NORTHWEST AFRICA 2828/AL HAGGOUNIA 001 IS A WEATHERED, UNEQUILIBRATED EL CHONDRITE: TRACE ELEMENT AND PETROLOGIC EVIDENCE

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Introduction: A very large enstatite-rich meteorite (previously regarded as an aubrite) found in thousands of pieces near a sabhka lake east of El Hagounia in southern Morocco appears to be an ancient EL chondrite fall that has undergone unusual terrestrial weathering [1]. This material has been classified under various names including Al Haggounia 001, Northwest Africa 2828, Northwest Africa 2965, etc. Especially since 2006, large amounts (>3 tonnes) of material were excavated from a partly buried deposit of Pleistocene age [2] composed of fluvially-transported meteorite (and terrestrial) cobbles. Pervasive (but unusual) weathering reactions leading to selective dissolution of most of the primary metal has hampered proper classification, but new information supports our earlier contention [1] (and in contrast to [2]) that this material is ***not*** an aubrite, and should be re-classified as an enstatite chondrite of low petrologic type.

Petrographic Features: NWA 2828 contains obvious but sparse RP enstatite chondrules, some of which contain K-bearing glass. The matrix is ***not*** recrystallized, but consists mostly of enstatite ($Fs_{0.2}Wo_{1.2}$) blades, sodic plagioclase and stained voids (former primary kamacite grains) with accessory alabandite and other phases[1]. Secondary (terrestrial) phases include calcite, gypsum, halite, sylvite, melanterite (completely replacing troilite), jarosite, sulfur and silica. Analyses of rare kamacite inclusions within enstatite, as well as fresh metal in less weathered stones from the same deposit, show it to contain 0.6-1.1 wt.% Si: within the range for metal in EL chondrites but not aubrites.

Bulk Trace Element Abundances in NWA 2828: INAA on a typical sample shows that its abundances of Fe, Mn, Co and Ni are depleted by factors of 10, 25, 40 and 50 (respectively) relative to EL and EH chondrite falls [3], yet abundances of trace siderophile elements (Ir, Os, Ru, Au) are all very similar to abundances in fresh enstatite chondrites [3]. Rare earth elements (except Eu) in NWA 2828 are depleted by about half relative to enstatite chondrites, probably as a result of dissolution of oldhamite (the major carrier of REE in enstatite chondrites).

Discussion: On the basis of textural features and bulk trace siderophile abundances it is apparent that NWA 2828 is not an aubrite, but is instead a weathered EL chondrite. The weathering of this ancient fall evidently involved unusual Eh/pH conditions in a semi-arid environment, so that differential dissolution of the primary metal occurred. Goethite-rich rinds in material towards the stratigraphic top of the deposit are enriched in Ni, which is consistent with redistribution of transition metals in solution. The remarkable preservation of chondritic levels of bulk trace siderophiles in NWA 2828 may indicate that these elements were quantitatively electroplated onto the remaining metal. See also http://www4.nau.edu/meteorite/Meteorite/Al_Haggounia.html.

References: [1] Kuehner S. et al. 2006. *Trans. AGU* **87**, #P51E-1247. [2] Chennaoui-Aoudjehane H. et al. 2007. *70th Met. Soc. Mtg.*, #5329; Chennaoui-Aoudjehane H. et al. 2009. *72nd Met. Soc. Mtg.*, #5037. [3] Wasson J. and Kallemeyn G. 1988. *Phil. Trans. Roy. Soc. Lond. A* ***325***, 535-544.