NORTHWEST AFRICA 6693, A NEAR-ULTRAMAFIC ACHONDRITE WITH LOW (0.6 × CHONDRITIC) Mg/Si, Na-FELDSPAR, Ni-RICH Fo50 OLIVINE AND LOW $\Delta^{17}O$.

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The NWA 6693 meteorite was found as a single 5.1-kg stone. Much of its surface is weathered, but the many scattered metal grains in the interior are rust-free. This may be partly a consequence of the metal composition, which clusters tightly at (by weight) $Ni_{81}Fe_{19}Co_{0.7}$. A mode shows (in vol%) pyroxene 70, olivine 16, feldspar 13, Cr-spinel 0.6, metal 0.4, with traces of Ni-rich sulfides and merrillite. Pyroxene composition clusters tightly at $En_{57}Wo_{3.3}$ and FeO/MnO = 90; with scattered $En_{40}Wo_{40}$ lamellae rarely (where blebby) large enough for EPMA. Olivine clusters tightly at Fo_{50}, with 0.77 wt% NiO (~10% of the bulk rock's Ni occurs as NiO in olivine). The feldspar is $Ab_{92}Or_{2.5}$, except for rare grains of $Ab_{57}Or_{42}$. The spinel composition (in wt%) is 57.8 Cr_2O_3, 32.0 FeO, ~2.1 Fe_2O_3, 2.8 TiO_2, 1.7 MgO.

The igneous (no relict chondrules) texture is hard to categorize. The dominant pyroxene includes an oikocryst 5 mm across, enclosing chadacrysts of both olivine and feldspar. However, most pyroxenes are non-poikilitic and <2 mm. Most olivines are blocky and 0.5-1 mm; some grains have embayed shapes and a few grains exhibit a mantle of pyroxene. The feldspar appears interstitial, yet separated outcrops exhibit optical continuity over distances as great as 2.5 mm. In places the feldspar wraps around small mafic silicates; cf. "pincer" textures observed [1] in impact-melted but essentially undifferentiated chondrites.

The bulk oxygen isotopic composition, determined by replicate laser-fluorination at KOPRI, averages $\delta^{18}O = 4.32‰$, $\delta^{17}O = 1.19‰$ and $\Delta^{17}O = -1.08‰$. These data are in principle consistent with the acapulcoite-lodranite clan [2], but in those meteorites the mafic silicates are highly magnesian, and feldspars have lower Na/Ca. The ungrouped LEW 88763, with $\Delta^{17}O = -1.2‰$ [2,3], is a closer precedent to NWA 6693, but LEW 88763 consists mainly of olivine, its mafic silicates have higher *mg* (e.g., Fo_{65}) and its feldspars range to $Ab_{55}An_{44}$. Several CH/CB chondrites are also similar in O-isotopes to NWA 6693 [e.g., 4].

The bulk composition is in most respects close to chondritic. Two ~360 mg chips were analyzed by INAA and FB-EPMA, representing (A) fresh interior and (B) material including some rusty brown alteration. Highly siderophile elements (Os, Ir and Au) and Ni are essentially chondritic in (A); in (B) they are 0.3× chondritic, except Ni, 0.5×. The REE pattern of (A) is sloped from 0.8× CI at La-Sm, to 0.4× CI at Lu, with a (+) Eu anomaly (1.5× CI). Ga/Al (wt.) = 0.00016. The numerically greatest divergence from typical chondritic composition is shown by highly volatile elements; e.g., Zn in (A) is <0.02× CI. The most significant divergence, however, is that the mafic silicates are so ferroan, bulk Mg/Si (0.48, by wt.) is only about 0.6× chondritic; and no juggling of the olivine/pyroxene ratio (to model vagaries of crystal accumulation) can shift Mg/Si to >>0.8× chondritic. Thus, in contrast with "primitive achondrites", Mg/Si indicates NWA 6693 is no restite. The origin of this unique material is enigmatic.

References: [1] Rubin A. E. and Jones R. H (2003) *MAPS* 38, 1507–1520. [2] Greenwood R. C. et al. (2007) *LPSC* 38, #2163. [3] Swindle T. D. et al. (1998) *MAPS* 33, 31-48. [4] Ivanova M. A. et al. (2008) *MAPS* 43, 915-940.