Microsc. Microanal. 8 (Suppl. 2), 2002
DOI 10.1017.S1431927602104910

A Comparative Look at Microstructures of Iron Meteorites

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Iron meteorites come from the core of asteroids (parent bodies), dislodged by impact. The size of meteorites varies significantly. The average size is not larger than a grain of fine sand and the largest known meteorite weighs 55 metric tons. The most common iron meteorites are octahedrites. The microstructure consists of varying distributions of the three phases, kamacite, taenite and plessite, with inclusions of sulfides, carbides and phosphides. All meteorites exhibit a Widmanstatten structure of interwoven kamacite and taenite.

Kamacite is ferritic iron (α) with 5.5 to 7.5% Ni., quite often in a bar shape. *Taenite* is an austenitic phase (γ) with more than 25% Ni in solid solution. Taenite can decompose to a martensitc pattern.. *Plessite* is a fine mixture of kamacite and taenite. Plessite develops at low temperatures from retained taenite and fills the spaces between Widmanstatten patterns. Descriptive names like finger plessite are used for the different configurations of this phase. Inclusion present in meteorites are *schreibersite* $(Fe, Ni, Co)_3$ P, which is brittle, silvery in appearance and does not exist on earth, and *triolite* (FeS), which has a bronze color with a greenish tint and is usually surrounded by schreibersite.

The Canyon Diabolo meteorites fell in Arizona about 50,000 years ago creating Meteor Crater. Approximately 30 tons of this coarse octahedrite have been recovered. The macrostructure of the 250g slice examined does not show a distinctive Widmanstatten pattern (FIG. 1). The structure consists of a matrix of kamacite, irregular schribersite particles, and elongated patches of taenite. In the lower right hand corner is a triolite nodule, surrounded by schreibersite. The higher magnification image (FIG. 2) shows a matrix of kamacite that has been shock annealed to α_2, a ferritic looking structure. The darker etching areas in the taenite fields are a martensitc structure.

The Gibeon meteorites fell in Namibia, Africa. About 21 tons have been found. The Ni content of this fine octahedrite is 7.9%. The macrograph of this 10g slice (FIG. 3) shows a well developed Widmanstatten pattern of kamacite bands of uniform width and plessite fields filling the spaces between the kamacite bands. Some areas etch darker than others, indicating differences in plessite morphology. Many kamacite plates exhibit Neumann bands, which are mechanical twins caused by a cosmic collision. A high magnification image (FIG.4) shows the corner of a finger plessite field. The field is surrounded by a thin band of clear taenite and an area of very dark etching fine plessite.

The Taza meteorites were found in 2000 in Morocco with 80kg recovered to date. The high Ni content of almost 16% and the structure indicate a plessitic octahedrite. The low magnification photograph of this 2g specimen (FIG. 5) shows a plessitic, dark etching matrix with spindles of kamacite, outlined by wide taenite bands. In the high magnification photograph (FIG. 6) the plessite is resolved, revealing patches of taenite and kamacite. Also shown are a wide taenite band and kamacite.

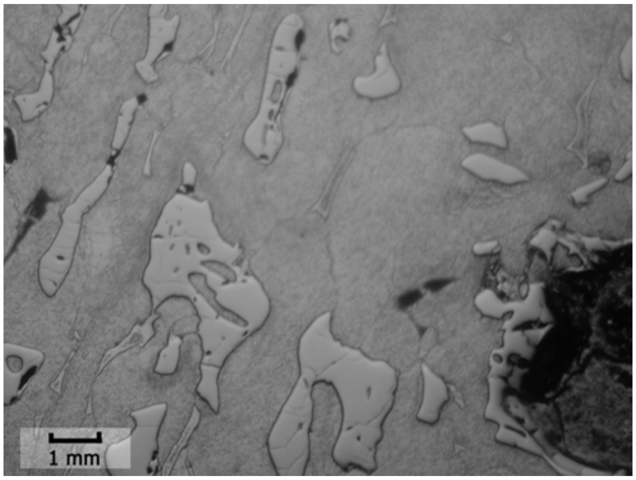

FIG. 1 Canyon Diabolo – kamacite, schreibersite, taenite and triolite

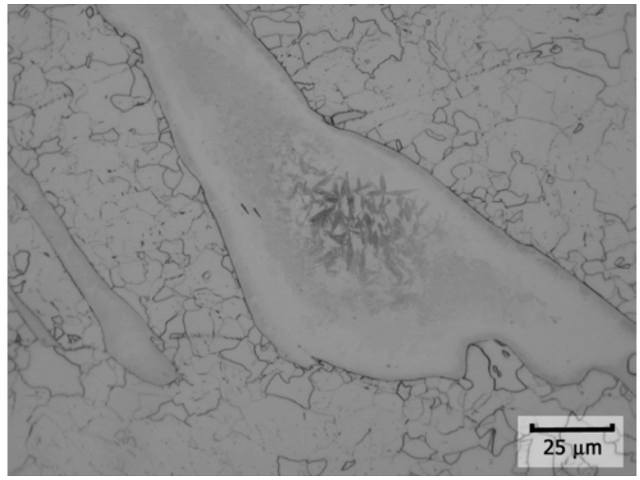

FIG. 2 Canyon Diabolo – annealed kamacite, taenite with martensitc core

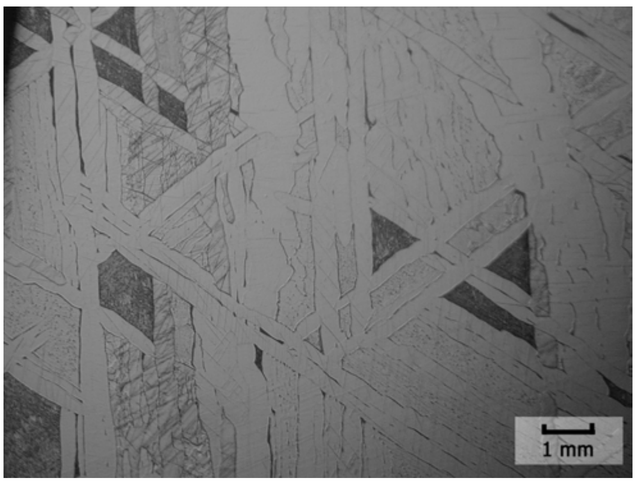

FIG. 3 Gibeon – kamacite bands, plessite fields, Neumann bands

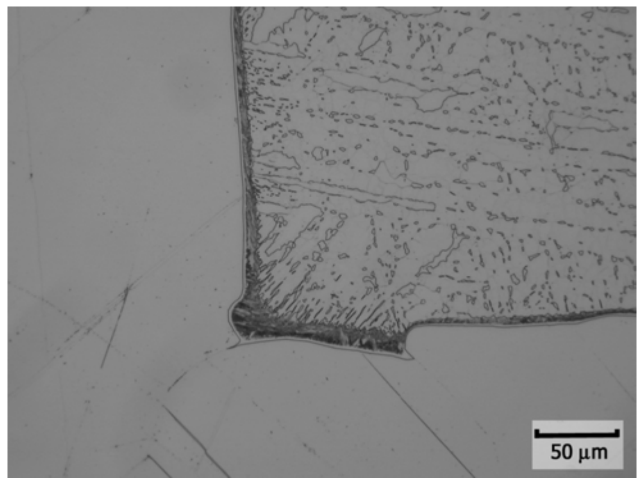

FIG. 4 Gibeon – finger plessite field with taenite band and kamacite, Neumann bands

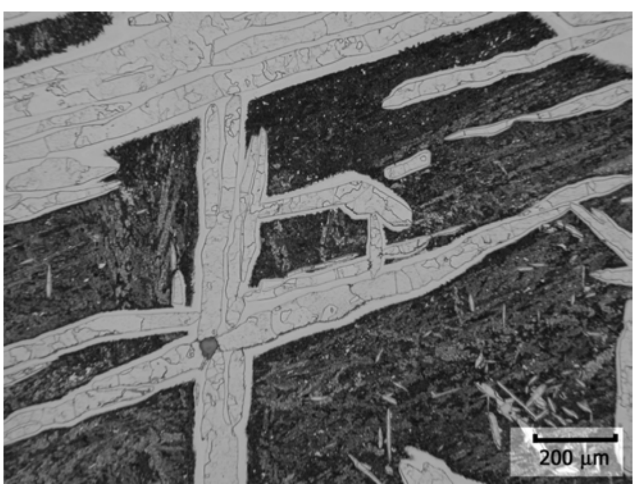

FIG. 5 Taza – plessite matrix, kamacite spindles, taenite bands

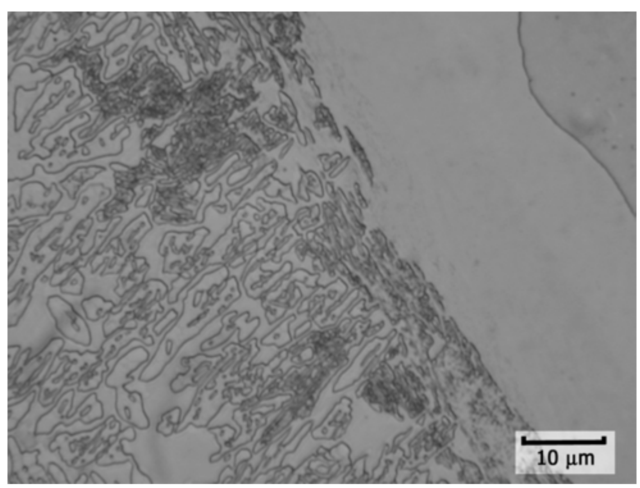

FIG. 6 Taza – patchy plessite, taenite band, kamacite

https://doi.org/10.1017/S1431927602104910 Published online by Cambridge University Press