PETROLOGY AND GEOCHEMISTRY OF ERRACHIDIA 004, A POLYMICT WINONAITE COMPOSED OF DISTINCT HIGH AND LOW METAL LITHOLOGIES.

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Introduction: Errachidia 004 is a recently recovered meteorite from Morocco in 2020 with a total mass of 2.64 kg. Most of the recovered fragments were only a few grams in mass, and it was noted that ~75% of the recovered fragments displayed low amounts of visible Fe-Ni metal while the remaining ~25% displayed high amounts of visible Fe-Ni metal. Multiple fragments were provided for classification by Sean Mahoney, of which two thin sections were made, one from a high metal fragment and one from a low metal fragment.

Petrology: Errachidia 004 exhibits two distinct lithologies (Fig. 1): 1) A low-metal lithology displaying a predominantly granoblastic texture composed of forsterite, enstatite, augite, and accessory sodic plagioclase (silicate grain size Av. 160 µm) with grain boundaries meeting at approximately 120° triple junctions. Troilite and accessory kamacite are finely scattered throughout the interior as either veinlets or individual grains; some have been altered to form Fe-oxides. 2) A high-metal lithology (up to 80 vol. % metal) displaying a well-developed Widmanstätten pattern containing kamacite, taenite, and accessory troilite and schreibersite (kamacite band width Av. 2 mm), and containing angular to sub-rounded grains of sodic plagioclase (some containing melt inclusions), augite, enstatite, and accessory Si-Al-rich glass (silicate grain size Av. 400 µm). No chondrules were observed in either lithology.

Geochemistry: Major and minor element data obtained via EPMA at *FIU* of the silicate phases in both lithologies is displayed in Table 1. No noticeable differences are observed between low-Ca pyroxene, high-Ca pyroxene, and plagioclase grains present in both the high and low metal lithologies. Oxygen isotopic data obtained via laser fluorination at *UNM* of both high and low metal lithologies are displayed (Fig. 2) and plot within the field for winonaites [1]. Siderophile element concentrations obtained via ICP-MS at *UAlberta* of a metal-separate from the high-metal lithology are reported: Ni 7.4, Co 0.30 (both reported in wt. %), Ir 5.9, Ga 28, Ge 123, As 10.1, Ru 5.0, Re 0.5, Os 13.6, Pt 9.5, Cu 180, Au 1.51 (reported in ppm). This composition would be placed into the IAB field [2].

Discussion: The textural, chemical, and isotopic characteristics of Errachidia 004 indicate that this meteorite is a winonaite [1, 3]. The co-existence of two distinct lithologies within this polymict winonaite: 1) metal-depleted ultramafic melt residue, and 2) silicate-rich IAB of basaltic composition, requires for breakup and re-assembly of the winonaite-IAB parent body [4-5] to have ocurred at a small enough scale for multiple lithologies from various depths to be mixed into meter-sized objects and subsequently thermally metamorphosed, i.e. a rubble pile.

References: [1] Greenwood et al. (2012) *Geochimica et Cosmochimica Acta* 94:146-163. [2] Wasson and Kallemeyn (2002) *Geochimica et Cosmochimica Acta* 66:2445-2473. [3] Benedix et al. (1998) *Geochimica et Cosmochimica Acta* 62:2535-2553. [4] Benedix et al. (2000) *Meteoritics & Planetary Science* 35:1127-1141. [5] Zeng et al. (2019) *Earth, Planets and Space* 71:38.

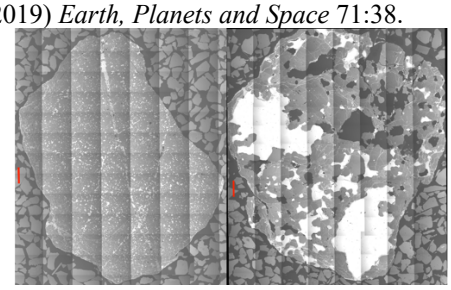

Fig. 1. BSE mosaics of low (left) and high (right) metal lithologies.

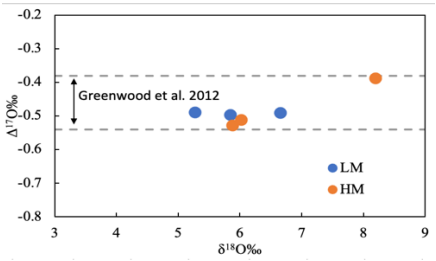

Fig. 2. O-isotopes of both lithologies.

Table 1. Representative Microprobe Data from Silicate Phases in High and Low Metal Lithologies

	Olivine-LM	Low-Ca Pyroxene-LM	High-Ca Pyroxene-LM	Plagioclase-LM	Low-Ca Pyroxene-HM	High-Ca Pyroxene-HM	Plagioclase-HM
wt. %	n=23	n=21	n=8	n=2	n=3	n=23	n=16
MgO	53.8 (*0.4*)	37.4 (*0.5*)	18.8 (*0.3*)	b.d.l.	34.4 (*0.6*)	17.6 (*0.6*)	b.d.l.
SiO_2	43.7 (*0.8*)	57.2 (*0.7*)	53.2 (*0.8*)	65.0 (*0.8*)	59.1 (*0.8*)	54.6 (*0.9*)	63.8 (*0.9*)
FeO	0.85 (*0.29*)	3.51 (*0.40*)	1.63 (*0.93*)	0.13 (*0.11*)	3.52 (*0.18*)	1.46 (*0.14*)	0.05 (*0.04*)
Na_2O	b.d.l.	b.d.l.	0.95 (*0.09*)	10.40 (*0.30*)	b.d.l.	0.99 (*0.05*)	10.03 (*0.67*)
Cr_2O_3	b.d.l.	0.26 (*0.05*)	1.44 (*0.24*)	b.d.l.	0.33 (*0.07*)	1.65 (*0.09*)	b.d.l.
Al_2O_3	b.d.l.	0.42 (*0.07*)	1.31 (*0.13*)	21.54 (*0.30*)	0.48 (*0.06*)	1.33 (*0.08*)	22.32 (*0.44*)
K_2O	b.d.l.	b.d.l.	b.d.l.	1.03 (*0.13*)	b.d.l.	b.d.l.	0.87 (*0.10*)
TiO_2	b.d.l.	0.21 (*0.07*)	0.75 (*0.10*)	b.d.l.	0.14 (*0.09*)	0.79 (*0.15*)	0.09 (*0.06*)
MnO	0.33 (*0.17*)	0.77 (*0.09*)	0.45 (*0.03*)	b.d.l.	0.72 (*0.11*)	0.48 (*0.05*)	b.d.l.
CaO	b.d.l.	0.90 (*0.15*)	21.86 (*0.67*)	2.16 (*0.02*)	1.03 (*0.24*)	21.39 (*0.79*)	2.47 (*0.35*)
Total	98.7 (*0.9*)	100.7 (*0.6*)	100.4 (*0.9*)	100.3 (*0.9*)	99.7 (*2.1*)	100.3 (*1.0*)	99.6 (*0.9*)
Fa	0.9 (*0.3*)	-	-	-	-	-	-
Fs	-	4.9 (*0.6*)	2.6 (*1.4*)	-	5.3 (*0.2*)	2.4 (*0.2*)	-
Wo	-	1.6 (*0.3*)	44.4 (*1.3*)	-	2.0 (*0.4*)	45.5 (*1.6*)	-
An	-	-	-	9.7 (*0.3*)	-	-	11.1 (*1.6*)
Or	-	-	-	5.5 (*0.8*)	-	-	4.8 (*0.5*)

LM- low metal, HM- high metal, b.d.l.- below detection limit, standard deviation in parenthesis.