NORTHWEST AFRICA 11575: UNIQUE UNGROUPED TRACHYANDESITE ACHONDRITE.

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Introduction: We report here the discovery of a unique achondritic meteorite, Northwest Africa (NWA) 11575, which has an estimated trachyandesite bulk composition and oxygen isotopes plotting within the LL-ordinary chondrite field.

History and Physical Charateristics: NWA 11575 was purchased by Darryl Pitt in Mauritania, 2016. The meteorite was reportedly found in June 2016 near the border region of Mali and Algeria. The specimen is a single stone, 598 grams, and is ~80% covered by fusion crust. A saw cut surface revealed a light colored surface with an aphanitic texture. A single, ~1 mm wide, dark colored shock melt vein crosscuts this surface. Also present are a few smaller xenoliths which are dark in color, angular, and aphanitic; the largest of which is approximately 1 cm across (see [1] for images of the main mass and deposit sample).

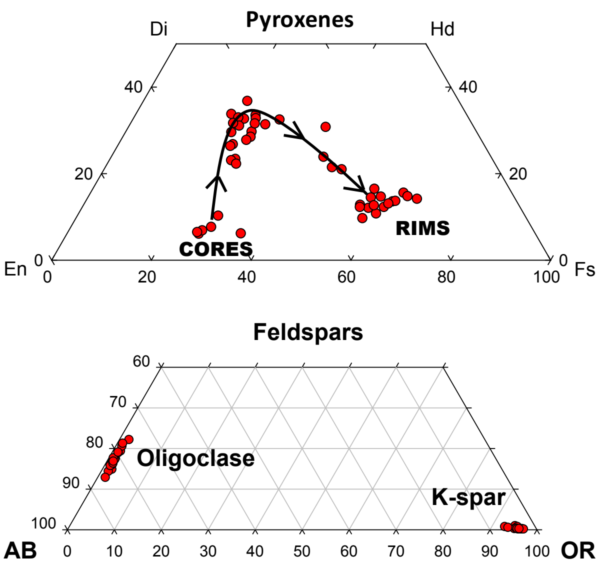

Fig. 1a (upper) Quadrilateral diagram showing the pyroxene compositions in NWA 11575. The arrows show the approximate zoning and crystallization trend within individual grains (n=45). Fig. 1b (lower) Truncated ternary diagram showing the feldspar compositions in NWA 11575 (n=43).

Petrology: Electron microprobe and SEM examinations were performed on a polished probe mount and on the saw-face of the deposit sample, respectively. An ophitic texture of pyroxene and plagioclase grains, making up approximately 90-95% of the modal mineralogy, was observed. Pyroxenes are typically 300-500 µm in size and show significant igneous zoning. The pyroxene grains have cores of magnesian pigeonite, outwardly transitioning to a zone of augite, and rimmed by a zone of sub-calcic ferroaugite to ferropigeonite (fig. 1a). Plagioclase grains are oligoclase, mostly lath-like in shape, and typically 200x50 µm in size (fig. 1b). We also observed ubiquitous potassium feldspar and a silica polymorph, which were commonly found in contact with each other, and together make up ~5% of the modal mineralogy. Minor ubiquitous phases make up ~1% of the modal mineralogy; these include ilmenite, iron sulfide phase, iron metal (nickel not detected with EMPA), chromite, phosphate phase, zircon, and iron oxide.

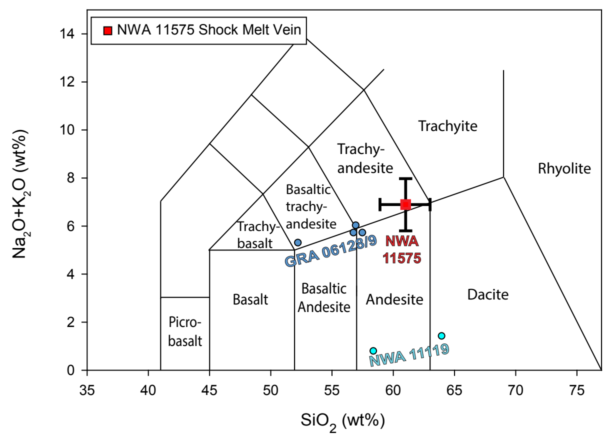

Fig. 2 Total alkalis versus silica (TAS) diagram showing the average composition of a shock melt vein in NWA 11575, which is a proxy for bulk compositon. Also shown are values for two other magmatically evolved achondrites GRA 06128/06129 [2] and NWA 11119 [3].

The dark xenolithic clasts consist of pyroxene microphenocrysts set in groundmass of quench crystals and mesostasis, and are described in [1]. The shock melt vein average composition (within the host light lithology) plots in the trachyandesite field of the TAS diagram with an error elipse that extends into the andesite and trachyite fields (fig. 2).

Electron microprobe results: Magnesian pigeonite Fs28.3±3.3 Wo7.3±1.6, Fe/Mn=37±4, n=5; augite Fs24.4±4.2 Wo30.0±3.8, Fe/Mn=33±4, n=21; ferropigeonite Fs57.3±6.2 Wo14.7±3.7, Fe/Mn=48±3, n=19; plagioclase Ab81.3±1.9 An17.4±2.0 Or1.3±0.2, n=20; potassium feldspar Ab4.0±0.9 An0.4±0.3 Or95.6±1.1, n=23; shock melt vein (proxy for light lithology bulk composition) SiO_2 = 61.0±2.1, Al_2O_3 = 14.7±2.6, Cr_2O_3 = 0.11±0.05, MgO = 2.8±1.1, FeO = 8.4±3.1, MnO = 0.17±0.07, CaO = 4.8±0.6, Na_2O = 6.3±1.1, K_2O = 0.6±0.2 (all wt%), n=20. Figure 3 shows the Fe-Mn relationship for NWA 11575 pyroxenes compared to planetary pyroxenes. The magensian-rich pigeonite cores and augitic mantles of NWA 11575 pyroxenes plot between the Earth and Mars, while the ferropigeonite rims plot between the Moon and Mars.

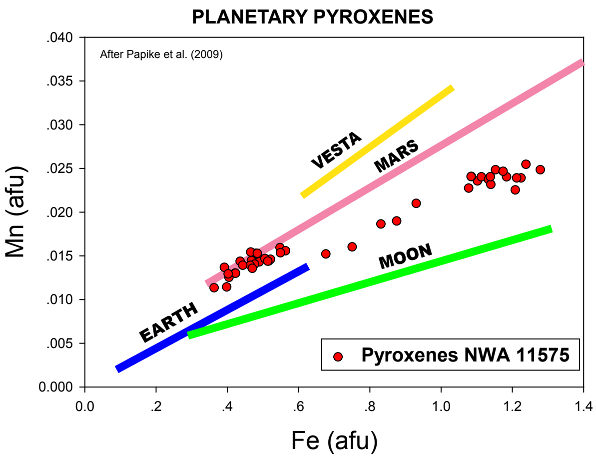

Fig. 3 Fe versus Mn (atomic formula units) diagram for planetary pyroxenes after [4] showing the range of values for pyroxenes in NWA 11575 (red dots) (n=45).

Oxygen Isotopes: Oxygen isotopes were performed at UNM on 3 acid-washed fragments analyzed by laser fluorination and gave $\delta^{18}O$= 4.875, 5.583, 5.349; $\delta^{17}O$= 3.760, 4.137, 4.006; $\Delta^{17}O$= 1.186, 1.189, 1.182 (linearized, all per mil, TFL slope=0.528), (fig. 4).

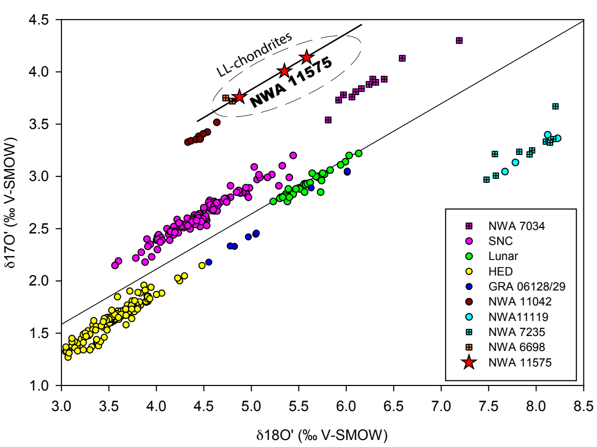

Fig. 4 Triple oxygen isotope diagram showing the values for NWA 11575 (red stars). Also shown are values from other achondrites and solar system magmatic rocks. The field for LL-ordinary chondrites is shown approximately as a dashed ellipse.

Comparison with other Solar System Magmatic Rocks: Pyroxene compositional core-rim zoning trends in NWA 11575, which reflect a change in temperature and composition of the liquid during crystallization, are similar to that observed in Martian basalt QUE 94201 [4,5] and in Apollo 15 Mare basalts [6]. In fact, this clinopyroxene differentiation trend toward extreme enrichment in the ferrosilite component is well documented in lunar igneous rocks, but is unknown in terrestrial pyroxenes [7]. Oxygen isotopes of NWA 11575 plot within the field defined by LL-chondrites (fig. 4). However the three data points from different fragments of the meteorite, form a slope of 0.53, which is parallel to the mass dependent terrestrial fractionation line (TFL) and suggests igneous differentiation [8]. Whether or not NWA 11575 was derived from an LL-ordinary chondrite precursor remains to be tested. On the other hand, the magmatically evolved bulk composition of NWA 11575 is markedly different from typical LL-melt rocks which are mafic to ultramafic and resemble a chondritic precursor bulk composition. The trachyandesitic composition of the shock melt vein of NWA 11575 plots on the TAS diagram in a broadly similar location to the estimated bulk composition of ungrouped achondrites GRA 06128/06129 (fig. 3); and also has similar oligoclase plagioclase (fig. 5). However, GRA 06128/06129 are not likely related to NWA 11575, since they are olivine-bearing, lack K-feldspar, and have oxygen isotopes that plot below the TFL. The recently reported silica-rich achondrite NWA 11119 [3] is markedly different from NWA 11575 in that it is strongly depleted in total alkalis, possesses anorthitic plagioclase, and plots well below the triple oxygen isotope TFL (fig. 5).

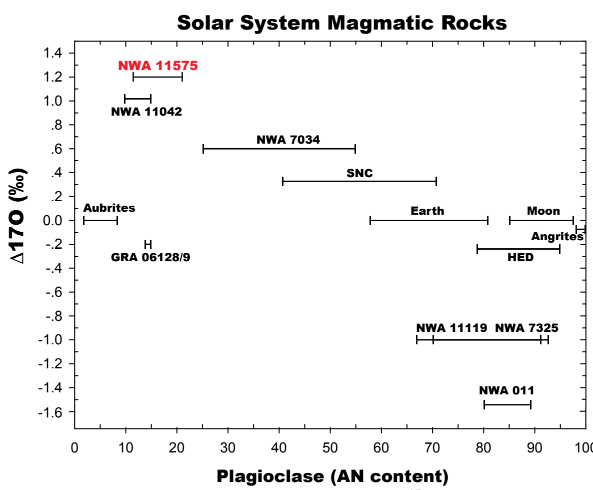

Fig. 5 Plagioclase anorthite content versus $\Delta^{17}O$ diagram showing the range of values for NWA 11575 (upper left). Also shown are value ranges from other achondrites and solar system magmatic rocks.

References: [1] Habermann M. A. and Agee C. B. (2018) *LPS XLIX,* this conference. [2] Day J. M. D. et al. (2009) *Nature,* 457, 179-182. [3] Srinivasan P. et al. (2017) *80th Annual MetSoc*, Abstract #6129.. [4] Papike J. J. et al. (2009) *Geochimica Cosmochimica Acta,* 73, 7443-7485. [5] McKay G. et al (1996) *LPS XXVII,* 851-852. [6] Kushiro I. (1973) *Carnegie Inst. Yearbook, 72,* 647-650. [7] Hargraves R. B. et al. (1970) *Science,* 167, 631-633. [8] Greenwood R. C. et al. (2017) *Chemie der Erde,* 77, 1-43.