Petrology and Geochemistry of Errachidia 004, a Polymict Winonaite Composed of Distinct High and Low-Metal Lithologies

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Abstract # 6253

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 (Fig. 1).
- ~75 % of the recovered fragments displayed low amounts of visible Fe-Ni metal while the remaining ~25 % displayed variable amounts of visible Fe-Ni metal (up to 80 vol. %).

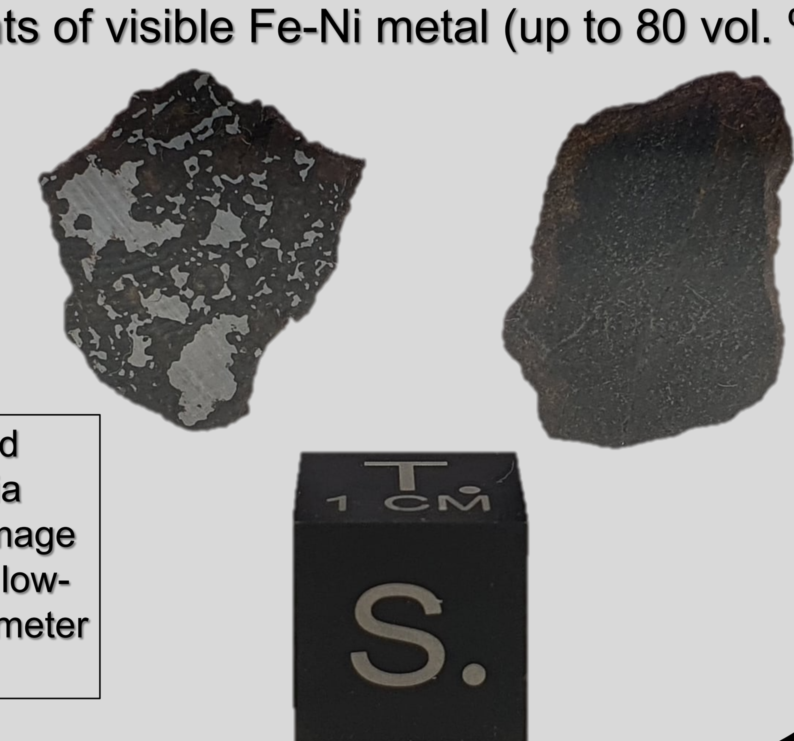

Fig. 1: Left: Recovered fragments of Errachidia 004. Right: Zoomed image containing a high and low-metal fragment. Centimeter cube for scale.

Methods

- Backscattered Electron (BSE) imaging and Electron Probe Microanalysis (EPMA) of a thin section made from both a high-metal and low-metal fragment was conducted at the Florida Center for Analytical Electron Microscopy at Florida International University (FIU).
- Oxygen isotopic data was obtained from both low-metal and high-metal fragments via laser fluorination at the University of New Mexico (UNM).
- Siderophile element compositions were obtained from metal grains separated from a high-metal fragment via ICP-MS at the University of Alberta (UAlberta).

Petrology

Errachidia 004 exhibits **two distinct lithologies** (Fig. 2):

- **A low-metal lithology** displaying a predominantly granoblastic texture composed of forsterite, enstatite, augite, and accessory sodic plagioclase (silicate grain size ~ 160 µm) with grain boundaries meeting at ~ 120º triple junctions. Troilite and kamacite are finely scattered throughout the interior as veinlets or individual grains.
- **A high-metal lithology** (up to 80 vol. % metal) displaying a well-developed Widmanstätten pattern containing kamacite, taenite, 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 ~ 400 µm).

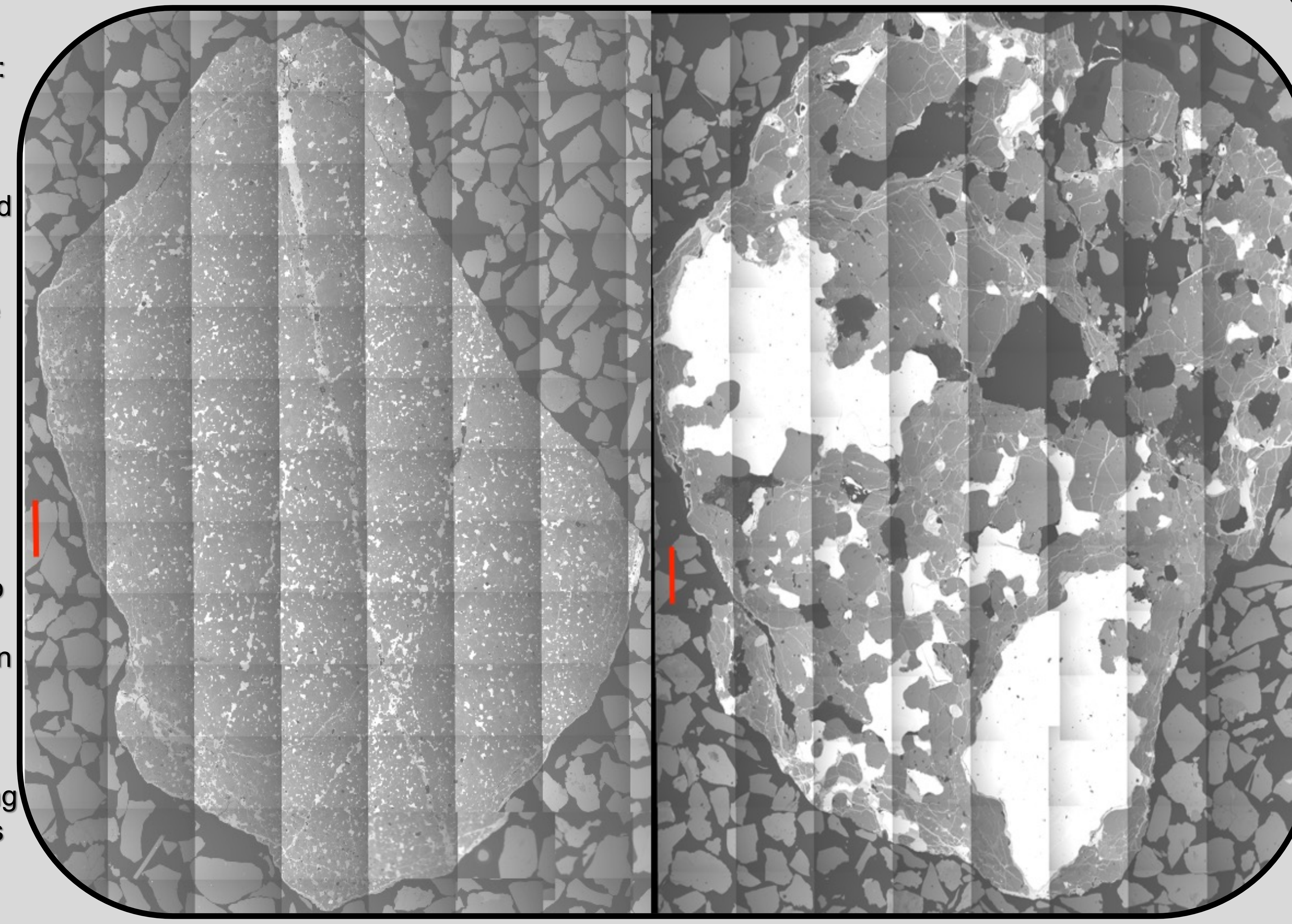

Fig. 2: Backscattered Electron (BSE) image mosaics of both low-metal (left) and high-metal (right) lithologies from Errachidia 004. Red 1 mm bar for scale.

Geochemistry

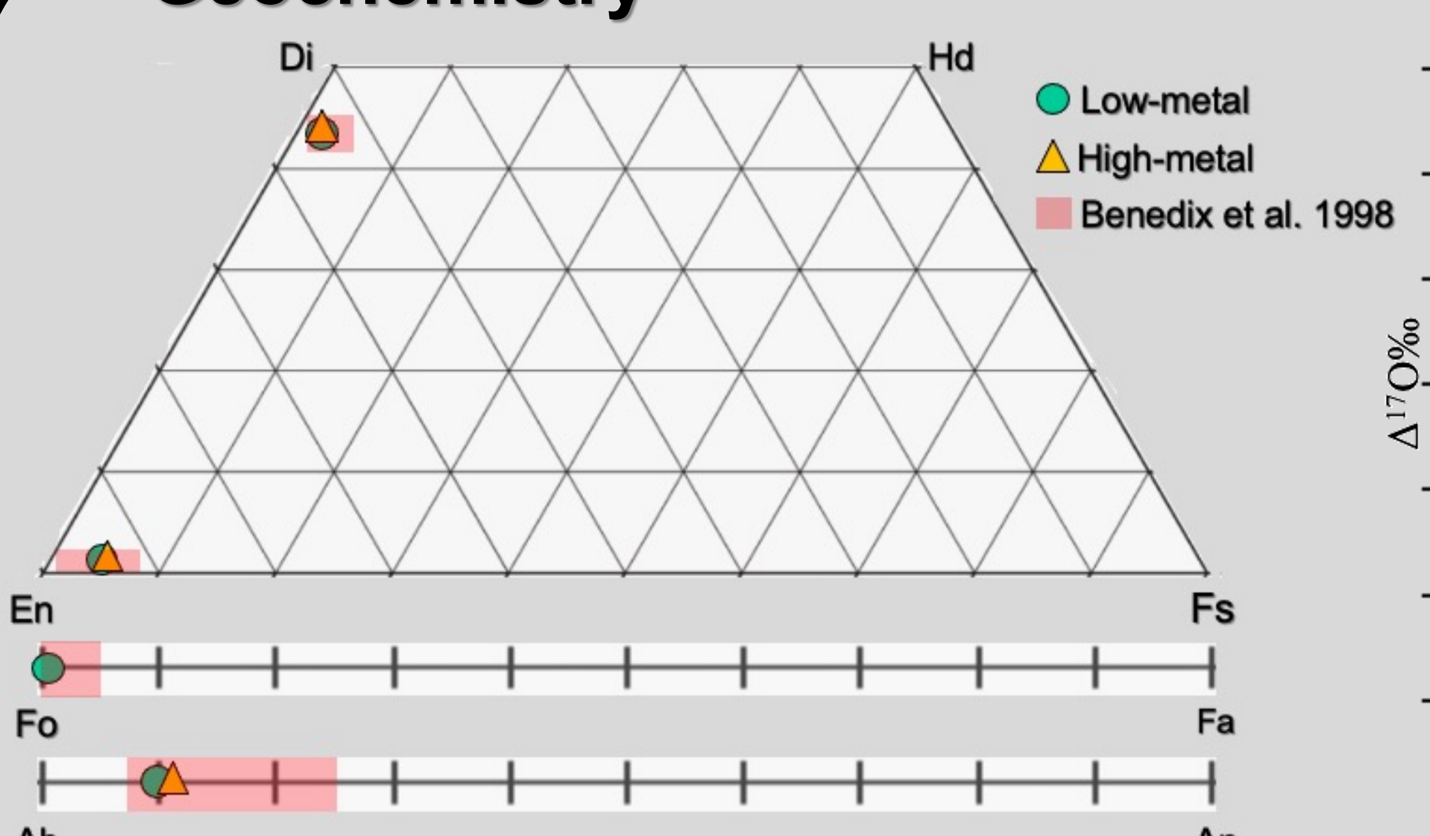

Fig. 3: Averaged compositions of silicates from low and high-metal lithologies of Errachidia 004, and from other winonaites [1].

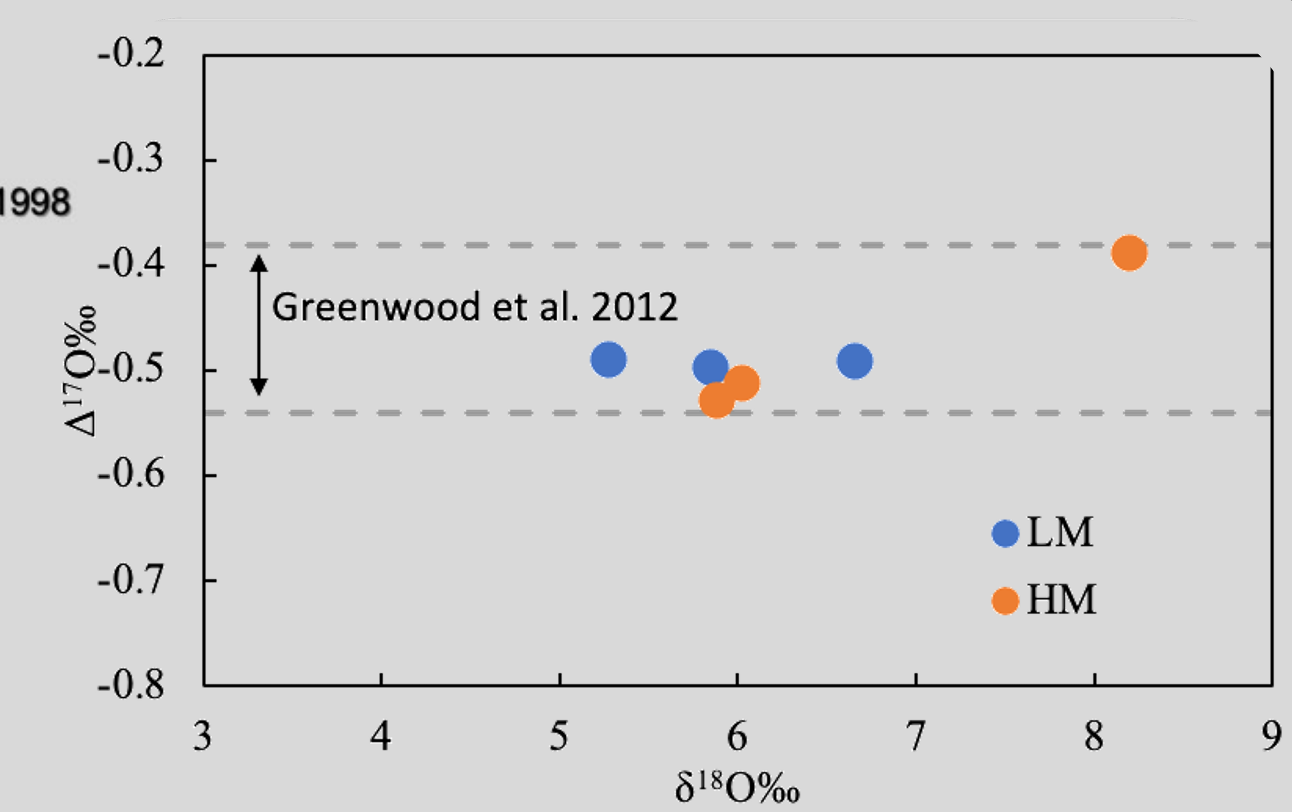

Fig. 4: Oxygen isotopic compositions of low-metal and high-metal fragments. Dashed lines outline winonaite field [2].

- Siderophile element concentrations: 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). Composition would be placed into the IAB field [3].

Conclusion

- 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 occurred on a scale small enough for lithologies from various depths to be mixed into meter-sized objects and subsequently thermally metamorphosed, i.e., a rubble pile.

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

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