SHORT COMMUNICATIONS

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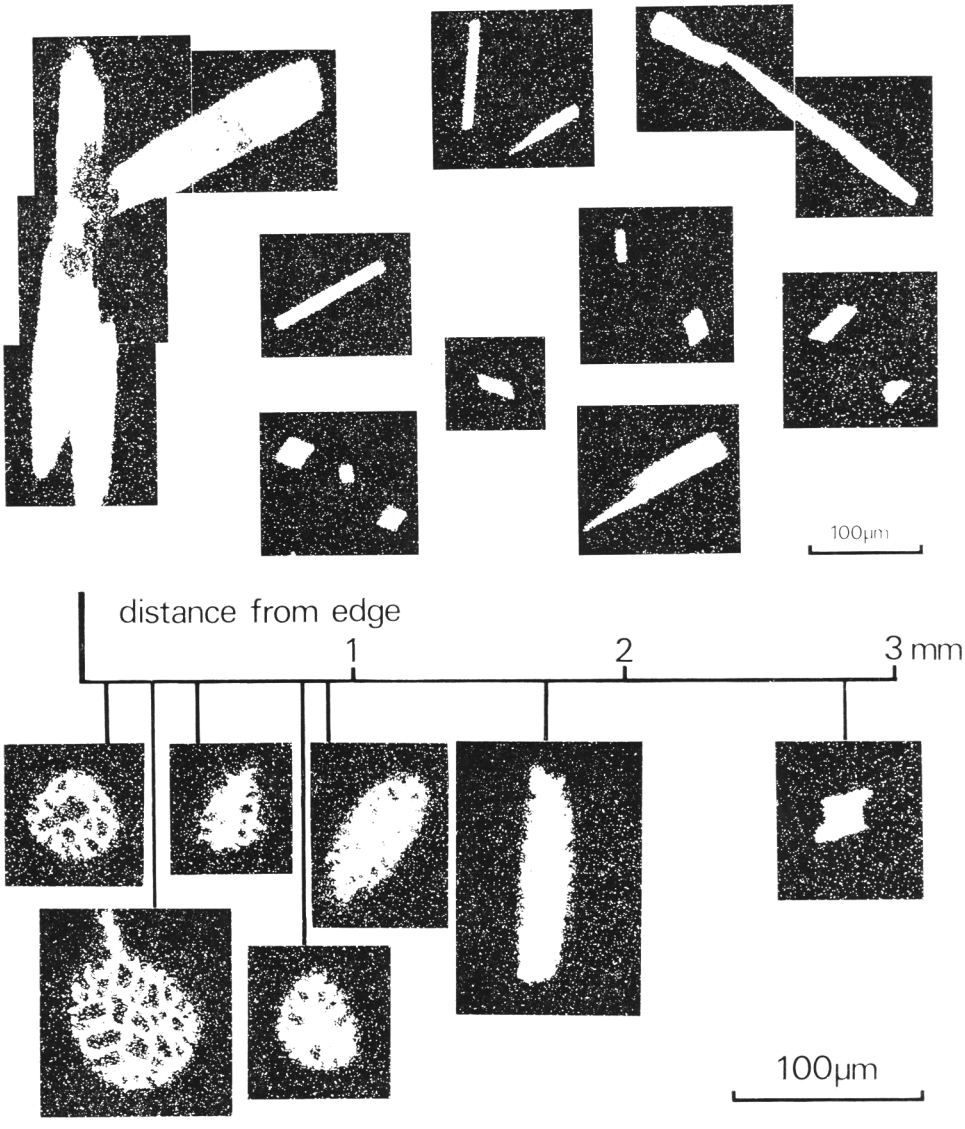
The Oktibbeha County iron meteorite

TAYLOR (1857) first described the unique Oktibbeha County iron meteorite, which was found in an Indian burial mound in Mississippi. It was originally egg-shaped and weighed about 150 g, but was split along a fissure by a sledge-hammer blow, dividing it into two nearly equal parts, one of which was forged, while the other was subjected to chiseling, sawing, and filing. According to Hey (1966) about 46 g now remains. Analyses by Taylor and by Cohen (1892) show a nickel content of about 60 %, the highest recorded in a meteorite. Hey lists another iron of similar nickel content (La Fayette), but none now remains. The next highest is the Santa Catherina iron with about 34 % Ni.

Doubts have been expressed from time to time about the authenticity of the Oktibbeha County meteorite, because of its extraordinary nickel content, although a natural terrestrial origin is improbable, since native nickel-iron (awaruite) from N. American localities contains too much nickel (74 to 77 % according to Palache *et al.*, 1944). Perry (1942, 1944) observed phosphide inclusions (identified by sodium picrate etching) in a specimen of Oktibbeha County from the American Museum of Natural History, New York, which resembled rhabdite (= schreibersite, $(Fe, Ni)_3P$) found in ordinary iron meteorites. The identity of similar inclusions in a specimen from the Academy of Natural Sciences, Philadelphia (no. 10067), has now been confirmed as schreibersite by electron microprobe analysis. Fig. 1 shows scanning pictures of 'rhabdite' in this specimen, taken with the phosphorus $K\alpha$ X-ray line. The formation of euhedral rhabdite-like schreibersite requires the very slow cooling typical of iron meteorites.

X-ray diffraction shows the metal to consist of large, well-oriented taenite (γ-nickel-iron) single crystals, giving further indication of slow cooling. In ordinary iron meteorites rhabdite occurs as orientated needles in kamacite (α-nickel-iron), and is thought to have formed below 500 °C. The Oktibbeha County 'rhabdite' probably formed at a considerably higher temperature, because diffusion is much slower in taenite than in kamacite at a given temperature. There appears to be a definite orientation relationship between the 'rhabdite' and the face-centred cubic taenite in Oktibbeha County, comparable with that existing between rhabdite and body-centred cubic kamacite in ordinary irons.

The Philadelphia specimen consists of a slice probably passing approximately through the centre of the original ovoid mass. At the edge the original schreibersite has been heated to form rounded metal–phosphide eutectoid areas. The microprobe scanning pictures in fig. 2 show how the heating effect decreases with distance from



FIGS. 1 and 2: FIG. 1 (*top*). Electron-microprobe scanning pictures of rhabdite-like schreibersite in the Philadelphia specimen of Oktibbeha County, taken with the phosphorus $K\alpha$ X-ray line. FIG. 2 (*bottom*). Electron-microprobe scanning pictures of heat-altered schreibersite near the edge of the Philadelphia specimen of Oktibbeha County, taken with the phosphorus $K\alpha$ X-ray line. The 100 μm bar refers to the scale of the pictures, while the upper scale gives the distance from the edge of the specimen.

the edge over a distance of a few mm. In the centre of the slice schreibersite is unaltered. This effect is almost certainly due to the thermal gradient produced by short-lived but intense surface heating caused by atmospheric friction, and is therefore further evidence for the meteoritic nature of the specimen. Similar effects are found in other iron meteorites.

The British Museum (Natural History) specimen (B.M. 34595) appears to be an artificially heated piece of material originally similar to the New York and Philadelphia specimens. The metal is of granular appearance in the microscope, and X-ray diffraction indicates disorientated granular taenite. Small irregular areas of barely resolvable metal–phosphide eutectoid distributed throughout the specimen are presumably relics of the schreibersite in the unaltered material. There is no evidence of a thermal gradient. Photomicrographs by Perry (1942, 1944) of a specimen from Harvard University show a similar microstructure.

Table I gives microprobe analyses of the B.M. (N.H.) and Philadelphia specimens, together with earlier analyses. Neither the metal nor the schreibersite were found to vary appreciably in composition in the Philadelphia specimen, outside the peripheral heated zone. The metal in the B.M. (N.H.) specimen was only slightly variable in composition.

TABLE I. *Analyses of the Oktibbeha County meteorite*

	Previous analyses		Microprobe analyses			
			Phil. 10067		B.M. 34595	
	Taylor (1857)	Cohen (1892)	metal	schreiber-site	metal	metal-phosphide eutectoid
Ni	59·7	62·0	60·1	65·1	61·0	65·3
Fe	37·7	37·2	39·0	20·0	38·0	22·5
Cu	0·9	0·3	0·6	—	0·8	—
Co	0·4	0·7	0·5	0·4	0·5	0·4
P	0·1	0·2	0·0	14·6	0·0	12·1
	98·8	100·4	100·2	100·1	100·3	100·3

The schreibersite in the Philadelphia specimen corresponds approximately to $(Fe_{0\cdot7}Ni_{2\cdot3})$ P, which is the most nickel-rich schreibersite recorded. The association of very nickel-rich schreibersite with taenite of similar nickel content is in accord with the phase diagram (Doan and Goldstein, 1969), in which schreibersite and taenite in equilibrium contain about the same wt. % Ni.

Conclusion. The Philadelphia specimen of Oktibbeha County is undoubtedly meteoritic. Theories of the origin of iron meteorites should therefore take into account the existence of meteoritic metal containing 60 % Ni.

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Arsenates of copper from Shetland

ROSETTES of clinoclase were observed on a specimen, no. 2671, from the collection of the Royal Institution, Liverpool, now incorporated in that of the University of Liverpool (in which it is numbered 8859).

The clinoclase, together with patches of a dark green botryoidal mineral, encrusts one side of a slab of quartz, coated on the other with a pale green clay-like substance. A narrow vein bearing cuprite crosses the middle. X-ray powder-patterns showed the botryoidal mineral to be cornwallite, accompanied by cornubite of a paler colour.

The manuscript catalogue of the Institution's collection, drawn up by Dr. T. S. Traill, describes the specimen as 'green carbonate of copper with crystals of malachite. The first is earthy investing the rock. Fitfall Head, Zetland.' Traill toured Shetland in 1803, but in his published account does not mention copper as being found on Fitful itself, though it was then being worked nearby 'at Quendal Bay,' probably on Garthsness.

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