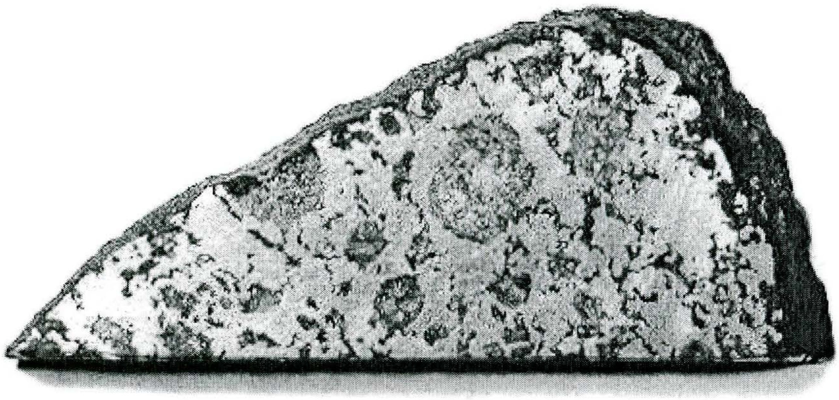
NORTHWEST AFRICA 176

Iron with silicate inclusions, ungrouped



Found 1999
no coordinates recorded

A rare Saharan iron meteorite weighing 2 kg was found near the border of Morocco and Algeria. The mass was obtained by Island Meteorites, and a portion was sent for study to several institutions; among these were the Hawaii Institute of Geophysics & Planetology, the Institute of Geophysics and Planetary Physics in Los Angeles, the Enrico Fermi Institute in Chicago, the Universitat Bern in Switzerland, and the Washington University in St. Louis. This meteorite contains sub-mm- to cm-sized, rounded, greenish-yellow, silicate inclusions dispersed throughout the metal host and comprising approximately 44 vol%. Some of the silicates are aligned along shear planes that were probably created during an impact event.

Northwest Africa 176 is nearly identical to the meteorite Bocaiuva in elemental abundances, oxygen isotope composition, and petrographic features, and both were likely derived from the same parent body - an asteroid with a composition similar to the CO-CV clan. NWA 176 also has O-isotopic compositions similar to the pallasites of the Eagle Station grouplet, but with higher Ge and Ga contents, suggesting an origin from similar chondritic material in the same region of the solar nebula. Northwest Africa 176 and Bocaiuva, along with the three Eagle Station grouplet members, are resolved from the Main Group pallasites and the major iron groups by their higher Ge/Ga ratios (>10), higher Cu and Ir contents, and lower Co contents. For those few irons that do have similar Ge/Ga ratios to NWA 176, in particular, the irons of group IIF and certain ungrouped irons, including the silicated iron, Mbosi, their elemental abundance ratios rule out a genetic relationship with NWA 176 and its relatives. Still, they all probably originated in the same nebular region from similar chondritic precursor material.

A multi-stage formation history is proposed for NWA 176 in which an initial impact generated enough heat (~1100°C) to form a melt pool. This was followed by gravitational differentiation that was sustained above ~500°C for a significant time. Differentiation resulted in a basement metallic layer with a cumulate silicate layer above. A subsequent impact event shattered the silicate layer and mobilized metal, forcing it into existing cracks in the silicate layer, while initiating a rapid cooling phase. Extended annealing at depth led to the rounding of the corners on silicate grains - a thermodynamic process acting to minimize the surface energy. Northwest Africa 176 has a remarkably high Ar-Ar age of 4.53 (±0.01) b.y., contrasted with a low CRE age for an iron of 41 (±12) m.y.

Several factors support this origin rather than the core-mantle interface origin envisioned for the Main Group pallasites. The nearly chondritic silicate composition with its relatively low proportion of olivine is more consistent with an impact-melt model than for a core-mantle interface origin. Moreover, the heat-generating radiogenic isotopes present in the later-forming carbonaceous chondrite parent bodies would be insufficient to produce melts that could form pallasitic compositions. Furthermore, the shear forces that produced the deformation features, as well as the loss of alkali volatiles, can be reconciled through impact mixing processes. Finally, the low Ir content of NWA 176 and its relatives is not consistent with the fractional crystallization processes necessary for a core-mantle origin. One possible alternative origin for this meteorite can be proposed - that the precursor was a metal-rich, highly metamorphosed, chondritic asteroid.

A portion of the above information was gleaned from the paper, *Bocaiuva - A Silicate-Inclusion Bearing Iron Meteorite Related To The Eagle-Station Pallasites* (Malvin, Wasson, Clayton, Mayeda, & Curvello), in *Meteoritics* , Vol. 20, No. 2, Part 1, June 30, 1985. Many thanks. The specimen pictured above is an 8.07 g partial slice displaying rounded silicate inclusions. It's fresh dark fusion crust attests to a recent arrival.