NORTHWEST AFRICA 12273: UNIQUE UNGROUPED METAL-RICH CHONDRITE. C. B. Agee, Z. Vaci, K. Ziegler, M. N. Spilde, Department of Earth and Planetary Sciences and Institute of Meteoritics, University of New Mexico, Albuquerque, NM 87131, agee@unm.edu.

Introduction: We report here the discovery of a unique ungrouped chondrite, Northwest Africa (NWA) 12273, which consists primarily of Fe-Ni metal (~64%) and small porphyritic olivine and pyroxene type II chondrules (~30%). This metal-rich chondrite is unlike CB and G chondrites in that it has chondrules with exclusively ferroan olivines and pyroxenes, and has oxygen isotope values plotting within the LL-ordinary chondrite field.

History and Physical Charateristics: NWA 12273 was purchased by Jay Piatek from a Moroccan meteorite dealer on October 25, 2018. The original specimen was a complete individual of 280 grams, having a smooth, slightly oxizided surface, with subtle regmaglypts. A saw cut surface revealed abundant small, shiny metal grains and scattered small, dark gray chondrules (fig.1).

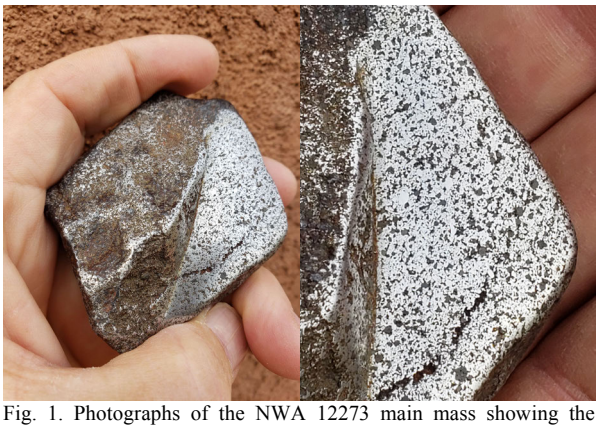

Fig. 1. Photographs of the NWA 12273 main mass showing the exterior surface and a polished saw cut exposing the interior texture.

Petrology: Electron microprobe and SEM examinations were performed on a polished probe mount taken from the classification deposit sample at the Institute of Meteoritics. SEM mapping gave the following modal abundances by area: kamacite 40%, taenite 17%, oxidized iron 8%, troilite 2.5%, silicate (primarily chondrules, only minor matrix) 30%. There was a trace amount of apatite observed. The meteorite also has a significant amount of porosity, especially in grain boundaries. Metal grains had diameters ranging from approximately 100-1000 microns. Most of the smaller grains were single phase kamacite, larger grains often possessed irregular shaped taenite cores and kamacite mantles (fig. 2). Fig. 3 shows backscatter electron images of representative chondrules in NWA 12273, which were typically in the diameter range of 200-500 microns. Most chondrules were porphyritic olivine, porphyritic pyroxene, or porphyritic olivine + pyroxene. Silica polymorph was observed in one porphyritic pyroxene chondrule. Some chondrules had crystals with pyroxene cores and olivine overgrowths. Most chondrules lacked plagioclase and instead contained mesostasis or glass, consistent with petrologic grade 3.

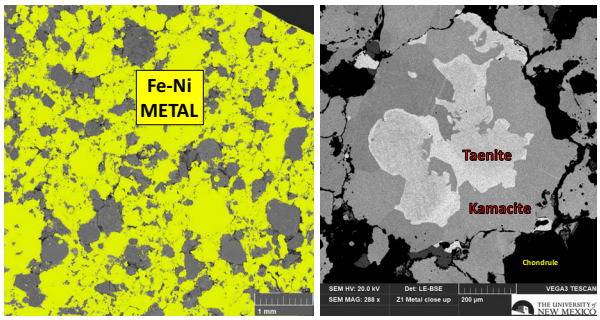

Fig. 2. SEM backscatter electron images. Left: false color yellow shows the distribution and abundance of iron-nickel metal. Gray patches are occupied by chondrules. Right: typical large metal grain with taenite core and kamacite mantle.

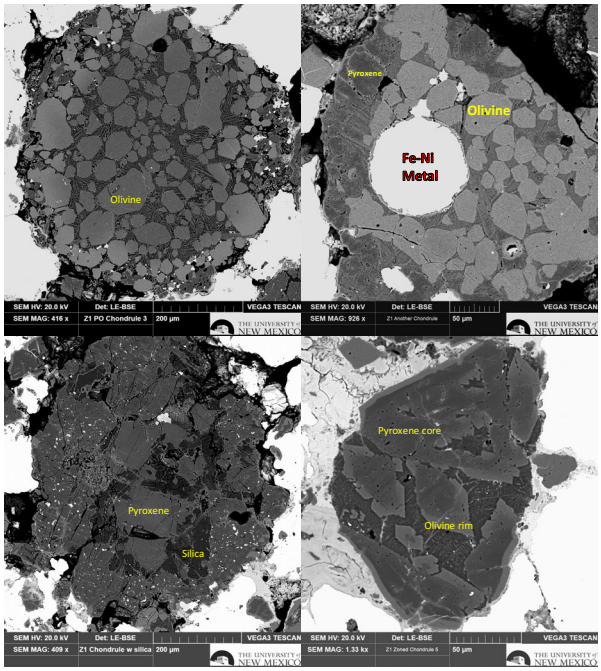

Fig. 3. SEM backscatter electron images of typical chondrules in NWA 12273.

Electron microprobe results: *Metal*: kamacite Fe=93.2±0.7, Ni=6.7±0.4, Co=0.50±0.02 (wt%) n=44; taenite Fe=78.6±8.0, Ni=20.8±7.8, Co=0.22±0.06 (wt%) n=13. Ni/Co of kamacite was sub-solar, while

Ni/Co of taenite was super-solar. *Chondrules*: olivine Fa26.3±3.0, Fe/Mn=55±5, n=45; low-Ca pyroxene Fs15.4±1.3 Wo1.0±0.7, Fe/Mn=27±10, n=27. Figure 4 illustrates the range in Fa, Fs, and Fe/Mn; olivine values are consistent with L3 or LL3, whereas low-Ca pyroxene values are consistent with H4.

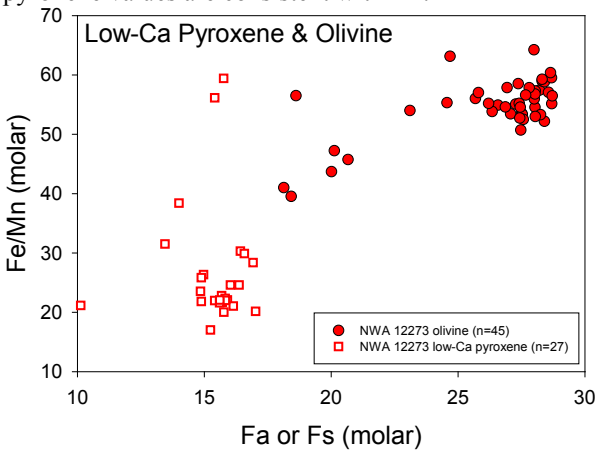

Fig. 4. Electron microprobe results for low-Ca pyroxene and olivine in NWA 12273.

Comparison of NWA 12273 with other Metal-rich Chondrites: The relatively high metal content (~64% area) and physical appearance (e.g. small chondrules) of NWA 12273 superficially resemble CB chondrites, in particular the subgroup CB-b members such as QUE 94627 and HaH 273 [1]. However, in numerous other respects NWA 12273 is unlike CB chondrites. For example, the majority of chondrules in NWA 12273 are porphyritic, whereas these are rare in CB, which instead have predominantly cryptocrystalline and barred olivine chondrules. Olivines in NWA 12273 are markedly ferroan, being similar to L/LL chondrites while CB chondrites have much more magnesian olivines with values in the range Fa1.5-4 (fig. 5). Metal in NWA 12273 shows a distinct phase separation of kamacite and taenite with non-solar Ni/Co in both phases. In contrast, CB have zoned single-phase Fe-Ni metal with approximately solar Ni/Co. Finally, oxygen isotope values of NWA 12273 (performed at UNM on 2 acid-washed fragments analyzed by laser fluorination, $\delta^{18}O$= 5.258, 5.613; $\delta^{17}O$= 3.939, 3.971, $\Delta^{17}O$= 1.163, 1.007, linearized, all per mil, TFL slope=0.528) plot in the same field as the LL ordinary chondrites (fig. 6). These values are unlike CB oxygen isotope values which plot below the terrestrial fractionation line in the vicinity of CR chondrites.

Although lower in metal abundance (23% vol) than NWA 12273, the G chondrites (GRO 95551 and NWA 5492) [2] have oxygen isotope values that plot above the terrestrial fractionation line much closer to NWA 12273 than CB values. A few chondrule oxygen isotope values of G overlap with LL, however the bulk average value is distinctly lower than NWA 12273 at approximately $\Delta^{17}O$=0.5, in between O and E chondrites. In contrast, there is no similarity between NWA 12273 olivines, which are ferroan, and G chondrite olivines (fig. 5). In fact, G chondrites appear to be even more reduced than CB, with olivine values in the range Fa0.3-1.3.

We conclude that NWA 12273 is a new unique metal-rich chondrite possessing ordinary chondrite affinities and having marked geochemical and isotopic differences with other known metal-rich chondrites such as CB and G.

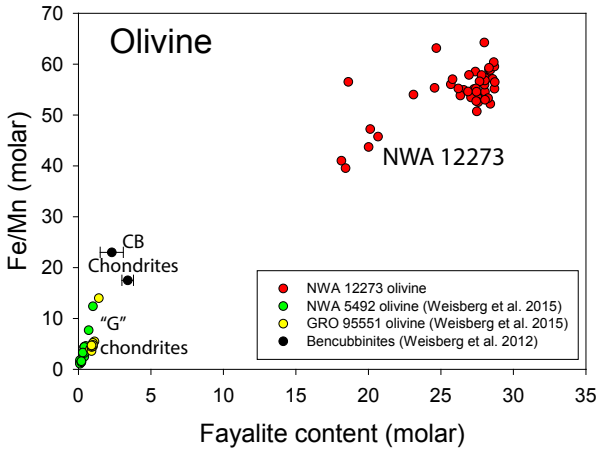

Fig. 5. Olivine Fe/Mn and Fa-content in NWA 12273, CB chondrites and "G" chondrites.

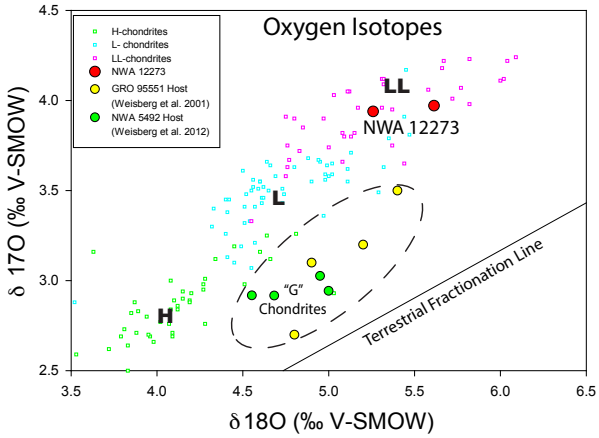

Fig. 6. Triple oxygen isotope diagram showing the values for NWA 12273 (red dots). Also shown are values from "G" chondrites and ranges of values for ordinary chondrites.

References: [1] Weisberg M. K. et al. (2001) *Meteoritics & Planet. Sci., 36,* 401–418. [2] Weisberg M. K. et al. (2015) *Geochim. Cosmochim. Acta*, 167, 269-285.