Introduction: Northwest Africa (NWA) 4472 is a fragmental breccia that has been classified as having a lunar origin [1-4]. The sub-split investigated here is a large wedge-shaped slab about 31.6 x 24.3 x 1.3 mm in size. The advantage of studying such a large sample size is important when studying such heterogeneous breccia material. Sub-sections studied in lunar meteoritic research are typically ~1 cm by 1 cm in scale, and as such modal class assessments or bulk composition studies are likely to be biased towards any single large clasts or towards clasts from a single bedrock source that may have become ‘nuggeted’ together within the local regolith, thus masking the true heterogeneity of the regional setting of the sample.

Methodology: Mineral chemistry was measured at the NHM using a WDS Cameca SX50. Element maps and BSE images were acquired using a JEOL 5900LV SEM EDS fitted with Oxford Instrument’s INCA microanalysis software. Bulk clast compositions were determined using the JEOL system with a digitally controlled broad area beam-sweep analysis.

Sample Petrography: NWA 4472 is comprised of a seriate range of polymict lithic clasts (yellow, brown and black coloration) consolidated into a dark grey matrix of glass (Fe-rich and feldspathic), clasts and mineral fragments (Fig. 1a). Rare impact melt beads (<150 µm) occur within the sample matrix, indicating that this breccia was partially fused in the lunar regolith. Clasts range up to ~4 mm in size, and from this we infer that the sample was consolidated in a relatively immature regolith environment [5]. Fractures cross-cut the sample and are infilled with terrestrially deposited minerals (mapped out by yellow fractures in Figure 1b).

Clast Inventory: Lithic fragment (Fig. 2, 3) and mineral (Fig. 3) lithology provenance appears to be diverse within the scale of this sub-split.

There is a small basaltic lithic component (<4 mm, ~10% of the sample) with a range of textures from plumose to sub-ophitic. Most basaltic clasts appear to have been derived from a low-Ti (<3.5 wt. % TiO₂: Fig. 2) to VLT source region, and have mid-range Mg# pyroxene compositions (thereby differing from basaltic lunar meteorites like the LAP paired stones and the Yamato/Asuka/MET/MIL paired group that were crystallized from Fe-rich, highly fractionated melts).

Clasts of black, quenched, Fe-rich glass (>20 wt. % FeO, >4 wt. % TiO₂: peach diamonds in Fig. 2) are distributed through the matrix, and are likely derived from impact melting of a proximal mare basalt bedrock deposit.

Components with Mg-suite affinities (~10% of the sample) include a rare harzburgitic clast (Fo₉₂₋₉₃, En₈₈₋₉₀Fs₇₋₉₀Wo₁₋₅), a pleonaste spinel-troctolitic fragment (An₉₃₋₉₆, Fo₃₃₋₃₇, En₇₄₋₇₉Fs₉₋₂₁Wo₁₋₁₀), and several monomict mineral fragments and brecciated clasts containing high-Mg# mafic mineral phases (Fig. 3a,b).

Figure 1. (a) Scanned image of the NWA 4472 slab. Fractures infilled with terrestrially deposited calcite, gypsum and barite cross-cut the sample. (b) Montaged X-ray element map: Si = blue, Al = white, Mg = green, Fe = red, Ca = yellow and Ti = pink. Mare basalt clasts appear red as they are Fe-rich. Mg-suite clasts appear green. Silicic KREEPy clasts appear blue.
Granophyric silica+K-feldspar intergrowth clasts occur throughout the groundmass (<5% of the sample: Fig. 1: right). They have evolved mineral compositions (An2.46Or42.93Ab1.11; Fig. 3), and are commonly associated with accessory fayalite, Zr-rich minerals and apatite or pockets of ITE-rich glass. These clasts are likely to be the main contributor to the KREEP geochemical signature of NWA 4472 [2].

Additional lithic clast components include a diverse range of feldspathic, Mg-rich impact melt breccias (~10 to 15% of the sample), fragmental breccias and granulitic feldspathic basalts (Fig. 2). Highly feldspathic clasts (<10% of the sample) have typical lunar ferroan anorthosite (FAN) bulk compositions (Fig. 2).

Discussion: NWA 4472 is a heterogeneous breccia containing a mixture of lunar lithologies that are derived from different source bedrock environments, but which were consolidated together in close proximity in the lunar regolith.

The sample has a Sm- and Th-rich bulk composition [2, 3], suggesting that it was derived from a regolith with a high-ITE signature (inferred bulk ~7 – 9 ppm Th). Based on comparisons with the Lunar Prospector datasets, it seems likely that this meteorite was launched from the near-side of the Moon, probably from within the Procellarum KREEP Terrane.

Future Work: The NWA 4472 slab has now been divided into several smaller sub-splits suitable for a wider range of geochemical investigations including Ar-Ar geochronology work and U-Pb radiometric dating of apatite, merrillite and Zr-rich mineral phases.

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