DUNITE BRECCIAS NORTHWEST AFRICA 12217, 12562: POSSIBLE PLANETESIMAL MANTLES

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Introduction: We report here the discovery of two new ungrouped achondrites, Northwest Africa (NWA) 12217 and 12562. NWA 12217 was purchased by Jay Piatek in 2015 from a Moroccan meteorite dealer. The specimen is a single 148 g stone partially covered with black fusion crust. NWA 12562, reportedly found in Algeria in 2017, was purchased by Zuokai Ke in 2018. The specimen is a single 3930 g stone with a small patch of fusion crust. Both samples appear brecciated in hand sample and contain cream-colored to pale green fragmental grains up to 1 cm in size. Discoloration from weathering on some clasts is apparent on both samples.

Mineralogy and Petrology: Polished mounts and a thin section of NWA 12217 show a dunite composed of approximately 93% olivine, 4% low and high-Ca pyroxene, and minor chromite, Fe-sulfide, FeNi metal, andesine plagioclase, alkali feldspar, merrillite, and silica. A polished mount of NWA 12562 shows a similar dunite with approximately 87% olivine, 9% pyroxene, and minor chromite, Fe-sulfide, FeNi metal, and plagioclase. Both meteorites also contain vermicular symplectites composed of chromite and both low and high-Ca pyroxene. Both also appear moderately shocked, with planar fracturing evident in olivine grains. Olivine grains in NWA 12217 display undulose extinction and heavy mosaicism, consistent with shock deformation. Lamellar inclusions composed of chromite, Fe-sulfide, and high-Ca pyroxene cut across olivine grains in NWA 12217. Fractures displace both these and the symplectites, suggesting that these secondary features preceded a shock event.

Major Element Chemistry: The mineralogy of NWA 12217 and 12562 appears equilibrated, as major phases show uniform, unzoned compositions. The variety in these compositions suggests that both meteorites are polymict fragmental breccias, with NWA 12562 displaying a larger amount of variance. Microprobe analyses, NWA 12217: olivine Fa9.1±2.3, Fe/Mn=36±2, n=90; low-Ca pyroxene Fs19.0±1.2 Wo2.7±0.5, Fe/Mn=25±2, n=9; high-Ca pyroxene Fs4.7±1.5 Wo39.6±3.9, Fe/Mn=21±10, n=5; plagioclase Ab62.5±8.8 An35.6±9.2, n=11; alkali feldspar Ab41.6±9.5 An2.6±7, n=9; chromite (in wt%) Al_2O_3=10.1±6.8 Cr_2O_3=59.8±5.1 MgO=10.2±2.9 MnO=0.6±0.1 FeO=17.2±3.1, n=9; kamacite (in mol%) Fe=93.1±0.1 Ni=6.8±0.1, n=8; taenite (in mol%) Fe=82.8±5.1 Ni=17.1±5.1. Microprobe analyses, NWA 12562: olivine Fa14.7±5.0, Fe/Mn=40±3, n=60; low-Ca pyroxene Fs28.8±11.6 Wo3.1±1.0, Fe/Mn=28±2, n=17; high-Ca pyroxene Fs32.3±13.9 Wo21.9±14.9, Fe/Mn=26±3, n=13; chromite (in wt%) Al_2O_3=7.2±4.8 Cr_2O_3=54.4±6.0 MgO=5.0±1.1 MnO=0.7±0.1 FeO=25.7±2.1, n=6.

Oxygen Isotopes: Laser fluorination analyses of three acid-washed fragments from each meteorite show the following oxygen isotopic values. NWA 12217: $\delta^{18}O$ = 3.723, 3.869, 3.660; $\delta^{17}O$ = 1.793, 1.884, 1.796; $\Delta^{17}O$ = -0.173, -0.159, -0.136; weighted average $\delta^{18}O$ = 1.836; $\delta^{17}O$ = 3.776; $\Delta^{17}O$ = -0.158. NWA 12562: $\delta^{18}O$ = 3.477, 3.795, 3.492; $\delta^{17}O$ = 1.609, 1.788, 1.619; $\Delta^{17}O$ = -0.227, -0.216, -0.225; weighted average $\delta^{18}O$ = 1.671; $\delta^{17}O$ = 3.586; $\Delta^{17}O$ = -0.222 (linearized, all per mil, TFL slope = 0.528). The oxygen isotopic composition of the two meteorites is almost indistinguishable, and their values plot in the vicinity of the HED meteorites, angrites, and brachinites in triple-oxygen space. Their $\Delta^{17}O$ values plot between the eucrite and angrite fractionation lines [1].

Discussion: Both NWA 12217 and 12562 exhibit petrological and geochemical characteristics that preclude their designation in any achondrite group. While the brachinites have similar dunitic mineralogy, their olivine composition is much more forsteritic (~Fa27-36 [2]). The brachinite-like achondrites contain more forsteritic olivines (~Fa20-30 [3]), but they exhibit reverse zoning and rims of orthopyroxene and opaques due to sulfidization [3]. The ureilites contain forsteritic olivine (~Fa5-25 [3]), but their diversity in oxygen isotopic composition, high CaO and Cr_2O_3 in their olivines, wt% levels of interstitial C, and olivine reduction rims [3] suggest NWA 12217 and 12562 are not associated with ureilites. The oxygen isotopic composition of these new meteorites could imply affinity with the HED meteorites such as the dunitic diogenites Miller Range (MIL) 03443 or NWA 2968 [4]. However, the presence of albitic plagioclase and alkali feldspar argues against this, as HEDs generally contain anorthitic plagioclase [5]. The symplectites identified in NWA 12217 and 12562 closely resemble similar inclusions found in lunar rocks [6], although those are associated with plagioclase. They also resemble symplectites found in the ungrouped achondrite Queen Alexandria Range (QUE) 93148 [7]. Olivines in brachinites, ureilites, and other primitive achondrites show near-constant chondritic Mn/Mg ratios, suggesting that they are residues of low degrees of partial melting [3,7]. The olivines in NWA 12217 and 12562 show constant Fe/Mn and variable Fe/Mg, suggestive of cumulates formed by large degrees of igneous differentiation and fractional crystallization, potentially within a planetesimal mantle.

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