

Figure 1557. Savannah. Detail of Figure 1556. The parent austenite crystals on either side of the boundary, A-B has given rise to independent Widmanstätten patterns. Black patches are due to corrosion and imperfect polishing. Deep-etched. Scale bar 20 mm. S.F. neg. 24940b.

Scherz. See Canyon Diablo (Scherz)

Schwetz, Kwidzyn, Poland

53°24'N, 18°27'E; 50 m

Medium octahedrite, Om. Bandwidth 1.00±0.15 mm. Deformed Neumann bands. HV 220±30.

Group IIIA. 7.44% Ni, about 0.09% P, 18.3 ppm Ga, 33.5 ppm Ge, 11 ppm Ir.

HISTORY

A mass of about 43 pounds (Berlin-pounds of 500 g) was found in the spring of 1850 by workmen engaged in excavating a sand hill on the East Railroad line. The locality is on the left bank of the Schwarzwasser Creek near Schwetz an der Weichsel; the coordinates are given above. Today the place is a part of Poland, and the proper name is Swiecie, under which entry the meteorite is listed in several East European collections. The mass was uncovered about 1.2 m below the surface at the transition from sand to a

sandy clay. It was corroded so much along the Widmanstätten planes that it could be divided on the spot into three pieces. All the fragments were acquired for the Berlin Museum, where the meteorite was described by Rose (1851; 1864a: 59).

The meteorite was sliced and distributed, and many brief notes appeared in the nineteenth century, see Wülfing (1897: 312). Cohen (1891: 147; 1892: 148 and 1894: 111) provided the best analyses available, but otherwise few good descriptions appear to have been published. Pokrzywnicki (1964: 114) reviewed the literature briefly. Voshage (1967) found too small a $^{40}\text{K}/^{41}\text{K}$ concentration for a cosmic ray age determination.

COLLECTIONS

Berlin (one 5 kg piece and 4.7 kg slices and fragments), London (1,060 g), Vienna (840 g), Tübingen (689 g), Budapest (582 g), Warsaw (534 g), Amherst (532 g), Copenhagen (334 g), Göttingen (303 g), Yale (257 g), Münster (205 g), Calcutta (172 g), Washington (165 g), Dorpat (162 g), Madrid (152 g), Rome (119 g), Chicago (91 g), Leningrad

(70 g), Paris (62 g), Bonn (54 g), Harvard (32 g), Stockholm (18 g). Small slices are also in several other collections.

DESCRIPTION

The larger specimens in present collections are almost all deep-etched sections prepared generations ago. From these one obtains only the following general information: (i) the meteorite is weathered and penetrated by corroded grain boundaries; (ii) the kamacite lamellae are slightly undulating; (iii) the amount of accessory minerals is low.

The specimens in the U.S. National Museum are small splinters and corroded fragments with little preserved of the original surface. There is, however, a hardness decrease towards the exterior corroded surface – from about 225 in the interior to 200 ± 10 at the surface – indicating that perhaps 3-4 mm have been lost by terrestrial corrosion. The heat-affected α_2 zone is lacking.

Schwetz is a medium octahedrite with somewhat undulating, long ($\frac{l}{W} \sim 25$) kamacite lamellae with a width of 1.00 ± 0.15 mm. The kamacite shows lenticular deformation lamellae, and the Neumann bands are distorted as is the Widmanstätten structure itself. The hardness ranges from 185 to 255, reflecting the various degrees of cold-deformation. This range is encountered within a small section 2×2 cm in size; perhaps a still larger range will be found on larger sections. Subboundaries are common and are decorated with 1μ thick rhabdites.

Taenite and plessite cover about 40% by area. The comb and net plessite fields are almost resorbed and have discontinuous taenite borders. The larger taenite ribbons frequently show martensitic transition zones to a poorly resolvable duplex $\alpha + \gamma$ interior. The corresponding hardness sequence is 350 ± 20 (taenite border), 450 ± 50 (martensite) and 300 ± 40 (duplex interior). It is remarkable that the acicular martensite variety attains peak hardnesses of 500.

Schreibersite is only present as $2-10 \mu$ wide grain boundary precipitates and as $2-10 \mu$ blebs inside the plessite fields. Rhabdites occur in some grains as $1-2 \mu$ tetragonal prisms. The troilite bodies exhibit a few $10-20 \mu$ thick, but discontinuous, schreibersite rims. Evidently the bulk phosphorus content of Schwetz is quite low; it may be estimated to be $0.09 \pm 0.02\%$ P.

The hard lamellar carlsbergite described as found in Cape York, Costilla Peak and other irons, is abundant. Typically it forms $50 \times 20 \times 1 \mu$ oriented plates which are distorted due to late cosmic deformation. The platelets occur with a frequency of about 35 per mm^2 in the kamacite phase. Occasionally the platelets are enveloped in late schreibersite precipitates.

Troilite occurs as scattered rhombic and lenticular bodies, $0.5-3$ mm across. Larger bodies are probably present in larger sections. The troilite is polycrystalline due to shock-transformation. The crystals range from $5-100 \mu$ in size and appear as irregular fringed units. Near interfaces the shock intensity was sufficient to micromelt the troilite; this resulted in fine eutectics ($\sim 1 \mu$) of metal and sulfide with dispersed fragments of daubreelite.

Daubreelite occurs as parallel, $10-200 \mu$ thick lamellae in the troilite. The larger troilite nodules have relatively little daubreelite, but the smaller nodules show considerably more than 50%. Daubreelite also occurs as individual $20-100 \mu$ crystals in the kamacite. This daubreelite is often intercalated by $1-5 \mu$ wide parallel kamacite lamellae.

In one place a rather unusual texture was observed. Several small troilite-daubreelite bodies, each $20-50 \mu$ across, were situated inside an open net plessite field. They were partially shock-melted, but it appeared that they still occupied their original positions and had not been injected into the plessite by shock. Otherwise, troilite appears exclusively within kamacite.

Schwetz is a shocked medium octahedrite, related to Davis Mountain, Costilla Peak and Red River. It is a normal member of the resolved chemical group IIIA.

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

11 g splinters (no. 1135, $2 \times 2 \times 0.4$ cm)
153 g corroded part slice (no. 3254, $6 \times 5 \times 0.8$ cm)

Scottsville, Kentucky, U.S.A.

$36^\circ 46'N, 86^\circ 10'W; 200$ m

Hexahedrite, H. Single crystal larger than 15 cm. Decorated Neumann bands. HV 200 ± 25 .

Group IIA. 5.40% Ni, 0.45% Co, 0.21% P, 60 ppm Ga, 172 ppm Ge, 49 ppm Ir.

HISTORY

A mass weighing a little more than 10 kg was found in 1867 by J.H. More, while he was hoeing tobacco near Scottsville, Allen County. The meteorite was acquired by Ward's Natural Science Establishment, which made a cast of it before it was sectioned into numerous slices (Ward 1892: 10, 41). It was described by Whitfield (1887) who compared the structure to that of Scriba and Salt River. Scriba was, however, shown by Cohen (1898d) to be an artificial product, and Salt River is an artificially heat-treated meteorite of a very different composition, so exactly why Whitfield compared Scottsville to these masses is not easy to understand.

SCHWETZ – SELECTED CHEMICAL ANALYSES

Reference	percentage			C	S	Cr	Cu	ppm				Pt
	Ni	Co	P					Zn	Ga	Ge	Ir	
Scott et al. 1973	7.44								18.3	33.5	11	

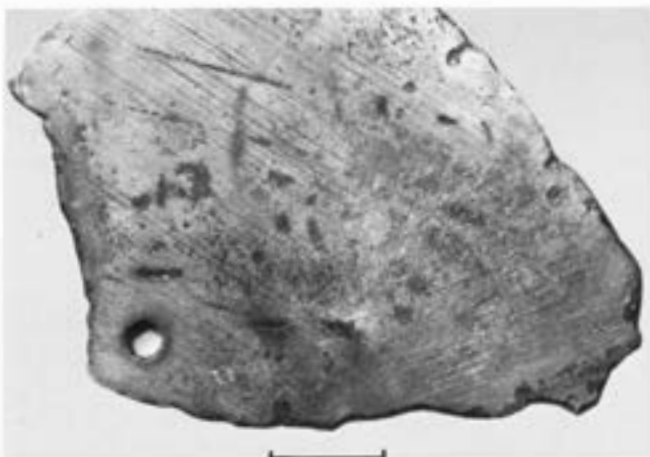


Figure 1558. Scottsville (Vienna no. D8449). A 3 mm thick slice. Dark and light shaded areas alternate according to the density and size of the rhabdites. Shock-melted troilite nodules appear black. Deep-etched. Scale bar 30 mm.

Huntington (1888) correctly observed the similarity to Coahuila and a few North American meteorites, and the following year he proposed

“that at some remote period an enormous iron meteorite may have passed over the entire breadth of the United States, the main mass reaching Mexico, but large fragments breaking off and falling during its passage across the country.”

An event of this kind is entirely hypothetical; no documented falls have ever covered more than about 100 km in length. The recent fall of the Allende carbonaceous chondrite covered a strewnfield of 50 x 10 km² (Clarke et al. 1971a), and other falls such as Saratov (Kulik 1922) *perhaps* extended along a 130 km long line. Gibeon (See the Supplement) apparently covered a still larger area, but a final decision must wait for more field work to be conducted. Quite apart from the physical validity of a hypothesis like Huntington's, it can be said with confidence that Scottsville and Coahuila in detailed composition and structure are too different to constitute one fall.

Cohen (1905) gave a good description, and Wülfing (1897) and Farrington (1915) reviewed the older literature. Böggild (1927) examined the rhabdites and concluded that two kinds were present. One type was plate-shaped, large and oriented parallel to (100) and (221). The other type consisted of slender tetragonal prisms with their c-axis parallel to the cube axes of the kamacite and their faces parallel to the (210) face of the kamacite. Perry (1944) presented two photomicrographs, and Buchwald (1967a) gave a full description with five photomicrographs.

COLLECTIONS

Vienna (1,570 g), Chicago (1,481 g), Washington (1,042 g), Harvard (535 g), New York (533 g), Vatican (490 g), Budapest (481 g), London (404 g), Prague (111 g), Yale (85 g), Copenhagen (74 g), Berlin (72 g), Bonn (57 g), Paris (49 g), Rome (39 g), Strasbourg (24 g), Ottawa (20 g).

DESCRIPTION

According to Whitfield (1887), the meteorite was wedge-shaped, the thickness at base being 14 cm, width 18 cm, and length 16 cm.

The larger pieces extant, for example Vienna No. D8449 of about 500 g and Chicago No. 1043 of 1,085 g, show that the mass is corroded and pitted. The pits are generally 5-10 mm across and about 1 mm deep. Other pits are up to 10 mm deep and covered by adhering oxide-shales. It appears that the regmaglypts are weathered away and that the surface is significantly altered due to corrosion.

Etched sections confirm this observation. The fusion crust and the heat-affected α_2 zone are lost. The oxide-shales reach a thickness of 5 mm in places, and corrosion penetrates locally several centimeters into the interior along plane cracks. These appear to be cubic cleavage cracks similar to those observed in, e.g., North Chile and Edmonton (Canada). Some specimens show exterior flattened regions, 2-5 cm across, which are due to a sledge hammer. The human effort was not responsible for the typical cubic cracks which are preatmospheric and now corroded, however.

Scottsville is a hexahedrite. Neumann bands extend across the sections in numerous directions. Patches of bright and frosty kamacite alternate as is common in hexahedrites. A few conspicuous troilite nodules, 2-20 mm across, constitute the nonmetallic constituents, while smaller phosphides may be seen aligned in one direction.

High magnification reveals that the bright kamacite is a rather clear type in which somewhat rounded rhabdites, 6-10 μ across, are dispersed. The frosty kamacite on the other hand is very rich in almost submicroscopic (< 1 μ) rhabdite particles. The kamacite has subboundaries forming a network of elongated cells, 5-10 μ across; these boundaries are particularly well observed in the frosty areas, presumably because they are here decorated by minute phosphides.

The Neumann bands exist in profusion. They all appear to have suffered some modification from gentle reheating,

SCOTTSVILLE – SELECTED CHEMICAL ANALYSES

References	percentage			C	S	Cr	Cu	ppm Zn	Ga	Ge	Ir	Pt
	Ni	Co	P									
Lovering et al. 1957		0.47				43	113		58	132		
Wasson 1969	5.31								60.4	172	49	
Moore et al. 1969	5.50	0.44	0.21	75	70		155					

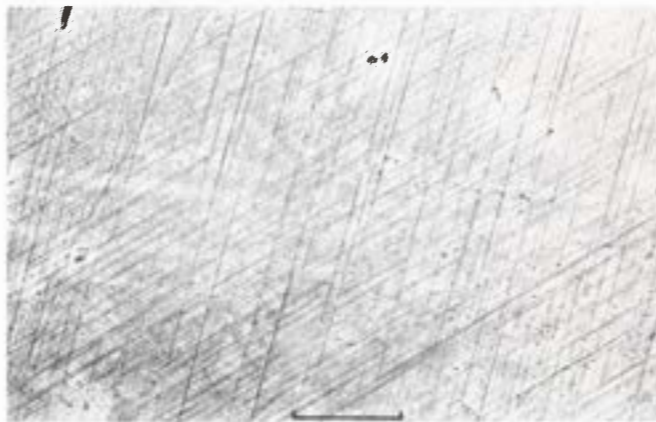


Figure 1559. Scottsville (Copenhagen no. 1891, 54). Hexahedrite of group IIA. Several sets of Neumann bands cross the entire sample. The almost horizontal one is heavily decorated with rhabdites. Black denotes larger phosphides. Etched. Scale bar 3 mm. See also Figure 66.

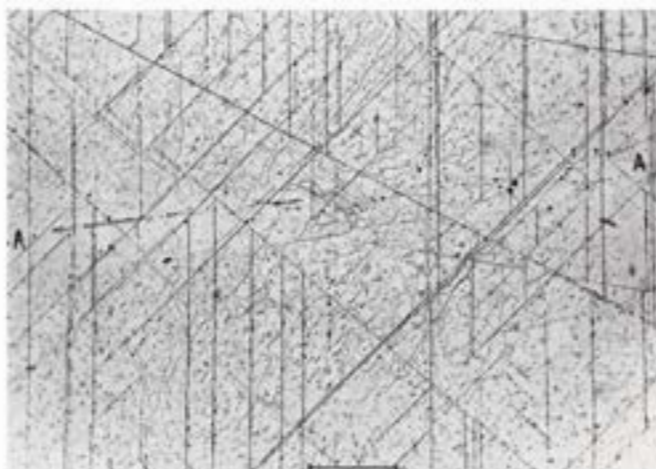


Figure 1560. Scottsville. Detail of Figure 1559 showing one of the decorated Neumann bands, A-A. Subboundaries are prominent in the kamacite. Etched. Scale bar 300 μ .

since their edges are very straight. However, no recrystallization has taken place. Two sets of Neumann bands have acted as nucleation sites for rhabdites. Small rhabdites of the prismatic type, about 1-8 μ across, have precipitated here and form almost continuous rows of slender prisms oriented in the 12 possible directions of the (210) planes. In many places the Neumann bands themselves have disappeared, and only the rhabdites which are arranged in exact lines remain.

The microhardness of the kamacite varies considerably from section to section. Typical hardness values are 195 ± 10 , but the range is from 170 to 230. The significant scatter is apparently due to slight variations in nickel and phosphorus in solid solution and to different degrees of cold working by some cosmic event. Annealing effects were not detected, and artificial reheating has not occurred.

Schreibersite is present as 0.2-1 mm wide rims around some of the troilite nodules and also as clusters of irregular bodies 0.05-0.2 mm in size. The plate-shaped rhabdites are

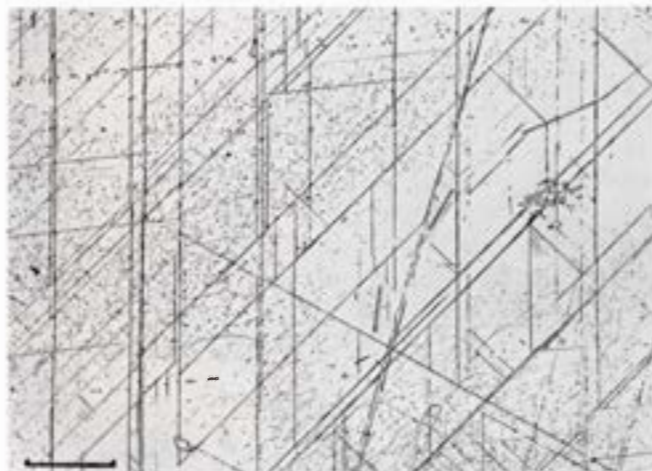


Figure 1561. Scottsville. Detail of Figure 1559 showing clusters of rhabdites within clear P- and Ni-depleted kamacite. Decorated Neumann band at top. Etched. Scale bar 300 μ .

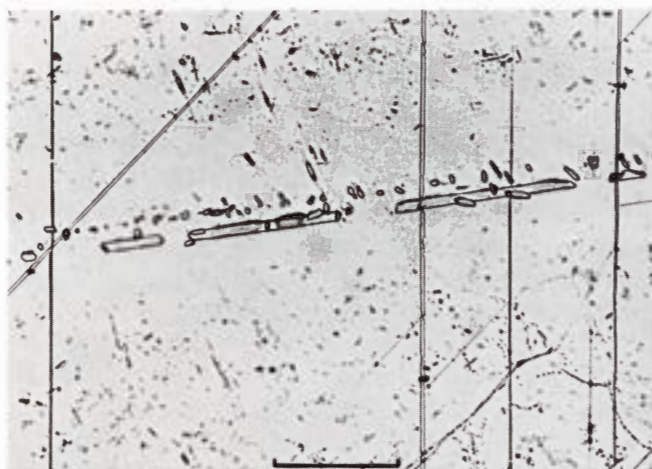


Figure 1562. Scottsville (Copenhagen no. 1891, 54). The decorated Neumann bands are partially annealed out. Each particle is a small rhabdite crystal. Etched. Scale bar 100 μ .

typically 500 x 500 x 3 μ in size, while the prismatic ones are 5-10 μ across. Finally, there are the microrhabdites which are less than 1 μ and occur in large numbers. The bulk phosphorus content is estimated to be $0.20 \pm 0.02\%$, in accordance with the wet chemical analysis.

Troilite forms conspicuous nodules 5-20 mm in cross section. It also occurs as lenticular bodies, 2 x 0.5 mm, that radiate away from some of the larger nodules. Remnants of 0.1-0.4 mm wide daubreelite lamellae are vaguely discernible inside the nodules. All troilite has been shock-melted. It has dissolved part of the adjacent kamacite and invaded and shattered coexisting schreibersite and daubreelite. The nodules are now intricate intergrowths of eutectic Fe-FeS with 2-5 μ daubreelite blebs and subangular schreibersite fragments. There is a macroscopically visible alternation of bright patches, rich in iron, and dull patches which appear iron-free. The ragged edges of the nodules indicate that the molten liquid penetrated and partly dissolved the adjacent metallic matrix.

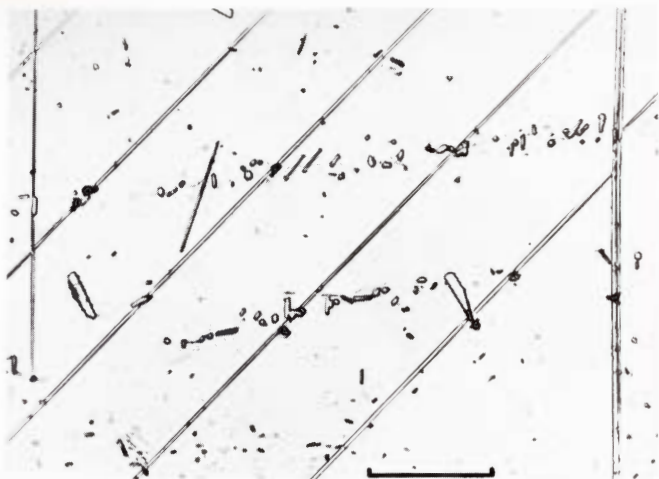


Figure 1563. Scottsville (Copenhagen no. 1891, 54). Two almost horizontal Neumann bands that are almost washed out. Their former location is, however, clear from the rhabdite precipitates. Other Neumann bands appear straight and with parallel sides, probably also an effect of annealing. Lightly etched. Scale bar 100 μ .

Remnants of cohenite were observed once. On a schreibersite crystal, rimming a troilite nodule, a former cohenite crystal, 100 x 20 μ in size, had decomposed to microcrystalline graphite and columnar, serrated ferrite.

Scottsville is a shocked hexahedrite which is particularly closely related to Edmonton (Canada), Angra dos Reis and Sierra Gorda. It is a low-phosphorus, high-iridium member of the resolved chemical group IIA.

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

- 59 g part slice (no. 77, 5.5 x 4 x 0.2 cm)
- 708 g slice (no. 1136, previously Shepard Collection no. 80)
- 275 g slice (no. 3057, 13 x 12 x 0.2 cm)

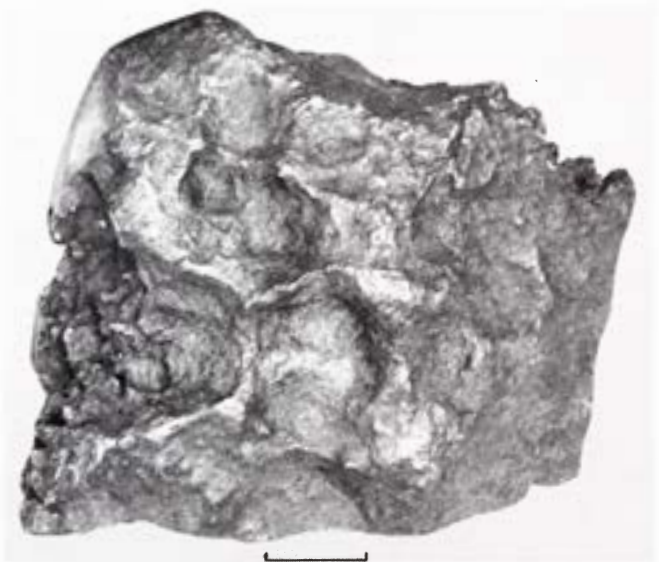


Figure 1564. Seeläsgen (Tübingen no. 946, 2178). The largest preserved sample, an endpiece of 9.95 kg. Regmaglypts are well-preserved and no artificial damage is visible. Scale bar approximately 3 cm.

Seeläsgen, Brandenburg, Poland

52°14'N, 15°23'E

Coarse Octahedrite, Og. Bandwidth 3.1±0.9 mm. Annealed Neumann bands. HV 140±20.

Group I, 6.59% Ni, 0.49% Co, 0.19% P, 96 ppm Ga, 475 ppm Ge, 1.1 ppm Ir.

Probably annealed twice: once in cosmos, later artificially to about 600° C.

HISTORY

A mass of about two hundredweights was discovered some years before 1847 by a farmer from Seeläsgen, near Schwiebus. It was found at a depth of about 4 m (6-7 Ellen) during drainage work in a damp meadow between Seeläsgen and Nieschlitzer See. The corresponding coordinates are given above. The locality, which is near Oder, was then a part of Germany but is now a part of Poland. The farmer sold the mass to a blacksmith named Jähnsch in the nearby village of Züllichau; there it was rediscovered by a Mr. Hartig in 1847. He took samples from it and, having ascertained its meteoritic nature, acquired the whole mass for a dollar and a half late in the year 1847. After refusing an offer of \$135, probably from Duflos and Glocker, he finally sold the mass for \$225 to Dr. Schneider in Breslau. Schneider reserved one-half for his own use and disposed of the other to the mineral dealer, Krantz, in Bonn who had it sawed up and sold for \$1500 (Glocker and Duflos 1848; Clark 1852; Buchner 1863: 178). According to Schneider (1848), who owned the entire mass for a while, the exact weight was 218 Pfund (equal to 102 kg, given Prussian pound equal to 468 g). Schneider described the meteorite and had a cast made before sectioning began. He also gave a woodcut of the exterior showing the original ovoid shape.

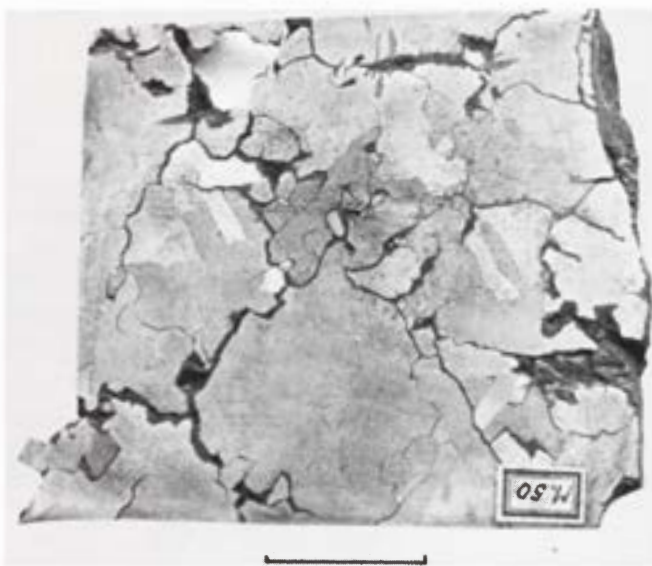


Figure 1565. Seeläsgen (Leningrad no. M.50). A coarse octahedrite of group I showing excessive kamacite grain growth. The Widmanstätten pattern is eliminated over large areas. Deep-etched. Scale bar 20 mm. See also Figure 68.

The Seeläsgen octahedrite was brought to scientific attention within a few months of the fall of the Braunau hexahedrite, and since it was rapidly distributed through Kranz and Schneider, it was widely studied and compared to Braunau. Rammelsberg (1848; 1864) was the first to show that the meteoritic sulphides had almost the theoretical composition FeS, and that they were different from both "Schwefelkies" and "Magnetkies." Haidinger (1863a) later proposed the name troilite for this sulfide, in honour of the Italian Domenico Troili, who in 1766 described the chondrite fall from Albareto, Modena. Troili was convinced of the reality of meteorite falls a generation before Chladni and Biot, but his opinions were not shared by the leading authorities – e.g., the French Academy of Sciences.

Rose (1864a) described the specimens in Berlin and presented excellent drawings based upon the microscopic examination of gelatin films (*Hausenblasenabdrücke*) stripped from the etched surfaces. He showed the presence of regularly oriented small needles in Braunau and Seeläsgen and proposed the name rhabdite (from Greek rhabdos, meaning rod), without solving the problem of the chemical composition. With his technique, Rose was a century in advance of the technique now so commonly applied in electronmicroscopy. Independently of Sorby he made many original observations of the detailed microstructure of irons and iron meteorites.

Numerous other older works on Seeläsgen have been quoted or reviewed by, e.g., Cohen (1894; 1897a), Wülfing (1897), Pokrzywnicki (1964) and Hey (1966). More recently Owen & Burns (1939), using an X-ray technique, measured the α -parameter to 2.8628Å, and Perry (1944) presented seven photomicrographs. Buchwald (1967a) gave a full description of the meteorite with nine photomicrographs and discussed the evidence for a mild cosmic reheating after the initial slow cooling period. Reed (1965a; 1965b; 1969) examined the detailed composition of the phases with the microprobe; the kamacite was found to be rather homogeneous with 6.4% Ni and 0.068% P in solid solution.

Vilcsek & Wänke (1963) estimated on the basis of $^{36}\text{Cl}/^{36}\text{Ar}$ ratios a cosmic ray exposure age of 160 ± 20 million years. Hintenberger et al. (1967) measured the content of noble gases such as ^3He , ^4He , ^{20}Ne , ^{21}Ne , and ^{22}Ne .

COLLECTIONS

Tübingen (9.95 kg corner piece and 3.20 kg slices), London (9.83 kg), Vienna (6.8 kg), Leipzig (4.8 kg), Bonn

(3.61 kg), Dresden (2.58 kg), Calcutta (2.0 kg), Breslau (2.0 kg), Moscow (1.22 kg), Prague (1.12 kg), Budapest (973 g, lost in 1956?), Harvard (944 g), Chicago (635 g), Canberra (428 g), Washington (407 g), Copenhagen (306 g), Warsaw (277 g), Leningrad (262 g), New York (258 g), Uppsala (242 g), Hamburg (231 g), Utrecht (about 200 g), Stockholm (195 g), Strasbourg (183 g), Yale (167 g), Vatican (158 g), Rome (126 g), Tartu (120 g), Paris (107 g), Los Angeles (89 g), Helsinki (80 g), Ottawa (80 g), Sydney (72 g). Since specimens are also present in many other collections, Seeläsgen is one of the most widely distributed iron meteorites altogether.

DESCRIPTION

According to Schneider, the mass was lenticular to ovoid with the average dimensions 35 x 32 x 26 cm. It appeared to be an unbroken body with regmaglypts and some adhering oxide-shales.

The largest specimen extant today, the 9.95 kg corner piece in Tübingen, confirms this description. Several well-preserved regmaglypts cover a large part of the surface, generally as 3-5 cm wide and 1-2 cm deep depressions with softly rounded ridges in between. The fusion crust itself is weathered or spalled off, but the heat-affected zone of α_2 is preserved on many specimens as a 1-2 mm wide rim.

Etched sections display a coarse octahedrite structure of straight, short ($\frac{l}{w} \sim 6$) kamacite lamellae with a width of 3.1 ± 0.9 mm. In numerous places late grain growth has eliminated the original lamellae and by impingement created new, almost equiaxial, grains 5-30 mm across. In the interior of these grains minute areas of taenite and plessite are often to be found. A sample in Leningrad (No. M.50 of 121 g; Figure 1565) shows the degenerated Widmanstätten pattern very well, where remnants of octahedral structure are separated by equiaxial kamacite grains of centimeter size. Only minute quantities of taenite and plessite are present here. Specimens like this could well be classified as a coarsest octahedrite similar to Sikhote-Alin or El Burro. The bulk of the sections show, however, a coarse octahedral structure similar to Coolac, Osseo, Sardis and Campo del Cielo.

The kamacite is rich in Neumann bands. These are frequently broken and display straight edges. They often disappear near grain boundaries and phosphides, evidently because the lattice in these regions has had a chance to be reoriented during a slight reheating. At many Neumann band intersections and along many schreibersite bodies the kamacite has recrystallized and formed 5-50 μ new grains. Inside these, one or two concentric growth rings may often

SEELÄSGEN – SELECTED CHEMICAL ANALYSES

References	percentage			ppm								
	Ni	Co	P	C	S	Cr	Cu	Zn	Ga	Ge	Ir	Pt
Buchwald 1967a	6.70	0.49	0.19		70		150		62	459		
Smales et al. 1967					17	18	140	27	95	474		
Wasson 1970a	6.47								96.8	493	1.1	

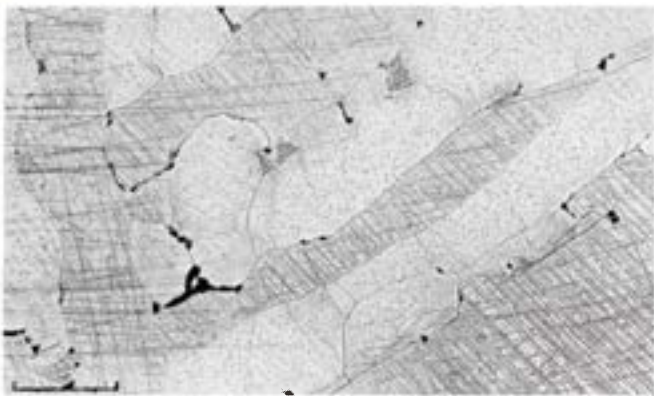


Figure 1566. Seeläsgen (Copenhagen no. 32). Several coarse kamacite lamellae with independent sets of Neumann bands. Schreibersite veinlets (black) and degenerate plessite fields indicate the former position of grain boundaries. Etched. Scale bar 3 mm.



Figure 1567. Seeläsgen. Detail of Figure 1566 showing a degenerate comb plessite field with a schreibersite crystal. Annealed Neumann bands and rhabdites are common. Etched. Scale bar 300 μ .

be distinguished. Many kamacite lamellae exhibit an incipient transformation to taenite which forms fine platelets in a Widmanstätten array. Such "isothermal taenite" is experimentally shown to occur at reheating to 650-700° C for a few hours (Brentnall & Axon 1962). The microhardness of the kamacite is extremely low, 140 ± 20 . It is also extremely variable, since a specimen in Copenhagen showed 120 ± 5 , while two different specimens in Washington showed 142 ± 5 and 160 ± 5 , respectively. It appears that the low values are due to recovery and partial recrystallization from late reheating.

Taenite and plessite cover about 1% by area, mostly as single 10-40 μ wide taenite bands but also as a few degenerated comb plessite fields. Pearlitic plessite with 0.5-2 μ wide taenite lamellae and spheroidized plessite with 2-20 μ taenite spherules are also present. The taenite lamellae are unusually soft (HV 165 ± 10) – again a result of annealing.

Schreibersite occurs scattered as irregular key-shaped skeleton crystals, typically 3 x 1, 6 x 0.5 or 10 x 0.2 mm in size. It also occurs as 0.2-0.8 mm thick rim zones nucleated

upon the troilite crystals. Schreibersite is common as 25-100 μ thick, irregular grain boundary precipitates but, since many grain boundaries have moved after precipitation took place, the schreibersite lamellae may now also be situated inside the kamacite. Rhabdites are extremely common as tetragonal prisms, 5-15 μ across. The rhabdites are – on specimens in Copenhagen and Washington – enveloped in 1-2 μ wide ragged halos of taenite (see Buchwald 1967a: 65 for further discussion and photomicrographs).

Troilite occurs as elongated sausage-shaped bodies, up to 7 cm long, and with a minimum width of 1 cm. These bodies are apparently aligned parallel in the same way as described for the Cape York meteorite. Troilite is also

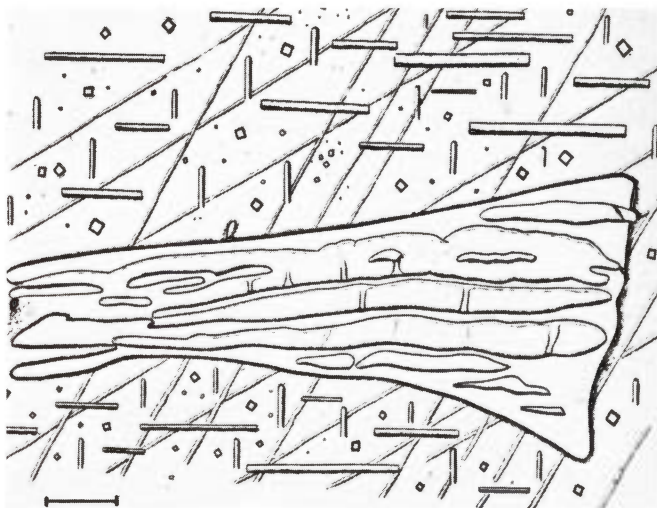


Figure 1568. Seeläsgen (Berlin). A comb plessite field between rhabdites. A fine example of the care with which Rose examined the meteorites about 1860. He made a gelatine print of a deep-etched surface and sketched the film while observing it under a biological microscope in transmitted light. The metallurgical microscope for reflected light was not available at that time. Scale bar 50 μ . (From Rose 1864a.) See also Figure 150.

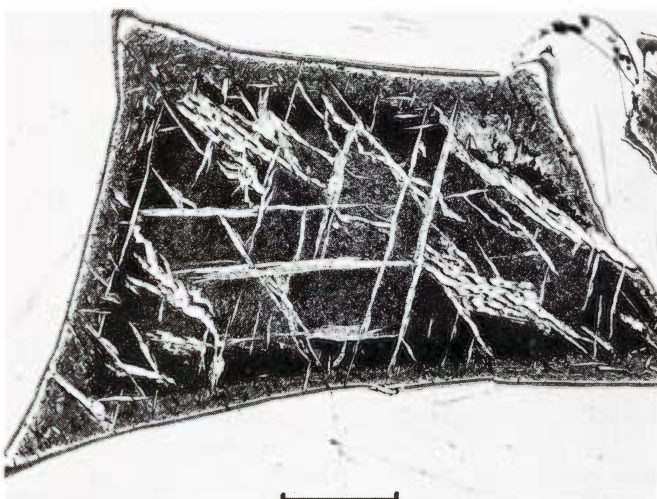


Figure 1569. Seeläsgen (U.S.N.M. no. 2206). Acicular plessite field in which the fine kamacite lamellae repeat the bulk Widmanstätten structure, which, however, is no longer obvious. Compare Figure 1565. Etched. Scale bar 200 μ . (Perry 1944: plate 38.)

present as minor nodules or lenses, 2-10 mm in diameter. The troilite is either monocrystalline with a few lenticular twins, or it is subdivided into millimeter-sized units with undulatory extinction, separated by lanes of microcrystalline shock-melted material. Locally a few fragments of cohenite and schreibersite are dispersed through the shock-melted material.

Many of the larger troilite bodies contain up to 50% by volume of graphite, often as a spongy intergrowth of monocrystalline troilite and micron-sized graphite. Daubreelite was not observed, but chromite occurs frequently as 0.1-0.2 mm euhedral crystals in the troilite or in the kamacite. The troilite nodules have served as substrate for the growth of 0.2-0.8 mm thick schreibersite rims, and upon these 0.1-0.4 mm thick cohenite rims are frequently found. The cohenite is under decomposition to ferrite and graphite forming 2-5 μ thick lamellae.

Cohenite occurs very locally as elongated rounded bodies with reentrant edges. They are typically 2 x 0.5 mm in size and, when present, often form clusters of 15-25 bodies. They are under decomposition to graphite and ferrite in the same way as described in Wichita County. Rammelsberg (1848) found no less than 0.52% C when examining 1.4 g of the meteorite from which graphite, troilite and other major inclusions had first been separated. The average Seeläsgen section appears significantly poorer in carbon, but no modern determination is available.

Carlsbergite is present as slender lamellae in the kamacite phase, generally only 10-20 μ long and 1 μ wide.

Silicates were not detected; some quartz grains were seen but this mineral was always associated with corroded cracks and is no doubt of terrestrial origin, introduced with the soil.

Many specimens show severely hammered and distorted surfaces. The Copenhagen sample has a 4 x 4 cm² flattened area as evidence of this treatment. Several of the

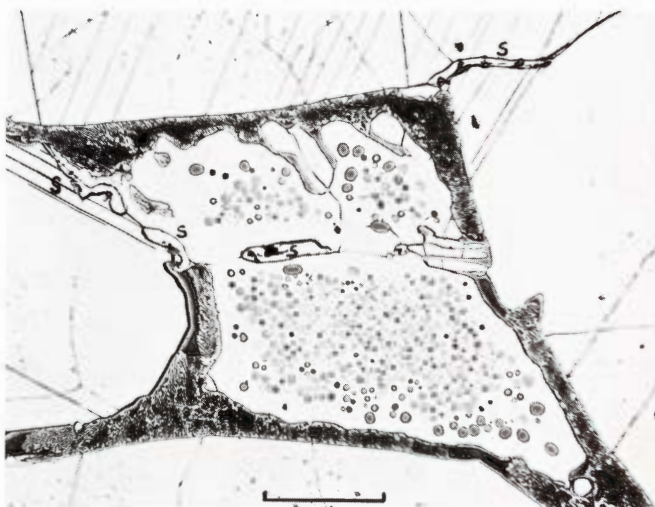


Figure 1570. Seeläsgen (U.S.N.M. no. 2206). Plessite field with pearlitic edges and spheroidized interior, all very typical for the carbon-containing meteorites of group I. Schreibersite crystals at S. Etched. Scale bar 200 μ . (Perry 1944: plate 46.)

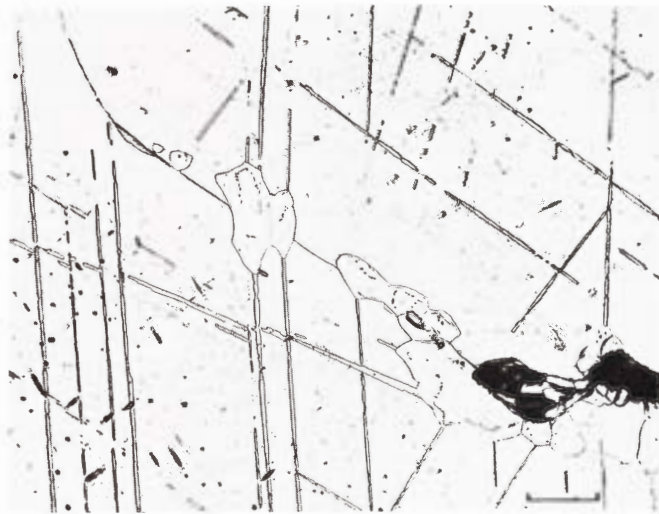


Figure 1571. Seeläsgen (Copenhagen no. 32). A curved $\alpha - \alpha$ grain boundary with chipped schreibersite crystals (black). Recrystallization has started where Neumann bands intersect the boundary and the schreibersite crystals. Etched. Scale bar 100 μ .

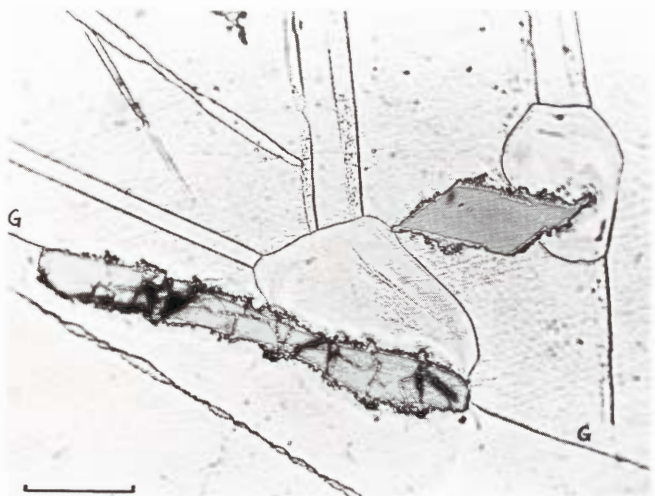


Figure 1572. Seeläsgen (Copenhagen no. 32). Annealed Neumann bands and recrystallized kamacite grains. Grain boundary, G-G, with schreibersite. The schreibersite and the rhabdite have adjusted their composition during annealing and developed a cream-colored taenite rim. Etched. Scale bar 30 μ .

Tübingen specimens are also severely hammered and fissured, and the 700 g Harvard specimen is an irregular fragment which has been violently separated from the adjacent metal with the aid of hammer and chisel. Many of the specimens in Berlin are ragged pieces with rough edges. It appears that Kranz and Schneider, when they divided the meteorite about 1850, instead of sawing, to a certain extent resorted to hammering and chiseling along the brittle phosphide-loaded grain boundaries. Numerous specimens show evidence of artificial reheating to between 500 and 700° C. The reheating was artificial because the limonitic corrosion products were influenced. These decomposed inside the cracks to 10-50 μ wide intricate laceworks of oxides and 1-2 μ metallic beads; also the interfaces between phosphides and limonite show high temperature reaction

zones. Finally, the extremely low microhardnesses of kamacite (~ 140) and taenite (~ 165) indicate that annealing has taken place.

The detailed structure of Seeläsgen is complicated, but the following is an attempt to explain the observed facts. First, the meteorite cooled slowly on its parent body and developed a structure similar to Sardis, Osseo and Campo del Cielo. Next, a mild shock introduced the Neumann bands, the damage to the troilite aggregates and also some intercrystalline cracks. Third, a mild cosmic reheating annealed the kamacite and taenite, created a few recrystallized ferrite units and partially decomposed the cohenite to graphite and ferrite. During a prolonged exposure to terrestrial environments, the meteorite started to corrode; the corrosion penetrated particularly along the preexisting intercrystalline cracks, while the surface was only slightly attacked. When the blacksmith Jähnsch acquired the mass in the 1840's he examined its nature and perhaps tried to divide it, reheating it mildly to about 600-700° C. Subsequently he threw it away, and the mass corroded somewhat more until it was finally purchased by Hartig. Kranz and Schneider divided the mass by violent cold chiseling.

Seeläsgen is a normal coarse octahedrite closely related to Campo del Cielo, Sardis, Osseo, Magura, and Yardymly. It is also related to the adjacent Morasko, a little known Polish octahedrite shower, discovered in 1914. Seeläsgen is a typical group I iron; its high gallium-germanium content places it near the end of the presently known members of the group.

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

- 18 g part slice (no. 662, 5 x 1 x 0.5 cm)
- 112 g part slice (no. 1139)
- 198 g part slice (no. 2206, 5 x 3 x 2 cm)
- 37 g part slice (no. 3059, 4 x 3 x 0.3 cm)
- 43 g part slices (10 g no. 3060, 32.9 g no. 3061)

Seeläsgen (Sulechow fragment), Poland

Coarse octahedrite, Og. Bandwidth about 3 mm.

Group I, 6.60% Ni, 0.51% Co, 0.22% P.

HISTORY

A fragment of 38 g labeled Züllichau, was discovered by Pokrzywnicki (1959) while he was examining the Breslau Meteorite Collection in 1954. The fragment was described with ten photomicrographs and analyzed, and it was compared to Seeläsgen. Pokrzywnicki (1959; 1964) came to the conclusion that the fragment constituted part

of a hitherto unrecorded hexahedrite which fell in 1845 near Sulechow. Buchwald (1967a: 59) concluded, however, that Sulechow was a fragment of the octahedrite Seeläsgen. This conclusion is further examined and supported below.

COLLECTIONS

The only specimen on record is the 38 g fragment from the Department of Petrography and Mineralogy, University of Wrocław (Breslau). It is now deposited in Warsaw.

DESCRIPTION

According to Pokrzywnicki (1959; 1964), the fragment is an endpiece measuring about 52 x 17 x 20 mm and weighing 38 g. It was marked with a label R.13, and another attached and somewhat damaged label read, "Meteoriten 38 g schwer gefallen 20/I 48 bei Züllichau."

A close examination of Pokrzywnicki's paper reveals that there is little basis for accepting the fragment as a hexahedrite. The chemical analysis clearly distinguishes it as a coarse octahedrite related to Seeläsgen and Campo del Cielo. Moreover, the attached photomicrographs show a coarse octahedral pattern and plessitic fields with spheroidized taenite, structures which are typical of Seeläsgen. Also, all other given micrographs of rhabdites, oxidized intercrystalline cracks, and winding grain boundary precipitates might well be micrographs of a Seeläsgen fragment. Pokrzywnicki rejected the idea that the fragment was identical to Seeläsgen mainly because he believed this to contain significantly less nickel (5.3-6.3%) than Sulechow.

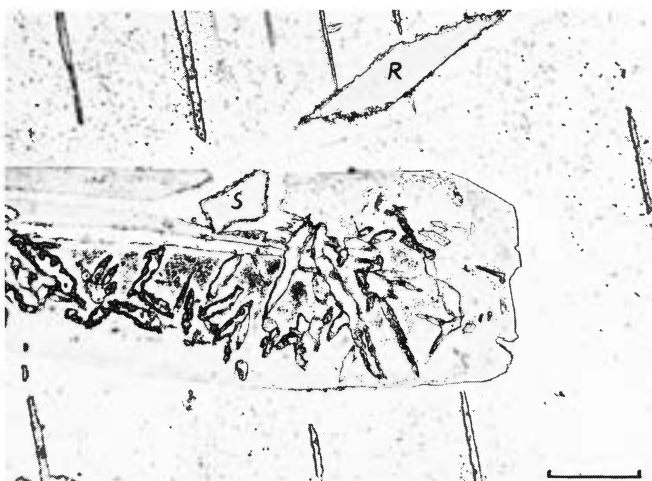


Figure 1573. Seeläsgen (Copenhagen no. 32). An acicular plessitic field and two phosphide crystals (S,R). Annealing eliminated part of the Neumann bands and caused taenite fringes to develop around the phosphides. Etched. Scale bar 50 μ .

SEELÄSGEN (SULECHOW FRAGMENT) – SELECTED CHEMICAL ANALYSES

Reference	percentage			C	S	Cr	Cu	ppm				
	Ni	Co	P					Zn	Ga	Ge	Ir	Pt
Rossol in Pokrzywnicki 1959	6.60	0.51	0.22	250	100		1200					

The copper value is probably too high.



Figure 1574. Seeläsgen (Copenhagen no. 32). Three annealed Neumann bands, one of them with a rhabdite (right) showing a reaction halo of taenite. Fine needles in the matrix, probably of isothermal taenite caused by the annealing. Etched. Scale bar 30 μ .

However, those analyses were of inferior quality compared to what we know today.

Pokrzywnicki also placed some weight upon the statement on the label “fell ... 20/I 48 ... near Züllichau.” He examined old records of shooting stars but did not succeed in finding any support of a fall on the relevant date. The closest shooting star on record was one of 20/I 1845, so he was forced to interpret the label as a misprint of 48 for 45. In no record was any recovery of a meteorite mentioned, so the association of the Sulechow fragment with this shooting star is really farfetched. Working with old collections I have often met labels, stating “fell on” a certain date when it really just implies “was found” or “was described” on that date.

That a small fragment of the Seeläsgen meteorite is preserved in the Breslau collection is not surprising, since the whole mass was for a while in the possession of Dr. Schneider of Breslau; and Schneider was busy cutting and distributing it. There is also a chance that the sample marked R.13 was once part of Reichenbach’s collection and came to Breslau by exchange. Reichenbach (1788-1869) was an ardent collector, living at the castle Reisenberg am Cobenzl near Vienna; and he purchased a great part of the Seeläsgen meteorite. These specimens are now in Tübingen and constitute the largest amount of Seeläsgen material at one place.

Summing up, it may be stated: (i) the Sulechow fragment has a macro- and microstructure identical to Seeläsgen; (ii) it has the same chemical composition as Seeläsgen; (iii) it is a minor piece cut from a large iron meteorite with regmaglypts; (iv) it is recorded as an iron

from near Züllichau in 1848. The Seeläsgen meteorite was found near Züllichau and was in the possession of the blacksmith Jähnsch in Züllichau until November 1847; (v) no meteorite fall is on record from Brandenburg in 1847-1848.

The inevitable conclusion is that the Sulechow fragment is a specimen detached from the Seeläsgen meteorite. Most probably it was once part of Reichenbach’s collection but was exchanged at an early date with Breslau. There it remained with the old label attached; unfortunately the label became worn and partly destroyed, whereby the word Seeläsgen may have disappeared.

Selčany, Bohemia, Czechoslovakia

49°39'N, 14°25'E

A piece of 20 g is in the Bohemian Museum in Prague. It was found in 1900 and appears to be a coarse octahedrite (Vrba 1904); but only a modern examination can determine whether it can be upheld as an independent meteorite.

Seligman, Arizona, U.S.A.

35°17'N, 112°52'W; about 1600 m

Coarse octahedrite, Og. Bandwidth 2.3±0.5 mm. Neumann bands. HV 174±6.

Group I. 6.69% Ni, about 0.2% P, 91 ppm Ga, 423 ppm Ge, 2.8 ppm Ir.

HISTORY

A fresh mass of 2.2 kg was found in 1949 near Seligman, Coconino County. It was rich in schreibersite and



Figure 1575. Seligman (Tempe no. 583.3). A coarse octahedrite of group I. Cohenite crystals in the left part. Deep-etched. Scale in centimeters. (Courtesy C.B. Moore.)

SELIGMAN – SELECTED CHEMICAL ANALYSES

Reference	percentage			ppm								
	Ni	Co	P	C	S	Cr	Cu	Zn	Ga	Ge	Ir	Pt
Wasson 1970a	6.69								91.3	423	2.8	



Figure 1576. Seligman (U.S.N.M. no. 1761). Cluster of cliftonitic graphite crystals in kamacite. Polished. Crossed polars. Scale bar 200 μ .

cohenite and showed a distinct heating zone (Nininger, as quoted by Hey 1966: 439). A photomicrograph of a full, polished and etched section was presented by Nininger & Nininger (1950: plate 4). Wasson (1968; 1970a) examined Seligman chemically in order to test whether it was a stray member of the Canyon Diablo group. He concluded that its Ni, Ga, Ge and Ir values were sufficiently different from Canyon Diablo to warrant Seligman's identity as a separate fall, a conclusion which is supported in the present study.

COLLECTIONS

Nininger, Sedona, Arizona (1,200 g), Tempe (274 g), London (150 g), Washington (147 g), Los Angeles (37 g).

DESCRIPTION

The mass has the average dimensions of 14 x 9 x 6 cm and displays several well developed regmaglypts 12-20 mm in diameter. Cross sections through the mass show that the heat-affected rim zone is partially preserved. In places it has the usual thickness of 2-3 mm, in others it is thinned down to below 0.1 mm by corrosion. Where it is best preserved, it has a hardness of 189 ± 5 ; the hardness reaches a minimum of 153 ± 5 at the transition to the unaltered interior, which displays a hardness of 174 ± 6 (hardness curve type II).

In the heat-altered zone there are numerous micro-melted rhabdites, and part of a micromelted troilite nodule is also preserved. The cohenite, on the other hand, is either melted to ledeburite or has decomposed along the interface with the metal, having rejected a considerable quantity of carbon. The resulting carbon-saturated austenite forms black-etching, pearlitic reaction rims around the cohenite, very similar to the black zones described around cohenite from Canyon Diablo specimens of stages V and VI. At one place on the surface, a large schreibersite lamella has been ablated away, and its cavity has become filled to a depth of 6 mm with whirlpools of dendritically solidified metal, rich in phosphides and oxides.

Etched sections reveal a coarse Widmanstätten structure of bulky, short ($l/w \sim 5-10$) kamacite lamellae ranging in width from 1.8-3.0 mm. The narrow lamellae are always associated with cohenite-rich areas. The kamacite has numerous Neumann bands which are 3-10 μ wide in pure kamacite but only 1-2 μ wide in kamacite rich in 0.5-1 μ rhabdite precipitates. Subboundaries decorated with 1-3 μ rhabdites are common. Locally, there are bulky kamacite grains reaching sizes of 20 x 10 or 15 x 8 mm. The hardness of the kamacite is 174 ± 6 .

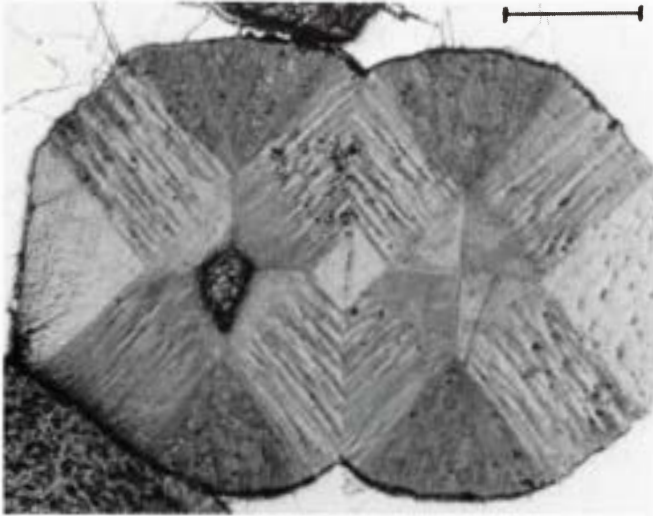


Figure 1577. Seligman. Detail of Figure 1576. Two well developed graphite crystals, similarly oriented and intergrown. Lightly etched. Crossed polars. Scale bar 80 μ .

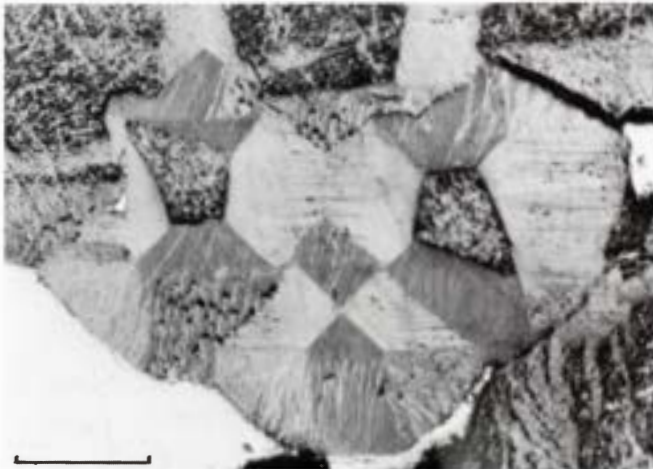


Figure 1578. Seligman. Detail of Figure 1577. Complex intergrowth of cliftonite crystals. Crossed polars. Scale bar 100 μ . See also Figures 166 and 167.

Taenite and plessite cover 1-2% by area, either as degenerated comb plessite or as ribbons with acicular, martensitic or pearlitic interiors. The pearlitic fields have 0.5-2 μ wide taenite lamellae. In the heat-affected rim zone, the blue-tarnished taenite is transformed to yellow taenite and surrounded by 10-50 μ wide bainitic zones. This is due to carbon, which diffused away from the taenite above 800° C.

Schreibersite is common as 20-100 μ wide grain boundary precipitates and occasionally occurs as 0.3-0.5 mm wide and 4-10 mm long primary lamellae. Rhabdites range in size from 15 to 0.5 μ and are very common. The bulk phosphorus content is estimated to be 0.2%.

Cohenite is present on about 40% by area of the available sections. It forms rounded blebs, elongated in the direction of the kamacite lamellae and typically 3 x 0.5 mm in size. It is monocrystalline and is not decomposed, except

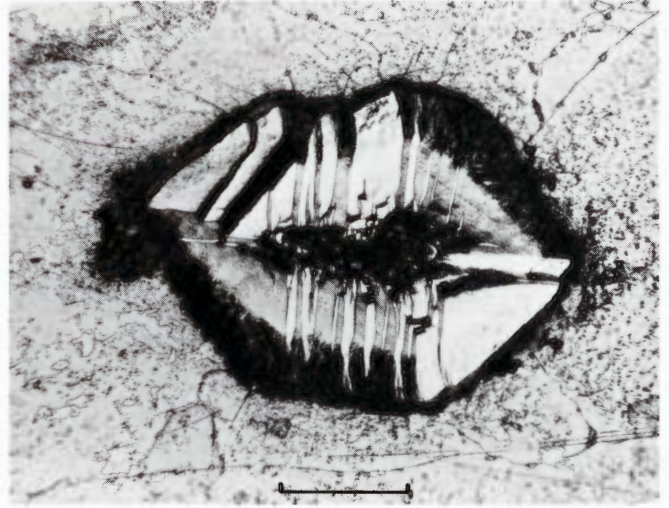


Figure 1579. Seligman (U.S.N.M. no. 1761). An unusually large cliftonite crystal that happens to be located in the inner part of the α_2 zone. Carbon has started to diffuse outwards from the crystal and, upon cooling, has created black bainitic rims. Etched. Crossed polars. Scale bar 200 μ .

in the heat-affected rim zones. Several of the primary schreibersite lamellae have nucleated rims of cohenite which attain thicknesses of 200-600 μ . The hardness is 1120 \pm 40 while the long schreibersite crystals are 910 \pm 30.

Troilite was not observed in the sections, but graphite is present locally in the kamacite as 1-2 mm irregular cakes. Graphite is further present as unusually well developed cliftonite crystals with fine, oriented extinction. A square cliftonite crystal, completely embedded in cohenite measured 200 μ across. Several square, hexagonal or octagonal crystals in the kamacite varied from 200-800 μ in size.

The meteorite is somewhat corroded. On the average, it has lost 1 mm of its surface. In addition, 10-100 μ wide limonitic veinlets penetrate the bulk of the mass along grain boundaries and phosphide-carbide precipitates. It is, however, significantly less altered than most Canyon Diablo specimens, which it otherwise resembles.

Seligman is a typical group I iron which is structurally and chemically closely related to Smithville, Gladstone and Seeläsgen. It is also slightly related to Canyon Diablo, but it does not appear to be a member of that fall. It probably occurred at a more recent date than Canyon Diablo.

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

98 g part slice (no. 1761, 8 x 5 x 0.4 cm)
49 g part slice (no. 1761, 7 x 5 x 0.3 cm)

Seneca Falls, New York, U.S.A.

42°55'N, 76°47'W

Medium octahedrite, Om. Bandwidth 1.10 \pm 0.20 mm. Recrystallized. HV 170 \pm 6.

Probably group IIIA. About 8.5% Ni and 0.3% P.



Figure 1580. Seneca Falls (Chicago no. 60). A recrystallized medium octahedrite of group IIIA. Several schreibersite crystals in the center of the kamacite lamellae. Deep-etched. Scale bar 3 mm.

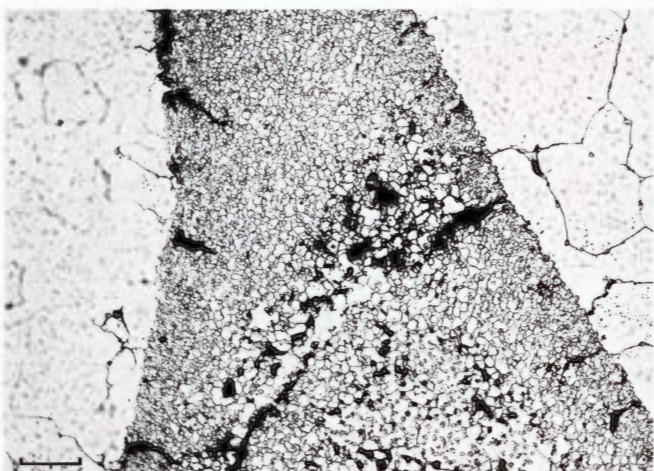


Figure 1581. Seneca Falls (Chicago no. 60). Entirely altered plessite field as the result of cosmic annealing. Recrystallized kamacite on either side. The black dots are pits from brecciated and unequilibrated phases that were torn out during polishing. Etched. Scale bar 100 μ .

HISTORY

A mass of about nine pounds (4 kg) was found in 1850 by a farmer who was digging a ditch near the free bridge on the Cayuga side (i.e., southeast side) of the Seneca River (Root 1852). Shepard (1853b), who described the material and presented a drawing of a deep-etched specimen, assumed that the locality was in Cayuga County, while other authors (e.g., Brezina 1896; Hey 1966) assumed that the locality was near Seneca Falls, in Seneca County. The coordinates above are, therefore, only approximate. The meteorite was frequently mentioned in papers of the nineteenth century; for references see Wülfing (1897: 319) and Farrington (1915: 410).

Ward (1904a: 23, plate 8) presented a figure of a 108 g slice with a 14 mm troilite nodule. Berwerth (1914: 1066, 1080) discussed the polyhedral kamacite grains and hesitatingly concluded that Seneca Falls was a metabolite, i.e., had

acquired its peculiar structure by artificial reheating. A similar, but erroneous, conclusion was reached by Buchwald (quoted in Hey 1966: 440) who had cursorily examined a deep-etched sample in Vienna. Paneth (1954) reported $15 \times 10^{-6} \text{ cm}^3$ helium per gram of meteorite.

COLLECTIONS

Vienna (817 g from Kunz's Collection (Brezina 1896: 277) and 13 g), Yale (382 g), Chicago (261 g and 104 g), Göttingen (90 g), Budapest (86 g, lost in 1956), Calcutta (60 g), Tübingen (59 g), London (54 g), Amherst (51 g), Tartu (50 g), Paris (46 g), New York (44 g), Berlin (17 g), Uppsala (14 g), Stockholm (11 g), Harvard (10 g). In 1852 a major piece of three pounds was in Hamilton College, Clinton, New York. In response to an inquiry made in 1972, Professor Donald B. Potter of the above mentioned college informed me that the college no longer housed the sample and that its fate was unknown.

ANALYSES

Shepard (1853b) reported 7.6% Ni, substantial amounts of phosphorus, and a trace of chromium. The nickel content is probably about 1% too low. Shepard proposed the name partschite for the phosphide mineral, but due to a curious misunderstanding, the phosphide eventually was called schreibersite, although Patera's "schreibersite" (1847) was very poorly defined and probably was an intergrowth of cohenite and schreibersite. The literature since the 1840's and up to the present day is often rich in inadequate identifications of these minerals; however, agreement as to terminology was reached in the 1880's. Cohen (1894: 118) reviewed the intricate disputes.

From the examination below, the composition is estimated to be $8.5 \pm 0.3\%$ Ni and $0.3 \pm 0.05\%$ P, with trace element concentrations appropriate to transitional stages between group IIIA and IIIB.

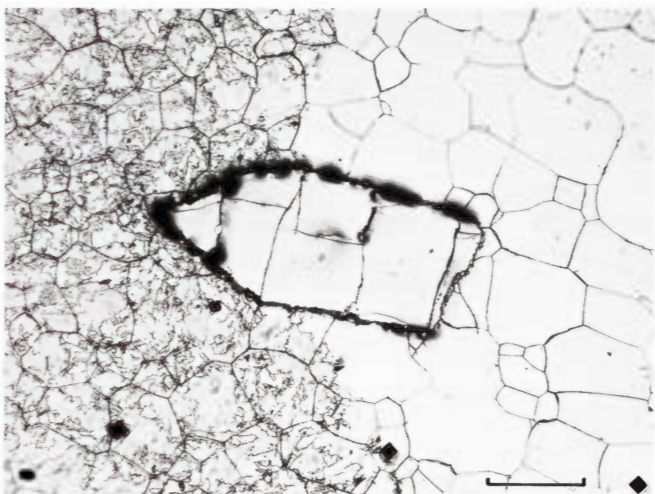


Figure 1582. Seneca Falls (Chicago no. 60). A kamacite lamella with a central schreibersite crystal. The kamacite is recrystallized to equiaxial grains with few precipitates here in the P- and Ni-depleted zone around schreibersite. The heat-affected α_2 zone has advanced from the left. Three Vickers microhardness impressions are visible along lower edge. Etched. Scale bar 200 μ .

DESCRIPTION

The mass was drop-shaped with the maximum dimensions 17 x 10 x 8 cm. It has now been thoroughly divided and distributed, but major samples are in Vienna, Yale and Chicago. The following is based on an examination of samples from the two last named collections. The Yale specimen (No. P31, 382 g) is an endpiece, measuring 7.5 x 6 x 2.5 cm. It is apparently severely corroded but not artificially damaged. Its structure is as described below. The Chicago specimen (No. Me60, 261 g) is a part slice, 8 x 3 x 1.8 cm. The old, polished and deep-etched surface bears an initial of the name of the first owner, Mr. L.C. Partridge. According to Root (1852) and Shepard (1853b), he lived in Seneca Falls and either discovered the meteorite or owned a significant portion of it in the beginning.

It has been generally assumed that Seneca Falls is severely corroded, but this is not the case. Although a

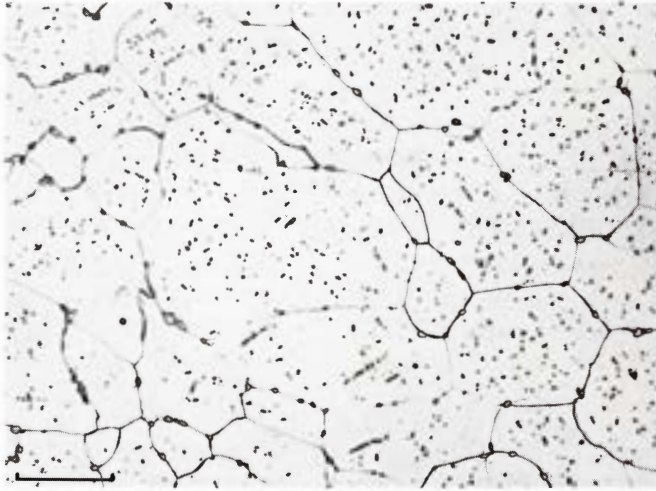


Figure 1583. Seneca Falls (Chicago no. 60). A kamacite lamella distant from any schreibersite crystals. The recrystallized grains are more irregular, mainly due to the presence of a large number of fine phosphide and γ -particles that obstruct grain growth. Etched. Scale bar 100 μ .

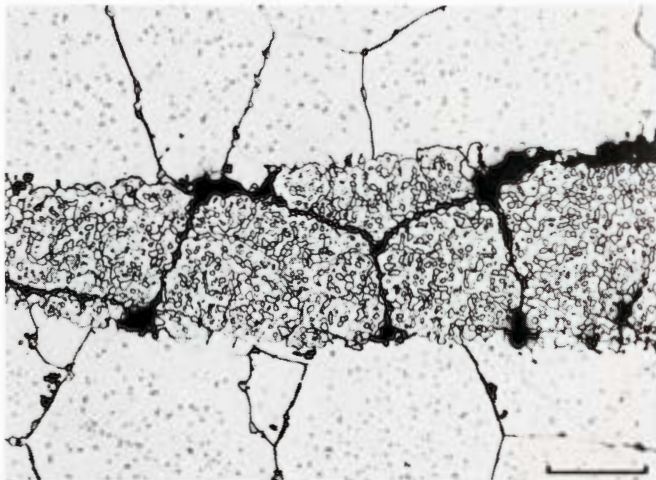


Figure 1584. Seneca Falls (Chicago no. 60). A decomposed plessite field. The taenite forms unequilibrated amoeba-like particles, irregularly intergrown with kamacite. Terrestrial corrosion penetrates along boundaries. Etched. Scale bar 100 μ .

0.1-1 mm thick limonitic crust irregularly covers the surfaces, sections display 0.5-2 mm thick rim zones of heat-affected α_2 . Clearly, the meteorite has lost only 1 mm on the average. Fusion crusts, albeit in a weathered state, may be detected in protected places. A 4 mm deep crack after an ablation-melted schreibersite lamella was thus filled with intricate whirlpools of fused oxidic and dendritic-metallic material, and the whole was cemented together by limonitic weathering products. The α_2 zone has a hardness of 180 ± 10 . The recovered transition zone is soft, 145 ± 5 (hardness curve type II).

Etched sections display a medium Widmanstätten structure of straight, somewhat bulky ($\bar{W} \sim 15$) kamacite lamellae with a width of 1.10 ± 0.20 mm. The kamacite is recrystallized to almost equiaxial grains, 50-250 μ in diameter. The grains are largest, purest and best equilibrated in the nickel- and phosphorus-depleted zones around the large schreibersite crystals. Elsewhere the grains are rich in subboundaries and have numerous 1-2 μ taenite and phosphide particles in the interior. In addition, there is a significant number of 1-6 μ irregular, amoeba-like taenite particles on the grain boundaries, partially pinning them. While most kamacite grains are devoid of Neumann bands, some grains adjacent to cracks display a few sharp and straight bands, perhaps from strains developed during the atmospheric flight. The kamacite phase has a hardness of 170 ± 6 .

Taenite and plessite cover about 40% by area. Apparently the normal varieties of comb, net and duplex plessite were originally present, but they are now severely altered by cosmic reheating. The taenite lamellae are decomposed to an aggregate of 5-25 μ α - and γ -grains in almost equal proportions ($HV 155 \pm 7$). The individual γ -grains are amoeba-like, with irregular edges and interior 0.5 μ windows of kamacite. The open-meshed plessite varieties are likewise decomposed to α -grains and γ -amoebae; the α : γ ratio varies according to the average nickel content from about 1 to about 10. It is also characteristic that original

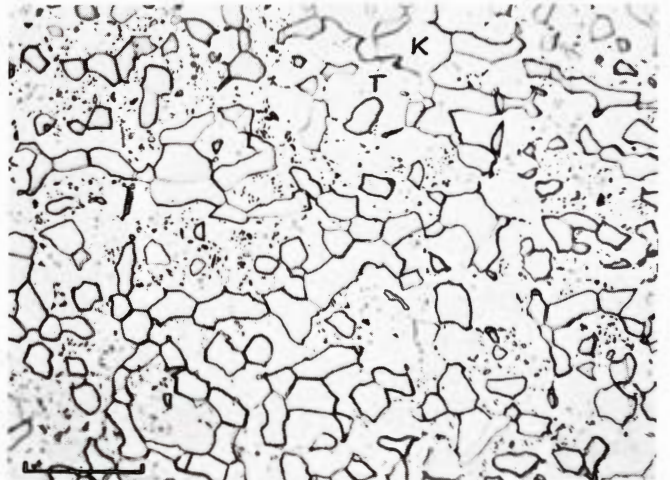


Figure 1585. Seneca Falls (Chicago no. 60). Detail of a plessite field similar to that in Figure 1584. The taenite (T) forms a continuous sponge with large (K) and small kamacite segregates. Etched. Oil immersion. Scale bar 20 μ .

continuous taenite lamellae are now subdivided into segments, each 50-400 μ across, and thus each comprising a large number of α and γ units. The same texture is present in, e.g., Reed City, but the reason for it is not clear. It seems, however, to be another indication of severe shock-reheating.

Schreibersite occurs as imperfect Brezina lamellae parallel to (110) γ and attains sizes of 12 x 0.5 mm (HV 870 \pm 20). Small crystals, e.g., 2 x 0.3 mm in size, are common centrally in some kamacite lamellae. Schreibersite also occurs as 20-100 μ wide grain boundary veinlets and as 5-50 μ blebs inside the plessite fields, but it is often difficult to identify because of the alterations. Almost all schreibersite is severely brecciated and has apparently been on the verge of remelting. The rims are scalloped, and one or two rows of amoebae-like 5-10 μ taenite particles and angular phosphide particles are situated in a 10-50 μ wide zone around them. The schreibersite interiors display fine (< 1 μ) exsolution products along fracture lines, and incipient recrystallization to 5-15 μ grains has occurred adjacent to shock-melted troilite.

Troilite was seen on the section in Yale as a large nodule, 17 mm in diameter, with a 0.1 mm schreibersite rim. Troilite also occurs as 0.1-1 mm blebs associated with the schreibersite lamellae. It is shock-melted and has penetrated into the fissured neighbor crystals as 5-15 μ wide veins which are now severely corroded. The shock-melted pools are fine eutectic aggregates of 1-5 μ metal (now often corroded) and sulfides in which phosphide particles are dispersed. These are rounded globules, 5-10 μ across, indicating that the reheating was more severe than in many other meteorites which display only angular fragments of schreibersite.

Shepard (1853b) reported “two very brilliant, black octahedral crystals, whose weight together was only 0.005 of a grain” (i.e., 0.3 milligram). He had isolated them from

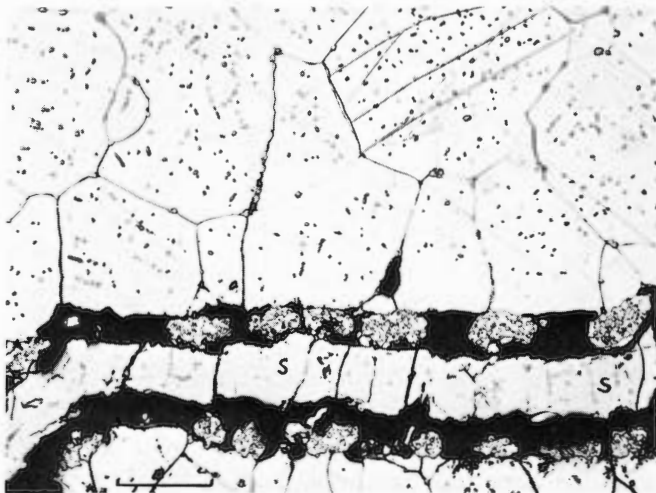


Figure 1586. Seneca Falls (Chicago no. 60). Schreibersite lamella (S) with decomposed duplex rims from cosmic annealing. The aggregates are extremely vulnerable to terrestrial corrosion and difficult to polish without pitting (black). Neumann bands in one of the recrystallized grains above. Etched. Scale bar 100 μ .

the insoluble matter in a wet chemical analysis and identified them as chromite.

Silicates, graphite and carbides were not detected.

As noted above, the corrosion of the surface is only slight. However, due to severe cosmic alteration the mass was evidently extensively fissured on a microscale. Later when the mass became exposed to the terrestrial environment, ground waters penetrated the microcracked schreibersite crystals and along Widmanstätten boundaries. In addition, the α -phase became selectively converted to limonite in many duplex structures, and the cell boundaries of the taenite lamellae and the grain boundaries of the recrystallized kamacite were attacked.

Seneca Falls is a medium octahedrite of a normal type, such as Lenarto, which, as the result of severe shock and associated (?) reheating, recrystallized and spheroidized to a peculiar structure. Somewhat similar structures are present in Maria Elena, Reed City and Hammond.

Chemically, it appears that the mass belongs to group IIIA. If so, the meteorites Bartlett, Lenarto, Ruff's Mountain, Seneca Falls and Juromenha – which are genetically related – display a series of irons with increasing stages of secondary metamorphosis due to cosmic events.

[J.T. Wasson (personal communication 1973): Group IIIA with about 8.25% Ni, 21.1 ppm Ga, 42.8 ppm Ge and 0.25 ppm Ir].

Seneca Township, Michigan, U.S.A.

41°48'N, 84°11'W; 240 m

Fine octahedrite, Of. Bandwidth 0.28 \pm 0.05 mm. Annealed ϵ -structure. HV 210 \pm 10.

Group IVA. 8.52% Ni, about 0.08% P, 2.17 ppm Ga, 0.124 ppm Ge, 1.8 ppm Ir.



Figure 1587. Seneca Township (U.S.N.M. no. 1325). The rear side of the 11.5 kg meteorite. Although the turtle-shaped mass appears severely weathered, the exterior form is in almost every respect a result of ablative sculpturing and not a result of subsequent corrosion. Scale bar approximately 4 cm. S.I. neg. 9464B.