carbides, is significantly higher here than in the dendrite interior. There are many small, interdendritic pockets of daubreeelite, 2-10 μ across, and graphite (e.g., 100 x 10 μ fillings), but silicates were not observed. There are also a few interdendritic shrinkage cavities of the same general size. It is interesting to note that a significant number of tiny graphite spheres are irregularly scattered with about one per mm² and are apparently a primary crystallization product. They often consist of a 10 μ perfect spheroidal nucleus composed of radiating graphite sheaves which have nucleated a 10 μ thick, outer fringe of unoriented, 0.5-1 μ graphite particles.

The structure leaves no doubt that Nedagolla at one time was completely melted and homogenized and then solidified and cooled, probably slightly covered by debris, at a rate comparable to the cooling of a 5 kg sand casting. Nedagolla, therefore, shows coring and is probably the only meteorite which most easily could be mistaken for a technological product. It is further remarkable by the absence of troilite. Perhaps a rapid separation of metal and sulfide occurred at the melting point.

The primary dendrites, which were composed of 40-100 μ equiaxial austenite grains, transformed to martensitic-bainitic structures, but the range in structure and microhardness indicates that homogenization was never completed and suggests that the rather rapid cooling continued to low temperatures where all diffusion stopped. The microhardness (100 g) is 200±10, but spotwise it increases to 260. No Neumann bands are found. Phosphides are not present, in harmony with the low analytical values quoted above.

The heat-affected rim zone is also conspicuous; it is mostly 2-2.5 mm thick, but at the pointed end increases to 8 mm due to the mixed high heat influx during atmospheric flight. In this zone it may be observed how the carbides become gradually resorbed until they disappear completely in the exterior part. Simultaneously the austenite becomes better homogenized and, upon cooling, produces a nickel-chromium martensite with proeutectoid Widmanstätten ferrite growing from the austenite grain boundaries. The microhardness is 600±50. No wonder that Cohen (1897d: 120) found the meteorite difficult to cut, since it has such a high rim hardness and numerous carbides in the interior. The graphite nodule and the graphite in the interdendritic boundaries are also dissolved – the higher the temperature attained, the more thoroughly dissolved. In many places the graphite has disappeared completely but has left a carbon-stabilized austenite, which remained at low temperature as 20-40 μ white blebs surrounded by acicular martensite.

A hardness track perpendicular to the surface starts at 600±50, gives rather erratic values between 300 and 600 in the heterogeneous rim zone, and then drops abruptly to 200±10 at the macroscopically visible border between the dark-etching rim and the light-etching interior. The border corresponds to an isotherm during atmospheric flight of about 700°C.

The thin fusion crust consists of numerous layers of metal overlain by a 50-100 μ thick oxide film. The metal is deposited as 10-25 μ thick layers that discordantly swell and taper out and include 1-5 μ thick oxide films and globules which appear to be wüstite. The outermost oxide layer is two-phased, composed of wüstite and magnetite. The magnetite is precipitated along the wüstite grain boundaries and as 1-5 μ cubic skeleton crystals in the wüstite interior. It also constitutes the outermost 20-40 μ thick covering, presumably because atmospheric oxygen was able to fully oxidize the surface during the final flight stage.

Nedagolla is a unique meteorite. So far, it is the only iron which shows unambiguous evidence of rapid solidification from a melt, followed by rapid cooling to low temperature. It is difficult to reconstruct the original body, but it is almost certain that it was not a normal hexahedrite or a coarsest octahedrite, because the trace element concentration is significantly different. Nedagolla rather appears to be related to Santiago Papasquiaro which has also been cosmically reheated and shows somewhat similar Ga-Ge-Ir ratios. Still, there are large differences.

**Specimens in the U.S. National Museum in Washington:**
22.5 g part slice (no. 745, 4 x 1.2 x 0.5 cm)
5.5 g part slice (no. 2396, 15 x 13 x 4 mm)

**Needles, California, U.S.A.**
[34°26.65'N, 114°49.95'W; 550 m]

Fine octahedrite, Of. Bandwidth 0.47±0.06 mm. Neumann bands. Partly recrystallized. RV 220±15.
Group IID: 10.3% Ni, about 0.85% P, 77 ppm Ga, 93 ppm Ge, 4.8 ppm Ir.
Carsons Well is a synonym for Needles.

**HISTORY**
A mass of 45.3 kg was found in 1962 by Carroll and Nora Cantrell while on a rock hunting expedition 50 km southwest of Needles, in San Bernardino County. A sample of the mass was taken to the University of Arizona where the meteoritic nature was confirmed. It was briefly mentioned under the name Carsons Well by Anthony & DuBois (1963) and passed under this name into Hey's Catalog (1966: 91). After the meteorite had been acquired by the University of California in 1967, it was analyzed and described under the name Needles by Wasson & Kimberlin (1969) who did not realize that the other name had already been used. The authors gave photographs of the exterior and of etched slices and further provided a map, stating the exact coordinates. They discussed the striking similarity to Wallapai, the two fragments of which had been found in 1926 about 150 km further northeast, but they hesitatingly concluded that the masses were different. I bring here further observations to support that conclusion.

**COLLECTIONS**
Los Angeles (33 kg), Washington (10.7 kg).
DESCRIPTION

The mass is roughly in the shape of a triangular slab with the average dimensions of 38 x 25 x 15 cm. It is weathered and covered with 0.1-1 mm thick, terrestrial oxides. No fusion crust and heat-affected α₂ zones are easily observed. In a few, protected cracks and cavities, formerly occupied by Brezina lamellae, the fusion crust is, however, preserved as a dendritic metallic deposit. It is extremely fine-grained and often displays concentric structures, indicating rapid deposition of successive layers. Under the crust are thin α₂ zones. On one side the surface shows several large depressions, 10-12 cm in diameter and 3 cm deep, while weathered shallow regmaglypts, 2-3 cm in diameter, are present on the other side. It is estimated that on the average only 2 mm of the iron is lost by weathering, so that its present shape almost truly represents its shape immediately after landing.

Etched sections display a fine Widmanstätten structure of straight, long (P ~ 40) kamacite lamellae with a width of 0.47±0.06 mm. The kamacite has subboundaries with decorations of 0.5-2 μ phosphides. The Neumann bands have a rather peculiar, frayed appearance because recrystallization of the kamacite is just about to occur. The recrystallization is well under way in 100-200 μ wide zones around schreibersite and troilite inclusions and along several grain boundaries. The new grains are 10-100 μ across and cover perhaps 1% by area. The microhardness of the kamacite is 220±15. It decreases to 190±10 in the recrystallized areas, which, however, is partly because these areas are 10-25% lower in nickel.

Taenite and plessite cover about 50% by area. Comb and net plessite are common and so are duplex, dark-etching, almost unresolvable areas. A large, well developed field will show a yellow taenite edge (HV 350±25) followed by a zone with acicular, high nickel-carbon martensite (extremely hard: 540±25). Then follows brown-etching, fine-grained martensite, developed parallel to the bulk Widmanstätten structure (HV 450±50); deeper in, the martensite gives way to duplex α + γ fields which range in hardness from 350 (fine-grained) to 250 (coarse-grained). The open-meshed, comb and net plessite fields, finally, have the same hardness as the kamacite lamellae. Locally, the plessite is well spheroidized, exhibiting numerous taenite spherules, 1-10 μ across.

Schreibersite dominates the sections as H-, L- and Y-shaped skeleton crystals. They are typically 30 x 10 x 3 mm in size and are enveloped in asymmetric, 1-3 mm wide ribbons of swathing kamacite. They are, no doubt, mainly precipitated as Brezina lamellae in the dodecahedral planes of the parent taenite crystal, but their frequent branching makes interpretation of their directions difficult. Their hardness is 900±25. Schreibersite further occurs as 0.1-0.5 mm blebs centrally in some kamacite lamellae, as 10-60 μ wide grain boundary veins and as 1-50 μ blebs in the plessite fields. Rhabdites occur as 1-8 μ prisms in varying concentrations. The bulk phosphorus content is estimated to be 0.8-0.9%.

Troilite was not observed as an essential constituent on sections totaling 600 cm². It is only present as 0.1-1 mm nodules and elongated bodies, associated with the Brezina lamellae. The troilite is shock-melted and solidified to aggregates of grains, 1-40 μ across and often incorporating a little metal from the adjacent walls. Daubreelite is present as 10-50 μ wide lamellae that are partially melted and dispersed in the troilite. The metallic matrix is particularly well recrystallized around the troilite melts — but not further away — indicating that there was a steep temperature gradient around the troilite.

Several fissures penetrate the mass; the Brezina lamellae, especially, are brecciated and have been easily accessible to terrestrial corrosion, but there are also tiny cracks following cubic cleavage planes in the kamacite. It appears that these features antedate the atmospheric flight and date right back to the violent event which shock-melted the troilite.

Needles is a fine octahedrite which is closely related to Wallapai both structurally and chemically. The following small but real differences indicate, however, that the two meteorites are independent falls: the main and trace element composition; the bandwidth; the incipient recrystallization and the shock-melted troilite in Needles; and the lower hardness of Needles. It appears that Needles has suffered a slight cosmic annealing (recrystallization, spheroplessite and relatively low kamacite hardness), while Wallapai has not.

Specimens in the U.S. National Museum in Washington:
9.89 kg corner (no. 3533, 14 x 13 x 10 cm)
515 g part slice (no. 3533, 12 x 9 x 0.7 cm)
290 g various slices (no. 3533)

Negrillos, Tarapaca, Chile
19°53'S, 69°50'W; 1,500 m

Hexahedrite, H. Single crystal larger than 25 cm. Neumann bands. HV 180±15.
Group II A. 5.38% Ni, 0.41% Co, 0.22% P, 59 ppm Ga, 179 ppm Ge, 59 ppm Ir.

NEEDLES — SELECTED CHEMICAL ANALYSES

<table>
<thead>
<tr>
<th>Reference</th>
<th>percentage</th>
<th>ppm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wasson &amp; Kimberlin</td>
<td>10.3</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Ni</th>
<th>Co</th>
<th>P</th>
<th>C</th>
<th>S</th>
<th>Cr</th>
<th>Cu</th>
<th>Zn</th>
<th>Ga</th>
<th>Ge</th>
<th>Ir</th>
<th>Pt</th>
</tr>
</thead>
<tbody>
<tr>
<td>77.2</td>
<td>92.7</td>
<td>4.8</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
HISTORY
A mass of 28.5 kg was found before 1936, buried in nitrate deposits in the Iquique Pampa, near Huara and Negrillos. The U.S. National Museum obtained 18 kg through the cooperation of Mr. Mark Bandy, but the exact details concerning the locality and circumstances of find were never received. It appears, however, that Negrillos is the same town as Negreiros which has the coordinates given above. In a letter of February 26, 1936, to Dr. A. Wetmore, Smithsonian Institution, Mark Bandy remarks: "The meteorite is in a rather bad condition externally as it has been found buried in the nitrate and has subsequently been through a fire."

Henderson (1941a) briefly mentioned Negrillos as a new locality and presented an analysis. Wasson & Goldstein (1968) discussed its relationship with other Chilean hexahedrites and concluded, mainly on basis of the iridium content, that it was a separate fall. Negrillos' isolated position is clearly seen in Wasson's listing (1969: table II) of the Ni-Ga-Ge-Ir content of a large number of hexahedrites. Herr et al. (1961) examined the osmium and rhenium isotopes; Negrillos proved to be the richest of 30 examined meteorites. Signer & Nier (1962) measured the noble gas contents and concluded that the preatmospheric mass had been an unbelievable 200 ton body, while the cosmic radiation age was estimated as 30±15 million years. Bauer (1963) determined the $^{3}$He/$^{4}$He ratio and estimated the cosmic radiation age to be 54 million years. Chang & Wänke (1969) estimated it to be 45±30 million years. They also estimated the terrestrial age to be more than 900,000 years, since the $^{36}$Cl activity was negligible.

COLLECTIONS
Washington (15.6 kg), London (1,644 g), Mainz (256 g), Moscow (252 g), Sydney (221 g), New York (24 g).

DESCRIPTION
The approximate overall dimensions of the irregular mass were 25 x 25 x 12 cm. It is severely corroded and covered with a somewhat porous oxide crust that ranges from 1 to 10 mm in thickness. The surface is rough, because it is pitted with large and small cavities, 3-40 mm across and 5-15 mm deep. All traces of fusion crust and heat-affected rim zones have been lost by terrestrial weathering. The surface is rather different from the regularly pitted surface of many other Chilean irons, probably because this one was completely buried in the nitrate deposits.

Etched sections show that Negrillos is a ferritic single crystal which is larger than 25 cm in diameter. On macroscopic examination several sets of Neumann bands and the 5-20 mm troilite-daubreelite nodules are the characteristic features, and also the corrosion, which at one end penetrates many centimeters along the Neumann bands and makes it easy to separate small, angular fragments. At high magnification the Neumann bands are seen to be wide (3-10 μm) in such kamacite that is poor in small rhabdites, but narrow (< 1 μm) in kamacite which is rich in small rhabdites. Some sets of Neumann bands have served as nucleation sites for a considerable number of rhabdites. These are 2-5 μm thick and arranged along both sides of the bands. It is probably the depletion of nickel and phosphorus around these bands that has created a significant chemical potential sufficient to lead to the severe corrosion attack along the Neumann bands mentioned above.

The etched surfaces, for the greater part, are irregularly divided into matte and bright areas, with each occupying about 50% of the surface. The matte areas are best developed around the sulfide nodules, while the bright areas fill in the remaining surface. The main reason for the variation appears to be the number and size of precipitated rhabdites. They are extremely numerous, and less than 1 μm across, in the matte areas, but fewer, and 5-15 μm thick, in

Figure 1222. Negrillos (U.S.N.M. no. 1222). A 7.45 kg endpiece showing the corroded crust. Corrosion penetrates along cubic cleavage planes and along certain sets of Neumann bands. Partially shock-melted troilite nodules with daubreelite lamellae appear black on the section. Deep-etched. Scale bar 2 cm.

<table>
<thead>
<tr>
<th>References</th>
<th>Ni</th>
<th>Co</th>
<th>P</th>
<th>C</th>
<th>S</th>
<th>Cr</th>
<th>Cu</th>
<th>Zn</th>
<th>Ga</th>
<th>Ge</th>
<th>Ir</th>
<th>Pt</th>
</tr>
</thead>
<tbody>
<tr>
<td>Henderson 1941a</td>
<td>5.32</td>
<td>0.35</td>
<td>0.22</td>
<td>200</td>
<td></td>
<td></td>
<td>80</td>
<td></td>
<td>55</td>
<td>136</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lovering et al. 1957</td>
<td>5.41</td>
<td>0.46</td>
<td></td>
<td>113</td>
<td></td>
<td></td>
<td>80</td>
<td></td>
<td>55</td>
<td>136</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wasson &amp; Kimberlin</td>
<td>5.41</td>
<td></td>
<td></td>
<td>113</td>
<td>59</td>
<td>179</td>
<td>136</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1967</td>
<td>5.41</td>
<td></td>
<td></td>
<td>113</td>
<td></td>
<td></td>
<td>80</td>
<td></td>
<td>55</td>
<td>136</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wasson 1969</td>
<td>5.41</td>
<td></td>
<td></td>
<td>113</td>
<td></td>
<td>59</td>
<td>179</td>
<td>59</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Wasson & Goldstein (1968) and Reed (1969) presented microprobe data on the kamacite composition.
Negrillos (Moscow). Lightly shaded areas with irregular outlines alternate with darkly shaded areas. In the light areas there are large (5-15 \( \mu \)) but few rhabdites; in the dark areas the rhabdites are small (< 1 \( \mu \)) and densely spaced. Deep-etched. Scale bar 20 mm. S.l. neg. 41976A.

the bright areas. The microhardness of the kamacite is 180±15, reflecting the inhomogeneities somewhat.

Troilite is common as irregular nodules and stringers, 1-16 mm across. Daubreelite occurs as parallel lamellae in the troilite and covers 10-20% by area. Some daubreelite crystals reach the large dimensions of 7 x 3 and 8 x 1 mm. The sulfide bodies are more or less deformed, and the daubreelite lamellae are violently bent in places. The troilite has been micromelted, probably by shock heating, and has partially dissolved the surrounding kamacite. The troilite has solidified rapidly to 10-20 \( \mu \) irregular grains, but these become increasingly finer where a significant amount of metal and daubreelite grains are dispersed. The daubreelite crystals are partially decomposed and contain numerous 1 \( \mu \) metallic grains; subangular daubreelite fragments, 1-5 \( \mu \) across, are dispersed through the troilite. The adjacent kamacite is partially recrystallized to 10-50 \( \mu \) equiaxial units.

Negrillos is a hexahedrite which is relatively poor in rhabdites, in harmony with the relatively low P-value of 0.22%. No large phosphides occur. No indications of the artificial reheating, mentioned by Mark Bandy, were observed, neither in the structure, nor in the hardness.

Negrillos is structurally and chemically related to Scottsville and the North Chilean Sierra Gorda. It is unrelated to a number of other North Chilean hexahedrites. The phosphorus content is significantly lower – and the iridium content significantly higher – than in Coya Norte, the type member of the North Chilean group.

Specimens in the U.S. National Museum in Washington:
7.45 kg endpiece (no. 1222, 22 x 12 x 7 cm)
5.96 kg corner (no. 1222, 16 x 11 x 9 cm)
1.70 kg slice (no. 1222, 20 x 12 x 1 cm)
0.50 kg fragments, polished sections and turnings (no. 1222)

Figure 1223. Negrillos (Moscow). Lightly shaded areas with irregular outlines alternate with darkly shaded areas. In the light areas there are large (5-15 \( \mu \)) but few rhabdites; in the dark areas the rhabdites are small (< 1 \( \mu \)) and densely spaced. Deep-etched. Scale bar 20 mm. S.l. neg. 41976A.

Figure 1224. Nelson County (Prague no. 52). A 99 g part slice that displays the anomalous washed-out Widmanstätten structure well. Deep-etched. Scale bar 20 mm.

Nelson County, Kentucky, U.S.A.
37°45'N, 85°30'W

Coarsest octahedrite, Ogg. Bandwidth ranges from 1-10 mm. Cold-worked. HV 300±50.
Anomalous. 7.00% Ni, 0.32% Co, 0.18% P, 6.3 ppm Ga, 0.84 ppm Ge, 7.9 ppm Ir.

HISTORY
A mass of 73 kg (161 pounds) was plowed up in 1856 in Nelson County; the exact locality is not known, so the coordinates above represent the approximate center of the county. The meteorite was acquired by J.L. Smith who briefly described it with an analysis (1860). A specimen of 32 kg was sold to the Vienna collection (Brezina 1896: 236), while the remainder apparently was distributed to a large number of other collections. Brief notes were published by Brezina (1885: 217), Huntington (1888: 75), Cohen (1892: 153) and Meunier (1893a: 238). A good figure of an etched specimen was given by Brezina (1896: 288). Farrington (1915) reviewed the literature. Perry (1944) gave a photomicrograph. Paneth (1954) reported a rather substantial helium content of 20 x 10^-6 cm^3/g.

COLLECTIONS
Vienna (17.2 kg endpiece and 7.30 kg slices), London (3,985 g), Harvard (2,800 g), Paris 2,631 g), Washington (1,205 g), Chicago (887 g), Bally (460 g), Göttingen (404 g), Bonn (385 g), Berlin (358 g), New York (346 g), Vatican (252 g), Calcutta (220 g), Yale (203 g), Tübingen (141 g), Copenhagen (134 g), Budapest (124 g), Ann Arbor (116 g), Strasbourg (103 g), Prague (99 g), Helsinki (91 g), Temple (82 g), Rome (77 g), La Plata (60 g), Leningrad (59 g), Sarajevo (57 g), Hamburg (44 g), Dresden (42 g), Ottawa (32 g), Stockholm (25 g).

Nejed. See Wabar (Nejed fragments)
DESCRIPTION

According to Smith (1860), the mass was turtle-shaped with the overall dimensions of about 40 x 35 x 15 cm. According to Huntington (1888: 75), the exterior was smooth except at one end where it was very ragged, as if torn apart by an explosion. This observation may indicate that a fragment broke off during the atmospheric deceleration, as is often the case. The morphology of the specimen in Copenhagen (No.1876,40) supports this conclusion. The specimen has preserved a one millimeter thick heat-affected \( \alpha_2 \) zone, but this ends abruptly at an intercrystalline fracture. The fracture zone, which runs more or less perpendicular to the surface and terminates the specimen, is covered with a 200-500 \( \mu \) thick fusion crust composed of several layers of dendritic metal. It appears, then, that after the fracture occurred, the velocity was still sufficient for some ablation to take place and that part of the ablation-melted metal was redeposited on the newly created surfaces. Otherwise the meteorite is weathered and in places is covered by terrestrial oxides, up to 4 mm thick. Corrosion also penetrates some distance into the mass, particularly along grain boundaries and along transcristalline fissures which may date from the atmospheric breakup or may have existed ever since the violent, plastic deformation which thoroughly kneaded the meteorite.

Etched sections display a coarsest Widmanstätten structure with very irregular kamacite lamellae that range from 1-10 mm in width. The octahedral structure is clearly observed on large sections and proves that Nelson County was formed by transformation from one parent austenite crystal. The coarse structure somewhat resembles Mount Joy, El Burro and Seelägen; but since much less schreibersite has been precipitated in the grain boundaries of Nelson County, the structures are significantly different. Where the structure is most regularly developed it resembles Union County and Clark County. The kamacite is either coarse-grained and homogeneous, with few subboundaries, or composed of a large number of cells which are arranged in subparallel fingers, each 1-2 mm thick. It appears that the cellular areas were the last to transform from taenite to kamacite and, in certain respects, correspond to very open-meshed, comb plessite fields. Taenite is present as 2-10 \( \mu \) wide ribbons or as 10-25 \( \mu \) spheroidized islands; a few larger taenite blebs, 50-100 \( \mu \) across, display brown-etching, martensitic interiors. On the whole, however, taenite covers less than 1% by area.

Figure 1225. Nelson County (Copenhagen no.1876, 40). The coherence across the grain boundaries is weak, and terrestrial limonite is present here (black). Severely deformed kamacite matrix. Etched. Scale bar 3 mm.

Figure 1226. Nelson County. Detail of Figure 1225 showing the deformed kamacite in more detail. Bent and faulted Neumann bands and a shear zone below. A line of spheroidized taenite particles (dark) near center. Etched. Scale bar 300 \( \mu \).

NELSON COUNTY – SELECTED CHEMICAL ANALYSES

The two modern cobalt analyses are in good agreement and indicate that Nelson County is unusually low in cobalt. The composition of Nelson County is surprisingly similar to Clark County. It would be interesting to know whether the chromium content of Nelson County is as high as that of Clark County.

<table>
<thead>
<tr>
<th>References</th>
<th>Ni</th>
<th>Co</th>
<th>P</th>
<th>C</th>
<th>S</th>
<th>Cr</th>
<th>Cu</th>
<th>ppm Zn</th>
<th>Ga</th>
<th>Ge</th>
<th>Ir</th>
<th>Pt</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manteuffel in Cohen</td>
<td>7.11</td>
<td>0.65</td>
<td>0.15</td>
<td>6.33</td>
<td>0.84</td>
<td>7.9</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Henderson &amp; Perry</td>
<td>6.78</td>
<td>0.34</td>
<td>0.21</td>
<td>5.67</td>
<td>0.89</td>
<td>7.7</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Moore 1969, pers. comm.</td>
<td>7.16</td>
<td>0.29</td>
<td>0.17</td>
<td>6.33</td>
<td>0.84</td>
<td>7.9</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Schaudy et al. 1972</td>
<td>7.02</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Schreibersite is surprisingly rare, considering the bulk phosphorus content of 0.18%. It is present in the grain boundaries as 2-30 μ wide lamellae, but apparently never as larger inclusions of the size observed in Mount Joy, Seelásgen, etc. Rhabdites are also rare but may be present as submicroscopic particles. In any case the kamacite must be highly supersaturated with respect to phosphorus.

Troilite is only present as a few lenticular or platy bodies ranging from 2 x 1 mm to 10 x 0.5 mm in size. Daubreelite covers about 10% by area of the troilite, mainly as 10-100 μ wide lamellae.

All the structural elements mentioned above are heavily kneaded and sheared. The kamacite displays a mixture of Neumann bands and e-structure in which all linear elements are bent and faulted. Narrow shear zones cross the kamacite grains, and some specimens show elongated grains as if the discoid-shaped mass had been squeezed between cosmic anvils. The kamacite ranges in microhardness from 250-350 in harmony with the different degrees of cold deformation present. The hardest material is located in the shear zones which locally resemble steel, cold rolled to 80 or 90% reduction. The taenite and plessite fields are sheared and torn apart; and the schreibersite bodies are sheared, torn apart and arranged en-echelon, while the adjacent metal has flowed plastically around the hard inclusions. The troilite shows numerous lenticular twins due to the plastic deformation, but it has not melted. Locally, the kamacite has narrow transcrystalline fissures. They are typically 10 μ wide and up to one millimeter long and apparently follow cubic cleavage planes. Terrestrial corrosion has attacked them and widened them.

Some parts of the surface were severely hammered by the finders, but the damage is only superficial and cannot account for the extensive deformation present in the interior of the mass.

Nelson County is an anomalous meteorite, both with respect to its primary, phosphide-poor structure and to its secondary, cold-worked structure which represents one of the most thorough deformations known in iron meteorites. Also, chemically, Nelson County is anomalous. There is, however, one iron which chemically resembles Nelson County closely: Clark County. Both have been found in Kentucky but apparently about 100 km apart. The primary structures are related, and the amount of inclusions is similar. Nelson County is, however, different in its extreme degree of secondary work hardening, which makes it difficult to accept the two masses as belonging to the same fall.

Specimens in the U.S. National Museum in Washington:
216 g chiseled and hammered fragment (no. 54, 6.5 x 5 x 2 cm)
343 g part slice (no. 54, 5.5 x 5 x 1.8 cm)
281 g part slice (no. 2554, 5.5 x 4 x 1.6 cm)
98 g part slice (no. 2951, 7 x 6 x 0.3 cm)
110 g endpiece (no. 3 245, 7.5 x 3.5 x 1 cm)
157 g various fragments (nos. 54, 674, 1094, 2282, 2950)

Figure 1227. Nelson County (Copenhagen no. 1876, 40). Two schreibersite crystals which were severely brecciated and shear-displaced when the surrounding ductile metal was deformed. Three gray spheroidized taenite blebs are also seen. Etched. Scale bar 100 μ.

Figure 1228. Nelson County (Copenhagen no. 1876, 40). Above right heat-affected α₂ zone. A grain boundary crack, AB, developed late during flight and fused metal was rapidly deposited in several layers on the newly created surface. Etched. Scale bar 300 μ.

Figure 1229. Nelson County. Continuation of Figure 1228 at B. The fusion crust is a multilayered complex of dendritic, columnar metal with fused iron oxide globules. Terrestrial corrosion has added some limonite (L). Etched. Scale bar 300 μ.
Coarsest octahedrite, Ogg. Bandwidth about 10 mm. Annealed e-structure. HV 190±15.
Group IIB judging from the structure. About 5.9% Ni, 0.3% P.

HISTORY
A mass of 25 Zollpfund (equivalent to 12.5 kg) was found by a miner at a depth of one-half meter near Nenntmannsdorf in 1872. The locality is about 15 km southeast of Pirna, corresponding to the coordinates given above. The meteorite was acquired by the Dresden Mineralogical Museum where it was described and analyzed by Geinitz (1873; 1876). Geinitz noted that the mass deteriorated rapidly in the museum and assumed that lawrencite was responsible for this behavior. Although chlorine was qualitatively identified in the corrosion products, Geinitz was unable to detect any grains of the mineral itself. The situation is common for weathered iron meteorites recovered from normal soil after a long terrestrial exposure: the chloride introduced from the ground water is erroneously believed to be an original component of the meteorite which then, a priori, is supposed to be present as iron chloride in its most reduced form, FeCl₂, lawrencite.

Brezina (1885: 218) classified Nenntmannsdorf as a hexahedrite together with Coahuila, and this conclusion has since been maintained by all authorities (Henderson 1965; Hey 1966; Chang & Wänke 1969). Cohen (1903c; 1905: 69) noted, however, that the meteorite deviated in certain respects from acknowledged hexahedrites and concluded that it was a nickel-poor ataxite.

Hintenberger et al. (1967a) determined the amount of the noble gas isotopes ³He, ⁴He, ²⁰Ne, ²¹Ne and ²²Ne. Chang & Wänke (1969) deduced from measured ³⁶Ar-¹⁹¹⁷Be ratios a cosmic ray exposure age of 140±30 million years.

COLLECTIONS
Dresden (about 11 kg), Vienna (69 g), Stockholm (48 g), Budapest (48 g, lost in 1956?), Yale (47 g), Leningrad (40 g), Chicago (27 g), London (15 g), Paris (10 g), Berlin (6 g).

DESCRIPTION
According to Geinitz (1873; 1876) the mass was rounded and covered with a rather thick layer of terrestrial oxide shale. I have not seen the main mass but have had the opportunity to examine the specimens in Vienna, London and Washington. These confirm that the mass is severely weathered; the Washington material is, in fact, nothing other than thick oxide shales. The fusion crust and the heat-affected α₂ zone have disappeared by weathering.

Etched sections display an unusual structure of large ferrite grains separated by high angle grain boundaries. The grains vary extremely in size, from about 5 mm to about 5 cm. Discontinuous precipitates of schreibersite, 10-500 μ wide, are to be found in the grain boundaries. Locally, there occurs what must be remnants of a former Widmanstätten pattern. These areas exhibit a residual octahedral arrangement of 5-10 mm wide α-lamellae, separated by minute quantities of taenite and schreibersite. Terrestrial corrosion has been very active along these boundaries and has partly destroyed the cohesion across them. The 15 g sample in London (Brit. Mus. no. 56840) appears to be part of such a detached finger-sized lamella, measuring perhaps 6 x 1.5 x 1 cm before cutting. It is enveloped by discontinuous wrappings of 0.1-0.5 mm thick schreibersite.

All kamacite is of the hatched variety indicative of a transient shock wave above 130 k bar intensity. The microhardness is 190±15. Since this is far lower than the hatched kamacite of, e.g., La Primitiva (H ~ 280), it appears that Nenntmannsdorf has suffered some annealing after the

<table>
<thead>
<tr>
<th>References</th>
<th>Ni</th>
<th>Co</th>
<th>P</th>
<th>C</th>
<th>S</th>
<th>Cr</th>
<th>Cu</th>
<th>ppm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Geinitz 1876</td>
<td>6.16</td>
<td>5.48</td>
<td>0.22</td>
<td>0.22</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cohen 1905</td>
<td>5.48</td>
<td>0.71</td>
<td>0.29</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

A modern analysis is highly needed. It is expected that the composition is similar to El Burro and Sikhote-Alin, with about 5.9% Ni, 0.45% Co, 0.3% P and trace elements characteristic of group IIB.
shock hardening. Neumann bands are not present, as rightly noted by Cohen (1905).

Schreibersite occurs in the grain boundaries, as mentioned above. On either side, there are wide zones of clear kamacite because the matrix here is too depleted in nickel and phosphorus for any phosphide particles to precipitate. In the grain interiors there are numerous somewhat spheroidized phosphide particles, generally only 1-2 μ across. Such regions appear frosty when etched, in contrast to the clear phosphide-free kamacite. Parallel zones, which occur with a distance of 5-10 mm, contain somewhat larger (4-10 μ) rhabdite particles arranged as precipitates upon a string, in a way similar to what is described for Scottsville (Buchwald 1967a) and Hex River. Perhaps these zones represent high temperature shear planes which, at an early date, became nucleation sites for rhabdites.

Troilite occurs as scattered nodules of centimeter size. One, on the Vienna sample, measures 3 x 3 cm and exhibits a plane surface along one side. It has been described as anvil-shaped by Brezina (1885). It appears that this plane surface is created by shear in the metallic matrix which has led to an offset of perhaps 4 cm of the two sides of the troilite nodule. Only larger sections through the main mass can solve this problem. The troilite is associated with significant amounts of schreibersite which forms a 0.5 mm thick rim on the troilite and more massive skeleton crystals, about 2 x 1 cm in size, farther away.

Carlsbergite is present in minute quantities as hard rose colored platelets, 10 x 1 μ in size. In a few places, remnants of earlier cohenite can be detected on the grain boundaries. It appears that phosphide crystals have previously been wrapped in 10-20 μ wide cohenite precipitates. Due to gentle annealing, the cohenite is now decomposed to serrated or columnar α-crystallites and graphite.

Figure 1231. Nenntmannsdorf (Brit. Mus. no. 56840). Three kamacite grains meet along high angle boundaries with schreibersite precipitates. Fine phosphide precipitates may be seen in the grain interiors and on certain subboundaries. Etched. Scale bar 100 μ.

Figure 1232. Nenntmannsdorf (Brit. Mus. no. 56840). Two parallel rows of rhabdites and fine, somewhat spheroidized rhabdites in the matrix. Etched. Scale bar 50 μ.

Figure 1233. Nenntmannsdorf (Brit. Mus. no. 56840). A grain boundary (vertical) with three schreibersite crystals. The largest was once enveloped in a rim of cohenite. This decomposed on cosmic annealing to granulated ferrite and graphite (outside the plane of section). Etched. Scale bar 40 μ.

Figure 1234. Nenntmannsdorf (Brit. Mus. no. 56840). Near-surface section. Terrestrial corrosion serves to develop the duplex kamacite structure better than laboratory etchants. The kamacite is apparently an annealed shock-hatched ferrite; this interpretation is supported by its relatively low hardness. A Vickers pyramid indentation is seen. Lightly etched. Scale bar 50 μ.
Nenntmannsdorf is not a hexahedrite of the Coahuila or Hex River type. It contains somewhat more nickel and phosphorus, and it exhibits residual Widmanstätten structure. This would probably be clearly revealed if the main mass were exposed to new sectioning. It appears then that Nenntmannsdorf is a coarsest octahedrite, related to such well-known meteorites as Sikhote-Alin, Mount Joy and El Burro, or possibly to Mount Dooling. Its trace-element composition will probably reveal a relationship to group IIB.

Specimen in the U.S. National Museum in Washington: 15 g oxide-shales (no. 1095)

Neptune Mountains, Pensacola Mountains, Antarctica

83°15'S, 55°W

Coarse octahedrite, Og. Bandwidth 1.9±0.4 mm. Neumann bands. HV 180±10.

Group I. 7.1% Ni, about 0.20% P, 73.9 ppm Ga, 269 ppm Ge, 2.0 ppm Ir.

Figure 1235. Neptune Mountains (U.S.N.M. no. 2614). A well-preserved iron meteorite of 1 kg from Antarctica. Regmaglypts and indistinct fusion crusts. Scale bar approximately 2 cm. S.I. neg. 1616D.

Figure 1236. Neptune Mountains. (U.S.N.M. no. 2614). The end-piece from Figure 1235. A coarse octahedrite of group I related to Cranbourne and Canyon Diablo. Heat-affected zoned around the whole sample. Deep-etched. Scale bar 10 mm. S.I. neg. 1617.

NEPTUNE MOUNTAINS — SELECTED CHEMICAL ANALYSES

<table>
<thead>
<tr>
<th>References</th>
<th>Ni</th>
<th>Co</th>
<th>P</th>
<th>C</th>
<th>S</th>
<th>Cr</th>
<th>Cu</th>
<th>ppm</th>
<th>Zn</th>
<th>Ga</th>
<th>Ge</th>
<th>Ir</th>
<th>Pt</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wasson 1970, pers. comm.</td>
<td>7.1±0.2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

HISTORY

A mass of 1,070 g was found in February 1964 by engineers J.R. Heiser and D.C. Barnett who were members of an expedition of the U.S. Antarctic Research Program. The mass was located among glacial debris about 30 m above the ice base enveloping a nunatak in the central part of Neptune Mountains (Krinov: Meteoritical Bulletin, No. 34, 1965; D.L. Schmidt: Geology of the Pensacola Mountains. Bulletin of the U.S. Antarctic Projects Officer, 1964: No. 5: 98-101). In 1965 it was donated to the U.S. National Museum where it is preserved in its entirety.

DESCRIPTION

The mass has the overall dimensions of 10 x 6.5 x 5 cm and weighs 1,070 g. It is well-preserved. The surface is indented by numerous regmaglypts that range from 8 to 15 mm in diameter and from 5 to 10 mm in depth. If the meteorite was ever transported by the adjacent glacier, it proceeded in a very gentle way, since the fusion crust is still preserved locally; and the surface is undented and shows no signs of scoring. Sections through the meteorite confirm this conclusion. The oxidic fusion crust is lost, but the metallic fusion crust is preserved in several places as a 50-100 µ cover composed of two or more sheets of dendritic metal.

An unusual feature is the presence of veinlets of fused metal to a depth of 2-3 mm under the surface. A close inspection shows that the veinlets, which are 75-300 µ wide, occupy fissures which were formed when surface-outcropping schreibersite crystals melted and left gaping cavities. Ablation-melted metal from other parts of the

<table>
<thead>
<tr>
<th>References</th>
<th>Ni</th>
<th>Co</th>
<th>P</th>
<th>C</th>
<th>S</th>
<th>Cr</th>
<th>Cu</th>
<th>ppm</th>
<th>Zn</th>
<th>Ga</th>
<th>Ge</th>
<th>Ir</th>
<th>Pt</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wasson 1970, pers. comm.</td>
<td>7.1±0.2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
surface rapidly filled in the fissures, and solidified by heat conduction from the cold walls. The resulting columnar dendrites are perpendicular to the walls and have often grown continuously until they met the dendrites coming from the opposite wall. The dendrites are typically 50-150 μ long and 2-5 μ wide and have an arm spacing of about 1 μ, indicating a very rapid solidification. Along the middle of the fissures, a small amount of dendritic oxide species, 2-20 μ across, were trapped. Terrestrial weathering has added some limonitic oxides.

Under the fusion crust is a heat-affected α₂ zone, 1.0-2.5 mm wide. Under pointed edges it increases to 5 mm. Micromelted phosphides are present in the exterior 50% of the zone, which has a microhardness of 200±10.

Etched sections display a coarse Widmanstätten structure of straight, short (120 μ ~ 8) kamacite lamellae with a width of 1.9±0.4 mm. The kamacite has Neumann bands and numerous subboundaries decorated with 1 μ rhabdites. Its microhardness is 180±10. The full hardness curve, from the heat-affected α₂ zone inwards, is of type II with a minimum of 145±5, the minimum occurring just inside the α₂ zone, corresponding to recovered ferrite.

Taenite and plessite cover 3-5% by area. The comb plessite fields are degenerated and often enveloped completely in a single kamacite grain that has grown around them. Acicular plessite with pointed, 2-5 μ wide, α-needles is common. The interior of the larger taenite grains is martensitic or sometimes a fine-grained duplex α + γ mixture. The slender taenite ribbons are frequently decomposed to a pearlitic structure with 0.5 μ wide, subparallel taenite lamellae. The taenite rims etch in bluish to brownish colors because of carbon saturation. In the heat-affected rim zone where the carbon has diffused out from the taenite rims, they etch yellow. In between is a transition zone of taenite etching in mosaic patterns; compare Kayakent. While the unaltered, bluish-etching taenite rims have a microhardness of 360±40, the yellowish-etching taenite of the heat-affected rim zone is significantly softer, 220±20.

Schreibersite is common as 0.3-1 mm thick skeleton crystals with 2-2.5 mm swathing kamacite. It is mainly these phosphides that have melted in the rim zone and have disappeared and have given room for ingressing, dendritic metal melts. The unaltered schreibersite is monocristalline but brecciated and often sheared 10-20 μ along subparallel shear zones. Schreibersite is also common as 20-150 μ wide grain boundary precipitates. Rhabdites are ubiquitous in the shape of 5-15 μ thick, sharp prisms. The bulk phosphorus content is estimated to be 0.20±0.03%.

Troilite, graphite, cohenite and silicates were not observed on the small sections available. On the surface of the main mass, however, there is an ovoid depression, 2 x 3 cm in aperture and 1 cm deep; its morphology and the peculiar corrosion products present in this depression indicate that it was the site of a troilite nodule that partially burned out in the atmosphere.

Neptune Mountains is in every structural detail a typical group I iron, closely related to the unshocked and cohenite-poor varieties of Cranbourne, Canyon Diablo and Odessa. It is the fourth meteorite found in Antarctica that has now produced a chondrite (Adelie Land), a pallasite (Thiel Mountains), a coarse octahedrite (Neptune Mountains) and a pallasite of the Bremham type (?) (Lazariev).

Specimens in the U.S. National Museum in Washington:
139 g endpiece (no. 2614, 5.5 x 3 x 2 cm)
828 g main mass (no. 2614, 6 x 6 x 4.5 cm)

---

**Netschaevo, Tula, Kaluga Oblast, RSFSR**

54°14'N, 35°9'E

Anomalous medium octahedrite with angular, chondritic fragments. Mostly α₂ matrix. HV 155±15. Anomalous. 8.46% Ni, 0.47% Co, 0.15% P, 24 ppm Ga, 65 ppm Ge, 1.8 ppm Ir.

The whole mass was artificially reheated to above 700°C and most of it was lost.

**HISTORY**

A mass of more than 15 Russian Pud (about 250 kg) was found in 1846 by farmers from the village of Netschaevo who were improving the Moscow-Tula highway. The mass was lying at a depth of 2 feet, 7 km from Mariinskoje. The coordinates have been given differently by Krinov (1947: 36). The mass was sold for four Rubels to Dr. Krinov (1947: 36). The mass was sold for four Rubels to the iron foundry at Myschega and here the block was heated in a forge and - when found malleable – was transformed to axles, springs, anchor-parts, etc. When Dr.

---

*Figure 1237. Netschaevo (Vienna no. A658). A specimen which has almost escaped destructive handling and has preserved the Widmanstätten structure very well. However, since the kamacite is now unequilibrated α₂, even this sample must have been artificially reheated above 800°C. Deep-etched. Scale bar 20 mm.*
Auerbach was informed of the find in 1857 it was too late to save the main mass, but substantial amounts of fragments were “rescued.” Auerbach (1858) gave a brief note, while Haidinger (1860b) gave a full description and presented three figures, prepared by a galvano-plastic technique from the actual deep-etched sections. Rose (1864a: 63) and Klein (1906: 127) briefly described the Berlin specimen, and Brezina (1885: 214) classified Netschaevo as a medium octahedrite with chondritic inclusions. The early investigators were puzzled by the angular silicate inclusions, and it was suggested that they represented slags introduced at the iron works. This dispute was, however, solved by analyses of Auerbach (1863) and Laspeyres & Kaiser (1895) who showed that the inclusions were more magnesium-rich than iron slags and that the principal minerals were olivine and enstatite.

Zavaritskij & Kvasha (1952) reexamined the minerals and confirmed olivine (n=1.683±0.003) and orthopyroxene as major minerals. Minor amounts of twinned plagioclase were also reported. Vogel (1952) discussed the phosphides and gave a photomicrograph. Wood (1963) noted that the silicate inclusions in a British Museum specimen were unequivocally chondritic. Vinogradov (1965: figure 5) classified Netschaevo as a mesosiderite and gave a photomicrograph of the silicates. Buchwald (1965) noted that the structure had been severely altered by artificial reheating and presented a photomicrograph of material heated above 1000° C. Buchwald (1967a: 47) further examined the iron and gave 11 photomacro- and photomicrographs, noting the presence of chondrules in some samples. He showed that the meteorite must have been heated artificially to above the α-γ transformation temperature of about 700° C and that, in fact, most of the material contained micromelted phosphides and thus had been reheated above 1000° C. Since the structural alterations of the adjacent silicates are small — or at least difficult to observe when thin sections are not available — little is known of their reaction to the artificial heat treating.

Bunch & Keil (1969) analyzed the silicate inclusions and the chromite with the microprobe; the chromite grains contained 55% Cr2O3 and no less than 10% Al2O3 and 4% MgO. Wasson (1970b) noted that the composition of the metal tallied very well with the metal of Kodaikanal, Colomera, Elga and Weekeroo Station and discussed the implications. Olsen & Jarosewich (1971) examined the chondrules with the microprobe.

**Netschaevo — Selected Chemical Analyses**

The data in the table refer to the metallic portion of the meteorite. The chemical composition of the silicates and the chromite has been recently reported by Bunch & Keil (1969) and by Olsen & Jarosewich (1971).

<table>
<thead>
<tr>
<th>References</th>
<th>Ni</th>
<th>Co</th>
<th>P</th>
<th>C</th>
<th>S</th>
<th>Cr</th>
<th>Cu</th>
<th>Zn</th>
<th>Ga</th>
<th>Ge</th>
<th>Ir</th>
<th>Pt</th>
</tr>
</thead>
<tbody>
<tr>
<td>Buchwald 1967a</td>
<td>8.29</td>
<td>0.47</td>
<td>0.15</td>
<td>60</td>
<td></td>
<td>250</td>
<td></td>
<td>12</td>
<td>64</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wasson 1970b</td>
<td>8.63</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>24.0</td>
<td>65.7</td>
<td>1.8</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Collections**

Vienna (1,093 g), London (1,000 g), Berlin (562 g), Prague (460 g), Amherst (378 g), Tübingen (345 g), Calcutta (326 g), Washington (267 g), Leningrad (202 g), Moscow (185 g), Chicago (177 g), Bonn (153 g), Copenhagen (137 g), Tempe (77 g), Tartu (73 g), Paris (70 g), Canberra (50 g), Budapest (32 g), Yale (31 g), New York.
(28 g), Ottawa (28 g), Harvard (22 g), Wroclaw (11 g), Göttingen (7 g), Moscow, Ordzhonikidze Institute (327 g), Moscow, Timirjazewa Academy (76 g).

DESCRIPTION

The largest preserved fragments weigh about 500 g, and the total known weight is only about 6.1 kg. The remainder was evidently forged into agricultural implements. The fragments often show hammered surfaces, proving these assumptions. There are fissures and overfolded parts and metallic ears, and little, if any, of the original surface is left undamaged.

From an examination of a number of specimens, it appears that angular silicate fragments cover, on an average, 25% by area. They range in size from 5 x 1 mm to rather large chunks of 4 x 3 x 2 cm. Their specific gravity measured on a 13 g piece (No. 494) is about 4.1 g/cm³, but varies with the amount of metallic inclusions present. Olivine and orthopyroxene are the main minerals, while clinopyroxene, twinned plagioclase and chromite occur in minor amounts — the chromite usually as subangular 0.1 mm grains; see, e.g., Figure 51 in Buchwald (1967a). Indications of 0.5-1 mm crystalline chondrules are present in some silicate fragments (ibid., figure 50). Pockets of kamacite, taenite and troilite, usually 5-500 μm across, occur scattered through the silicates. Some troilite is precipitated as 100-250 μm thick discontinuous rims on the silicate fragments. The troilite is monocristalline but displays lenticular twins from plastic deformation. On such specimens that were reheated above 1000 °C, the troilite micromelted and reacted with atmospheric oxygen and with the limonitic corrosion products, creating weird, lace-like structures (ibid., figures 52 a and b). — Bunch & Keil (1969) reported chlorapatite.

The metallic portion displays — on the better preserved specimens — a medium Widmanstätten structure of bulky, short (w ~ 8) kamacite lamellae with a width of 1.25±0.35 mm. The silicate fragments are enveloped in rims of swathing kamacite, 1-3 mm thick. There are indications that the metal phase of some specimens is polycrystalline, somewhat like Four Corners and Weekeroo Station with variously oriented, parent austenite crystals, 1-3 cm in diameter, separated by silicates. Since all the material preserved is subdivided into small specimens, it is difficult to reach a final conclusion as to the parent austenite size. All the specimens I have examined have been reheated sufficiently to change the kamacite to the serrated α₂ variety, i.e., they have been reheated to at least 700 °C. The microhardness is 155±15, varying somewhat with the actual maximum time and temperature to which the particular fragment has been exposed.

Taenite and plessite cover about 10% by area. The taenite is developed as anomalously wide veins, ranging from 50-100 μm, which are apparently rather homogeneous in nickel. Some comb plessite was observed, but acicular, pearlitic and spheroidized fields are not present. Some

Figure 1240. Netschaev (Copenhagen no. 1862, 486). Almost homogenized plessite field with artificial martensitic α₂. Fused schreibersite in the grain boundary below. Unequilibrated α₂ matrix. Etched. Scale bar 300 μ.

Figure 1241. Netschaev (Copenhagen no. 1862, 486). A fused and rapidly solidified schreibersite crystal. The primary austenite dendrites etch dark, probably because they are transformed to α₂ and supersaturated with respect to phosphorus. Etched. Scale bar 200 μ.

Figure 1242. Netschaev (Brit. Mus. no. 33953). Part of an angular silicate inclusion. In several places chondrule-like structures occur 0.5-1.5 mm in diameter. One is seen here, in center, surrounded by kamacite (white). Polished. Scale bar 300 μ.
Netschaevo occurs as 25-100 μ wide grain boundary precipitates and as 10-25 μ thick rims deposited upon troilite but never directly upon the silicates. Rhabdites are numerous in the matrix as 1-5 μ prisms. Due to reheating, the rhabdites are partially or fully resorbed, and the schreibersite is often micromelted. In some specimens, e.g., U.S. National Museum no. 1096, the schreibersite is unmelted but has reacted with included terrestrial corrosion products and formed 2-3 μ wide, cream-colored reaction rims. The limonite in the fissures is frequently decomposed to lace-like intergrowths with metal.

No graphite, cohenite and daubreelite crystals were observed, and troilite was only seen associated with the silicate inclusions.

Netschaevo is an anomalous meteorite, composed of about 75% polycrystalline medium octahedrite and 25% recrystallized chondritic fragments. The detailed microstructure shows that Netschaevo has little in common with the coarse type I octahedrites, such as Campo del Cielo. Only the morphology of the silicate fragments resembles that of Campo de Cielo (El Taco) closely. The trace-element analysis indicates that Netschaevo is somewhat related to Colomera, Kodaikanal and Weekeroo Station.

Specimens in the U.S. National Museum in Washington:
13 g slice through silicate fragment (no. 494, 4.5 x 2.5 x 0.45 cm)
51 g part slice with silicate fragments (no. 1096, 3.5 x 3 x 1 cm)
18 g two silicate fragments (no. 2957, 2.5 x 1.5 x 1.5 cm and splinter)
38 g corner with silicate fragments (no. 2958, 4 x 2 x 8 cm)
146 g metallic fragment (no. 3255, 4 x 3 x 2.5 cm)

New Baltimore, Pennsylvania, U.S.A.
40°1’N, 78°49’W; 810 m

Anomalous mixture of Widmanstätten structure (1.0 mm) and 1-5 cm equiaxial grains. e-structure. HV 280 ± 25.
Anomalous 6.43% Ni, 0.38% Co, 0.04% P, 20.3 ppm Ga, 37.3 ppm Ge, 12 ppm Ir.

HISTORY
A mass of nearly 40 pounds (18 kg) was plowed up in a cornfield in 1922 by Jefferson Long. His farm was located at the crest of Allegheny Mountains 4 km northwest of New Baltimore and 4 km south of U.S. Highway 30, in Somerset County. The corresponding coordinates are given above. The finder broke the mass in two with a sledge hammer, a feat made possible by the coarsely granular character of the iron. The circumstances of finding were given by Stone (1932) who also presented four photographs of the exterior. Merrill (1923d) described the meteorite and noted (1923e) the unusual mixture of fine octahedral lamellae and coarsely granular areas. Analysis proved that the two types were chemically identical within analytical error. Several photographs illustrated the individual, irregular kamacite grains that were interlocked as a jigsaw puzzle. Perry (1944) presented four photomicrographs that showed the locally heavily deformed structure, and Henderson (1965) discussed the structural implications. Jaeger & Lipschutz (1967b) estimated the e-structure to have been formed by shock pressures between 130 and 750 k bar.

COLLECTIONS
Harvard (10.4 kg), Washington (3.0 kg), Chicago (1,613 g), London (537 g), New York (430 g), Philadelphia (106 g), Tempe (62 g), Ann Arbor (56 g), Cranbrook (52 g).

DESCRIPTION
According to Stone (1932) the meteorite had the extreme dimensions of 37 x 20 x 9 cm and a weight of 18 kg. Its overall shape was smoothly lenticular, and no
conspicuous ablation grooves were present. The specimens in the U.S. National Museum are weathered and covered irregularly with up to 4 mm thick limonite crusts. No trace of fusion crust or heat-affected rim zone is preserved. After its recovery it has, in some parts, disintegrated into individual granules which range in size from 1.5 x 1 x 1 cm to 5.5 x 4 x 2 cm and in weight from 7.2 g to 133 g. These grains, while closely interlocking in the fresh iron, separate on weathering and may be detached with but little mechanical effort. The grains are, in general, equiaxial, but, in details, highly irregular with ears and concave pits where they have accommodated to the shape of other growing grains.

Etched sections show a unique mixture of equiaxial grains and Widmanstätten lamellae. The granular structure covers on the average 2/3 of the area, and the grain size ranges from 1-5 cm, as already noted from the detached grains. The Widmanstätten patches range from 1-6 cm in diameter and display a uniform orientation within each area and from area to area, proving that the parent crystal was a single austenite grain that comprised the whole mass. The kamacite lamellae are irregular in their outlines, mainly because the grain boundaries have been little restricted in their movement by precipitates; they have a width of 1.0±0.3 mm. All kamacite, whether in the coarse-grained parts or in the Widmanstätten parts, shows the hatched structure typical for shock-hardened $\epsilon$. The microhardness is correspondingly high, 280±25, which is very high for a kamacite low in nickel (6.4%) and phosphorus (0.04%).

Plessitic areas are absent, but a little taenite occurs as scattered blebs, 5-10 $\mu$m across. There is generally no taenite lined up in the Widmanstätten boundaries, and the Widmanstätten pattern is only visible because of the shifting sheen from the regularly oriented kamacite lamellae.

Schreibersite and rhodobites are absent in accordance with the low, analytical P-value of 0.037%.

An important difference between the granular and the lamellar areas is the number of millimeter-sized inclusions. On sections, totaling 550 cm$^2$, it was observed that the inclusions were associated with the granular areas only and were frequently situated near the center of each grain. Many, perhaps all, inclusions are troilite-daubreelite intergrowths which are typically 2 x 0.5, 1 x 1 or 0.5 x 0.5 mm in size. A possible explanation for the unique structure of New Baltimore may be based upon the relative ease with which new $\alpha$-phase can be nucleated heterogeneously upon sulfide inclusions while the process of homogeneous nucleation apparently is extremely difficult. If a few, scattered sulfide inclusions are present in the otherwise homogeneous taenite single crystal kamacite may, upon continuous

---

**NEW BALTIMORE - SELECTED CHEMICAL ANALYSES**

<table>
<thead>
<tr>
<th>References</th>
<th>percentage</th>
<th>ppm</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Ni</td>
<td>Co</td>
</tr>
<tr>
<td>Whitfield in Merrill</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1923e</td>
<td>6.42</td>
<td>0.33</td>
</tr>
<tr>
<td>Same, octahedral area</td>
<td>6.38</td>
<td>0.43</td>
</tr>
<tr>
<td>Wasson &amp; Kimberlin</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1967</td>
<td>6.48</td>
<td></td>
</tr>
</tbody>
</table>

Whitfield's two analyses were performed on a large kamacite grain and on finely lamellar material, respectively.
Figure 1247. New Baltimore (U.S.N.M. no. 710). Shock-hatched kamacite and severe shear deformation. Etched. Scale bar 200 μ. (Perry 1950: Volume 3.)

Figure 1248A. New Baltimore (U.S.N.M. no. 710). One of the chromium sulfide inclusions, that approach brezinaite Cr₃S₄ in composition. Polished. Oil immersion. Crossed polars. Scale bar 20 μ.

Figure 1248B. New Baltimore (U.S.N.M. no. 710). The shock-hatched kamacite matrix has a high hardness, about 280 Vickers. Etched. Oil immersion. Scale bar 20 μ.

50-500 μ wide plates parallel to (0001) of the troilite. The troilite was shock-melted and exhibited fringed interfaces with kamacite. It also penetrated the shattered daubreelite lamellae in much the same way as observed in Huizopa. Terrestrial corrosion had selectively converted the fine-grained α of the Fe-S eutectic to limonite, and the sulfide was partly converted to pentlandite.

Several 20-60 μ wide bluish-gray sulfide inclusions, distinctly anisotropic and with narrow, martensitic deformation lamellae, were examined under the microprobe and found to contain 49% Cr, 3% Fe and 45% S. This corresponds to almost pure Cr₃S₄, which has been described as Brezinaite by Bunch & Fuchs (1969). The mineral appears to be common in New Baltimore in sizes up to 0.2 mm.

In the kamacite, particularly in the lamellar regions, there are numerous short platelets, typically 20 x 5 x 1 μ, of a hard, rosy mineral. The precipitates are oriented with respect to the kamacite and were found to consist of the chromium nitride, carlsbergite, similar to that in Cape York and other irons.

New Baltimore shows evidence of violent, cosmic deformation along a few, sharp-cut shear zones. The relative displacements are of the order of one centimeter, and the shear zones are only 50 μ wide. Only a few other irons, like Muzzaffarpur and Chinga, display similar large shears. Local bending of the kamacite lamellae may also be observed.

Terrestrial corrosion has been particularly active along the shear zones, but the boundaries in the granular areas are also limonitized. In contrast, the Widmanstätten boundaries are unattacked, which seems to imply that there is a considerably larger chemical composition gradient across the granular boundaries than across the lamellar boundaries. Alternatively, microcracks were primarily formed between the equiaxial grains when the meteorite was shocked and deformed. These cracks would be easily accessible to terrestrial ground water.

cooling – nucleate here and have a long growth period before the inclusion-free parts transform. In the case of New Baltimore, the swathing kamacite had grown to a distance of 1-2 cm from the nucleus – and many grains had met – before the remaining 33% taenite, squeezed between the various alpha grains, started to transform by a Widmanstätten mechanism. The explanation is consistent with the almost universal occurrence of swathing kamacite around silicates, troilite and schreibersite. In New Baltimore it appears that the only available inclusions were sulfides; they were very small, but the mechanism of transformation was apparently the same.

Of the larger troilite-daubreelite nodules, only a single one was available for microscopic examination. It measured 4 x 1 mm and had about 20% daubreelite in the form of
New Baltimore is structurally unique. Chemically, it is anomalous, too, in combining typical group IIIA Ga-Ge-Ir ratios with significantly lower P- and Ni-values. Compare, for example, with Wabar and Norfolk. Previous suggestions by Merrill (1923d) and Stone (1932) that New Baltimore was a paired fall with Mount Joy and Pittsburg were already disproved by Henderson & Perry (1958: 368); their conclusion is fully supported here.

Specimens in the U.S. National Museum in Washington:
- 1,470 g endpiece (no. 710, 13 x 8 x 3 cm)
- 748 g piece with artificial cleavage fracture (no. 710, 10 x 7 x 3 cm)
- 167 g piece (no. 710, 11 x 8 x 0.5 cm)
- 600 g individual, loose kamacite grains (no. 710, ranging from 7 to 133 g)
- 50 g oxide-shales (no. 710)

New Leipzig, North Dakota, U.S.A.
46°22'N, 101°57'W; 750 m

Coarse octahedrite, Og. Bandwidth 2.6±0.5 mm. Neumann bands.
HV 205±10.
Group I, judging from the structure. About 6.7% Ni and 0.2% P.

HISTORY
A mass of 20.0 kg was found in 1936 by Daniel Buckwitz, Jr., on his farm on Route I, near New Leipzig, in Grant County. The corresponding coordinates are given above. Buckwitz notified a senator from North Dakota who, in turn, established connections with the U.S. National Museum, and in 1937 the mass was purchased for $150. “It is deeply gratifying for me to hear that you found the specimen to be of such type that you could pay me this amount for it. I was confident that you would do the right thing and I assure you that I greatly appreciate your kind consideration in the matter,” wrote Buckwitz to the Secretary of the Smithsonian Institution on February 6th, 1937. The discoverer was “a man of poor circumstances, located in the worst drought area in the State of North Dakota” with an invalid wife, confined to her bed with arthritis. “The discovery of this meteorite on my farm and the sale of it is a blessing from Heaven for me and I thank God for it.”

The meteorite has been briefly mentioned by A.D. Nininger (1937), but it is not described.

COLLECTIONS
- Washington (17.9 kg), Chicago (558 g), Calcutta (183 g), London (19 g), Tempe (19 g).

ANALYSES
No analysis has been performed. From an examination of the structure I would expect 6.7±0.2% Ni and 0.2±0.04% P with Ga-Ge-Ir concentrations characteristic for group I.

DESCRIPTION
The meteorite is a beautifully sculptured, angular mass with the overall dimensions of 30 x 15 x 12 cm. On most of the surface it is covered by well developed regmaglypts, ranging from 1-3 cm in diameter and 5-10 mm deep. Between the individual pits there are rounded knobs and ridges which serve to give the surface a very irregular outline. The knobs may attain dimensions of 7 x 2 x 2 cm or 3 x 2 x 2 cm. A few deep pits indicate where troilite was removed by ablation melting; the largest has an aperture of 15 x 30 mm and is 20 mm deep. Near the middle of the oblong mass, a conspicuous, straight 6 cm long crevice forms a 2 cm deep and 3 mm wide and partly undercut scar; the incision was apparently formed by ablation