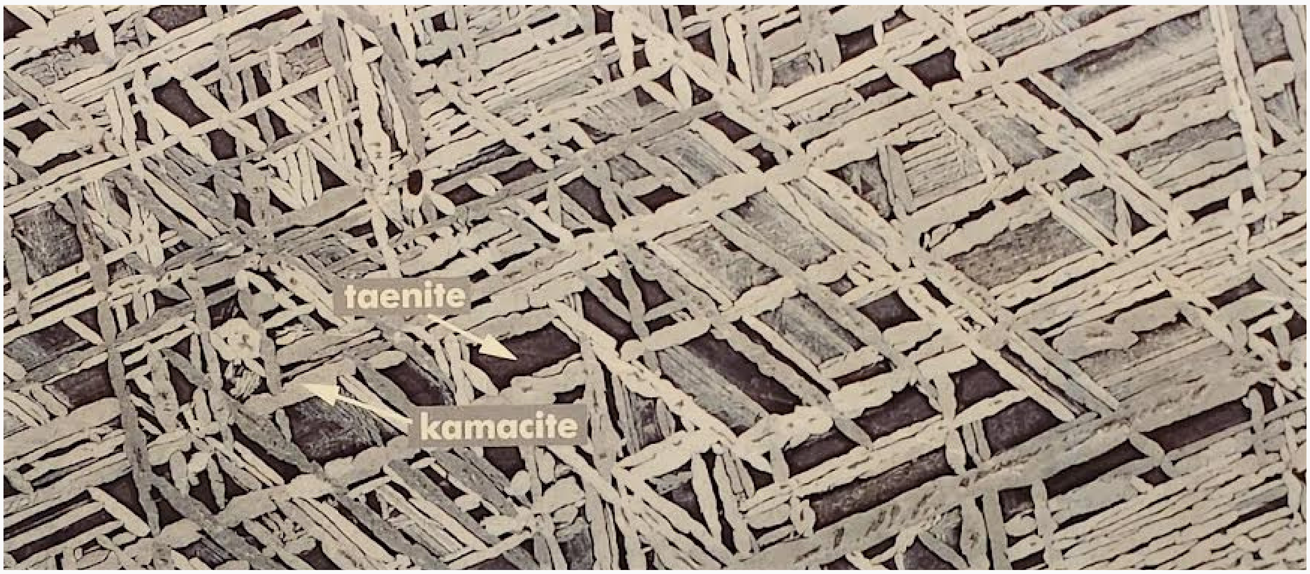
Cooling Down with Metals

FROM PEARLITE AND MARTENSITE FORMATION IN LAB EXPERIMENTS TO THE EXTRATERRESTRIAL PHENOMENON OF WIDMANSTÄTTEN PATTERNS IN METEORITES.



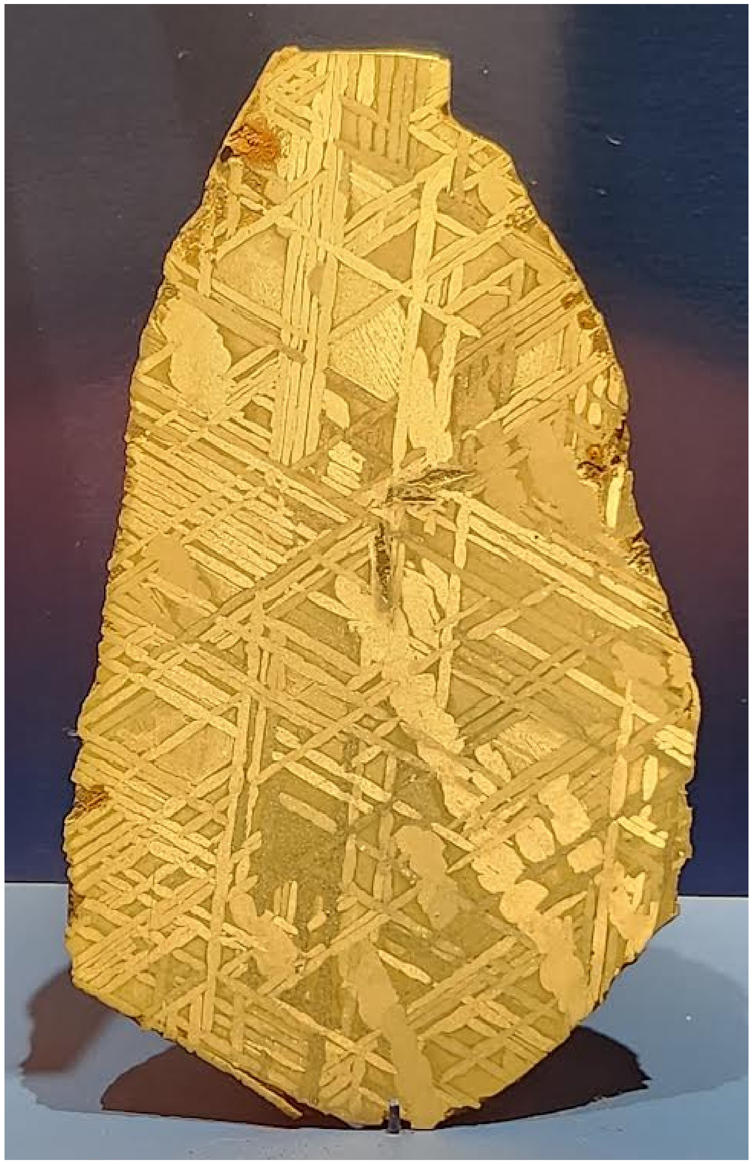
A DANCE IN THE LAB

When things cool down, they can get pretty metal! And by metal, it is obviously the study of the rate of cooling in metals. During our lab experiments, we control the cooling rate and observe how different cooling speeds lead to the formation of distinct crystalline structures in our samples. Slow cooling typically results in pearlite, while quenching in water gives rise to martensite. It's like having two different dance moves, with temperature acting as the DJ in our metallic disco! These earthly experiments also serve as a solid foundation for understanding the formation of extraterrestrial structures, such as the out-of-this-world Widmanstätten patterns found in meteorites.

Bridging the gap between our lab-scale experiments and the cosmic ballet of Widmanstätten patterns in meteorites, the growth of kamacite and taenite crystals within these celestial objects demonstrates a similar relationship between cooling rate and crystal structure as we witness in our labs. Kamacite, a body-centered cubic (BCC) iron-nickel alloy, contains approximately 90% iron and 10% nickel, forming elongated crystals that align along specific crystallographic directions. Taenite, a face-centered cubic (FCC) alloy, boasts a higher nickel content of around 20-30%, creating triangular or diamond-shaped areas interwoven between the kamacite bands.

METEORIC METAL MARVELS

The formation of these intricate patterns results from the slow cooling rates that occur in space, and play a crucial role in unveiling the cosmic history and origins of meteorites. Meteorites initially heat up due to processes like radioactive decay or collisions and gradually cool down over millions of years once ejected from their parent body. The cooling process of meteorites can span over millions of years, allowing the slow formation of the intricate Widmanstätten patterns. These patterns serve as a natural laboratory for understanding the relationships between cooling rates, nucleation, and growth of crystals, and the resulting mechanical properties of materials. To reveal the Widmanstätten patterns and the underlying grains, a meteorite sample undergoes a process of polishing to create a smooth surface, followed by etching with an acid solution, which selectively dissolves the different metallic phases, unveiling the intricate face of the interwoven kamacite and taenite crystals.



Coopertown Iron (III E) meteorite was discovered in 1860 in Robertson County, Tennessee by D. Crockett — USNM 30.