LETTERS TO THE EDITOR

PHYSICAL SCIENCES

Structural Variations in Iron Meteorites

SEVERAL authors[1-4] have drawn attention to the possibility that slight variations of composition and structure may be present within the original meteoroid mass which produced the Barringer crater and the Cañon Diablo iron meteorites. Transition between regions rich and poor in cohenite, $(FeNi)_3C$, is not uncommon in large sections of this meteorite, but we now draw attention to a transition of structure from a well developed Widmanstatten to a granular pattern in a 1,235 g individual (Wards Natural Science Establishment No. 34,4,678) which does not contain macroscopically visible inclusions of cohenite.

The external form of this specimen resembles an individual Yorkshire pudding with a fairly smooth rounded base but with pronounced "thumbprints" on the top surface. It is of a convenient size and weight for use as a hand-held hammer or anvil, and local surface deformation within the thumbprinted region suggests that the specimen may indeed have been used in this way. The metal in the interior bulk of the specimen is free from deformation although there is a very pronounced fracture path running between some of the coarse grains and also in the region of the transition zone from Widmanstatten to granular structure. In all cases the fracture path is invested with terrestrial corrosion product, but it appears to follow the line of large crystals of schreibersite, $(FeNi)_3P$, which were present in the original structure. The schreibersite is now badly fragmented and heavily corroded, but it is accompanied by occasional traces of cohenite which are visible only on microscopic examination. Fig. 1 shows a cross-section of the specimen. The Widmanstatten structure at the right consists of broad octahedrally orientated bands of α Fe–Ni (kamacite) which are separated by strips of residual γ Fe–Ni (taenite) or fields of α–γ aggregate (plessite). The diagonal sets of kamacite bands stand nearly perpendicular to the plane of section whereas the shorter, near vertical bands lie at 50°–60° to the section plane. By contrast the structure is granular at the left of Fig. 1 and this is not an accident of sectioning, for the same structure appears in sections perpendicular to the one shown. The microstructural features of schreibersite and plessite are similar in the Widmanstatten and granular areas, where the plessite aggregates usually take a comb or spindle form with small areas of a pearlitic variety.

Fig. 1. Cross-section of Cañon Diablo 34,4678 etched in Nital. The true length of this specimen is 8·5 cm. A conventional Widmanstatten pattern is visible at the right of the section, but the structure is more granular at the left. Microscopic examination of the large grain at the top centre of the section reveals the presence of fourteen plessite fields the orientations of which are consistent with the Widmanstatten pattern.

The largest grain at the top centre of the section is particularly interesting. It lies between the Widmanstatten and granular areas and contains fourteen fields of plessite or strips of taenite, many of which have decomposed to a pearlitic structure, and the orientations of the plessite–taenite areas within this grain are consistent with the Widmanstatten orientations at the right of the figure. This grain, which has at least equal dimensions perpendicular to the plane of Fig. 1, thus appears to have grown from parent taenite of the same initial orientation and, as far as can be seen, has developed by the growing together of the same four families of kamacite plates as are present at the right of the sample. It is reasonable to assume that the component plates of the Widmanstatten structure have welded together in this large grain because the local nickel content of the parent taenite was too low to leave plessite and residual taenite in sufficient quantity to mark out the Widmanstatten mode of growth distinctly.

In some senses Cañon Diablo 34,4678 is the reverse case to New Baltimore, which has been reported[5] as having occasional patches of medium to fine octahedrite pattern within certain individual grains of the overall coarsest, granular, octahedrite structure. One of us[6] has conducted a detailed metallographic examination of a fragment of New Baltimore and has concluded that the fine structure is a true Widmanstatten growth and not a mechanically produced artefact.

Thus there is evidence for structural variations within at least two iron meteorites and it appears that within the octahedrites granular areas may develop by the growing together of the ordinary Widmanstatten kamacite. This reopens the question whether the straightforward unigrain hexahedrites were also produced by way of an initially Widmanstatten pattern of kamacite precipitation which later welded together, but the present investigations are not capable of elucidating this situation.

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Universal Time Control of the Polar Ionosphere

SEVERAL authors have demonstrated that, at very high latitudes, the critical frequency and height of the ionospheric $F2$ layer are strongly dependent on Universal Time. For example, Duncan[1] has shown that, in winter, a maximum occurs in the $F2$ layer critical frequency (f_0F2) near 0600 UT for Antarctic stations close to the magnetic pole. Piggott and Shapley[2] have confirmed this and demonstrated a similar behaviour in the height of maximum electron density (h_mF2). Duncan has suggested that