paris (430 g), Washington (237 g), Moscow (236 g), Dresden (235 g), New York (222 g), Budapest (200 g, lost in 1956 ?), Göttingen (160 g), Calcutta (156 g), Copenhagen (117 g), Canberra (116 g), Leningrad (110 g), Breslau (96 g), Harvard (92 g), Bonn (91 g) Hamburg (47 g), Amherst (40 g), Tempe (26 g). Small pieces are also to be found in other collections.

DESCRIPTION

The weights in modern units of the two recovered masses are 23.8 kg and 17.2 kg, with the dimensions of 25 x 25 x 13 cm and 23 x 21 x 14 cm. Beinert (1848) described the masses as spherical segments; from his unsuccesful attempts to reconstruct the parent mass he concluded that two more fragments of similar sizes had also fallen but had not been found. It is, however, also possible that the two individuals were formed at sufficient altitude to become deeply ablated and grooved, whereby the original parting surface, presumably a $\{100\}$ cleavage plane, became unrecognizable.

The surfaces are heavily sculptured and subdivided in grooves, each about 2-4 cm in diameter and 5-15 mm deep. The fused crust has striae and streamers and spill-overs on edges. The sections show that a 100-200 μ thick magnetite-wüstite crust, often composed of five to eight successive layers, may be deposited either directly on the metallic meteorite or, more commonly, may be formed over one to six layers of dendritic, fused metal, totalling 50-200 μ. The microhardness is 300-350.

The heat-affected α_2 zone extends 2-3 mm below the crust, and the included rhabdites are melted within half this distance. As usual, the solidification of the small inclusions started from the cold interior which acted as a heat sink. This may be concluded from the observation that the primary dendrites line the rhabdite cavities, particularly on the inward side. The microhardness of the α_2 zone is

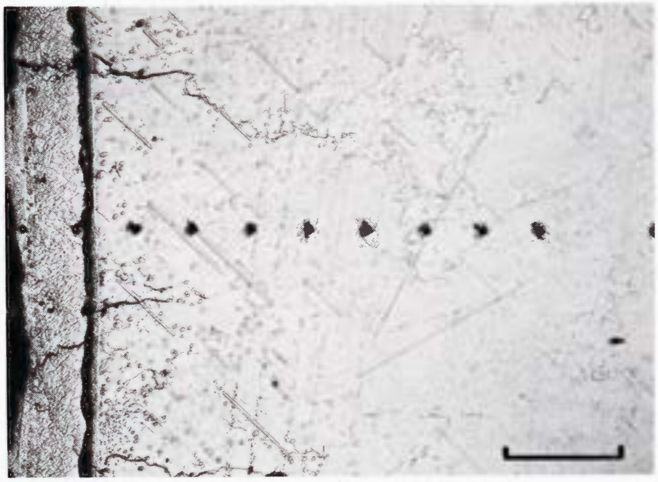

Figure 370. Braunau (U.S.N.M. no. 976). The metallic fusion crust, to the left, is spalling off along the interface with the heat-affected α_2 zone. A row of microhardness indentations is visible. The precipitates in several, almost vertical lines, indicate the site of previous Neumann bands. Etched. Scale bar 300 μ.

BRAUNAU – SELECTED CHEMICAL ANALYSES

	percentage			ppm								
References	Ni	Co	P	C	S	Cr	Cu	Zn	Ga	Ge	Ir	Pt
Duflos & Fischer 1848	5.52	0.53										
Knauer in Cohen 1905	5.21	0.92	0.24	900	800	500	700					
Cobb 1967	5.32	0.44					131		56.5		11	
Wasson 1969	5.49								61.5	183	12	

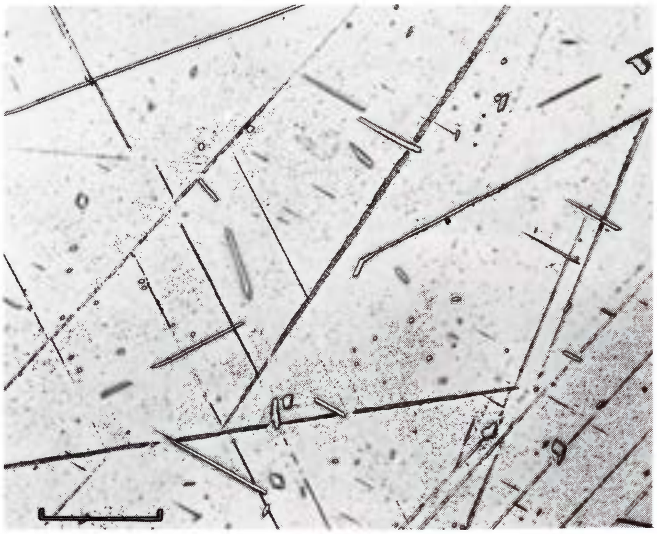

Figure 371. Braunau (U.S.N.M. no. 976). Decorated Neumann bands and plate-shaped and prismatic rhabdites. Etched. Scale bar 200 μ.

unusually low, 165±10. Neumann bands are still visible in the α_2 zone because the many rhabdites which earlier had precipitated here still mark their directions.

At an early stage in the analysis it was shown that Braunau is one large cubic ferrite crystal. The microhardness is 155±10, indicating a rather well-annealed ferrite. Neumann bands extend from rim to rim, but each band is often discontinuous and decorated along both sides with a number of 2-5 μ thick rhabdites. On several specimens of this meteorite it is evident that plate-shaped rhabdites, up to 2 mm long, are arranged in parallel planes with a mutual distance of about 1 cm, as in Hex River. Furthermore, in the matrix there is a profusion of rhabdites smaller than 1 μ across.

Troilite is present as 1-10 mm irregular nodules. They are fine-grained and complex in that they are apparently rapidly solidified melts produced by shock. Larger 10-20 μ partly dissolved fragments of daubreelite and schreibersite are trapped in the 1-2 μ polycrystalline sulfide-metal eutectic. The sulfide eutectic also penetrates the grain boundaries of the surrounding metal, creating a 25-50 μ network. Similar development of the troilite nodules is observed in a great many other meteorites, e.g., see Bingera, Bodaibo, and Wabar.

Braunau is a normal, monocrystalline hexahedrite, structurally resembling Coahuila, and with indications of a cosmic, mild reheating.

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

7 g irregular, hammered fragment (no. 49, 2 x 1 x 1 cm)
14 g polished section (no. 976)
68 g part slice (no. 1579, 3.5 x 2 x 1.5 cm)
148 g part slice (no. 3401, 8 x 6 x 0.5 cm)

Breece. See Grant

Brenham, Kiowa County, Kansas, U.S.A.

Although Brenham is a very important meteorite, it is not treated in this monograph because it is a pallasite. Brief mention and a few references will, however, be found under Hopewell Mounds which represents transported Brenham material.

Bridgewater, North Carolina, U.S.A.

35°43′N, 81°52′W; 300 m

Medium octahedrite, Om. Bandwidth 0.65±0.15 mm. ϵ-structure. HV 270±25.

Group IID. 9.9% Ni, 0.35% P, 81 ppm Ga, 82 ppm Ge, 10 ppm Ir.

HISTORY

A mass of 29 pounds (13.2 kg) was found in 1890 during plowing; the locality was 3 km from Bridgewater Station in the western part of Burke County, near the Mc Dowell County line. Since the direction from Bridgewater is not stated, the coordinates above are for Bridgewater. The mass was easily broken into two pieces by the finders who assumed it was silver. It was acquired by Kunz (1890a) who described it, and soon thereafter it came to Vienna with part of Kunz's collections (Brezina 1896: 234, 271). It was again described by Cohen (1905: 381), and photographs were presented by Vogel (1928; 1932).

COLLECTIONS

The smaller of the two broken pieces, 4.5 kg, and half of the larger piece, 4 kg, are in Vienna. The rest has been cut and distributed. Budapest (537 g) Prague (168 g), Helsinki (150 g), New York (156 g), Berlin (141 g), Chicago (102 g), Rome (92 g) Stockholm (67 g), Washington (54 g), London (51 g), Ottawa (42 g), Delft (about 30 g), Yale (19 g), Vatican (17 g).

BRIDGEWATER – SELECTED CHEMICAL ANALYSES

	percentage			ppm								
References	Ni	Co	P	C	S	Cr	Cu	Zn	Ga	Ge	Ir	Pt
Venable in Kunz 1890a	9.94	0.76	0.35									
Wasson 1970, pers. comm.	9.8								81.0	82.0	10	