TAFASSASSET AND PRIMITIVE ACHONDRITES: RECORDS OF PLANETARY DIFFERENTIATION.

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Introduction: Tafassasset (Tafa) is a unique primitive achondrite [1-5]. It has petrologic features similar to brachinites but is metal-rich and has oxygen isotopes similar to CR chondrites and the LEW 88763 (brachinite-like) meteorite [1]. It has been classified as CR7 [1], metachondrite [2], ungrouped achondrite [3] and brachinite [4]. Tafa (with LEW 887630) may represent a new parent body that has had a similar thermal history to the brachinite parent body or may be a record of isotopic heterogeneity preserved in the brachinite parent body. Another important aspect of Tafa is that it records lower degrees of partial melting than other brachinites. Here we review the petrologic features of Tafa and its relationship to other primitive achondrites and offer new hypotheses for formation of primitive achondrites.

Results: Tafa is texturally similar to Brachina, but is metal-rich, with an equigranular seriate texture dominated by olivine. Its metal abundance (~8 vol. %) [4] is much higher than in metal-poor primitive achondrites such as ureilites, lodranites and brachinites but is comparable to metal abundances in some acapulcoites and winonaites, as well as enstatite chondrite melt rocks. Chromite occurs as inclusions in the major minerals, as well as in interstitial areas. Metal and sulfides are interstitial to the silicates. Two pyroxene thermometry yields an equilibration temperature of about 875^{o}C [4], somewhat lower than those obtained for Brachina (about 1050^{o}C) [6].

Discussion: Primitive achondrites continue to be perplexing. This may, in part, be due to limited sampling from their parent bodies. Tafa (and LEW 88763) may have evolved from a different chondritic starting material than the brachinites (different parent body), possibly a CR chondrite-like parental material. This intiates the question of where and how these meteorites form. In incremental accretion models, asteroids continue to accrete during and shortly following differentiation. In [7], they show that a parent body that accreted to ~200 km in radius by ~1.5 Ma after the formation of CAIs might have a differentiated interior, and ongoing accretion would add a solid undifferentiated crust overlying the differentiated interior, consistent with the paleomagnetic record preserved in CV chondrites. We suggest that low degrees of partial melting may be generated in the lower part of chondritic veneers and primitive achondrites such as Tafa and the brachinites may be the residua of this type of process. An alternative might be the formation of the olivine-rich residue in a late accreting body, where Al-26 heating is inefficient, allowing only low degrees of partial melt to separate sulfide and basaltic liquids. Impact erosion removes the basaltic crust exposing the brachinite sub-surface.

References: [1] Bourot-Denise M. et al. (2002) *LPS XXXIII*, Abstract # 1611. [2] Bunch T. et al. (2008) LPSC XXXIX, Abstract # 1991. [3] Gardner et al., (2007) *LPSC XXXVIII*, Abstract # 2086. [4] Nehru C. E. et al. (2003) *LPS XXXIV*, Abstract #1370. [5] Gardner et al., (2012) *GCA 85*. [6] Nehru C. E. et al. (1983) *Proc. Lunar Planet. Sci. Conf., JGR, 88,* B237-B244. [7] Elkins-Tanton et al. (2010) *EPSL 305*, 1-10.