NORTHWEST AFRICA 11522: A NEW PAIRED STONE OF MARTIAN POLYMICT REGOLITH BRECCIA NORTHWEST AFRICA 7034. B. E. Cohen[1,2], C. L. Smith[3], M. R. Lee[2], D. F. Mark[1], N. Almeida[3], W. S. Cassata[4], L. Hallis[2], A. Smith[2], and L. Daly[2]. [1]Scottish Universities Environmental Research Centre, UK (ben.cohen@glasgow.ac.uk), [2]School of Geographical and Earth Sciences, University of Glasgow, UK, [3]Natural History Museum, London, UK, [4]Lawrence Livermore National Laboratory, California, USA.

Introduction: Northwest Africa (NWA) 7034 and its pairs are amongst the oldest and most diverse of the Martian meteorites. They are complex polymict breccias comprising clasts of impact, igneous, and sedimentary lithologies set in a fine-grained matrix [1-3]. These rocks also contain angular mineral fragments, including K-feldspar, plagioclase feldspar, and pyroxene [1-3]. Mineral fragments are often > 1 mm in size, and clasts can be > 1 cm. This diverse assemblage indicates formation via repeated impact events, which is supported by Rb-Sr, Sm-Nd and U-Pb ages ranging from 1.3 to 4.4 Ga [1-3, and references therein].

In this study we report petrographic and geochemical results from Northwest Africa (NWA) 11522, a newly classified pair of NWA 7034.

Specimen details: A single, dark stone weighing 3.2 g was purchased by SUERC/the University of Glasgow from Darryl Pitt in November 2013. A 948.2 mg type specimen was donated to and is held at the NHM, London (BM.2013,M8), while the remaining mass and a polished block has been loaned to SUERC/the University of Glasgow. The outer surface of this irregularly shaped stone lacks an obvious fusion crust and has a very dark, desert varnished appearance (Fig. 1). Some light colored clasts are visible on the surface of the stone (Fig. 1).

Figure 1: Photograph of the exterior of NWA 11522, showing the dark varnished outer surface. A few crystals (lighter colors) show through. Desert varnish has been removed from the lower left portion of the meteorite (arrowed) to reveal the dark grey color of the stone's interior.

Petrography: Characterization of the meteorite by X-ray micro-CT, SEM, and electron microprobe reveal that it is a polymict breccia comprising mineral and lithic clasts set in a fine grained matrix (Fig. 2). Lithic clasts are predominantly basaltic, although include impact melt clasts and spherules (Fig. 2, 3). Similar components have been previously described in NWA 7034 and other paired stones [1-3]. The main minerals present are pyroxene, feldspar, Fe-Ti oxides, and Fe-oxides. Chlorapatite is a minor constituent, and rare zircon is also present.

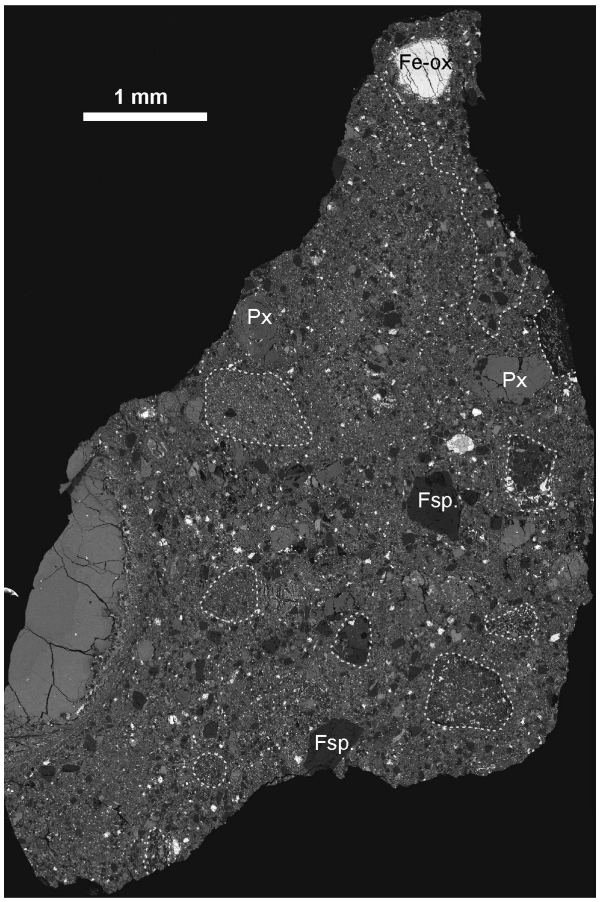

Figure 2: Backscattered SEM image of NWA 11522. Part of a large impact melt clast is visible in the lower left of the image. Some of the more prominent clasts are indicated by dashed outlines. Large grains of feldspar (Fsp.), pyroxene (Px), and iron-oxide (Fe-ox) are also indicated.

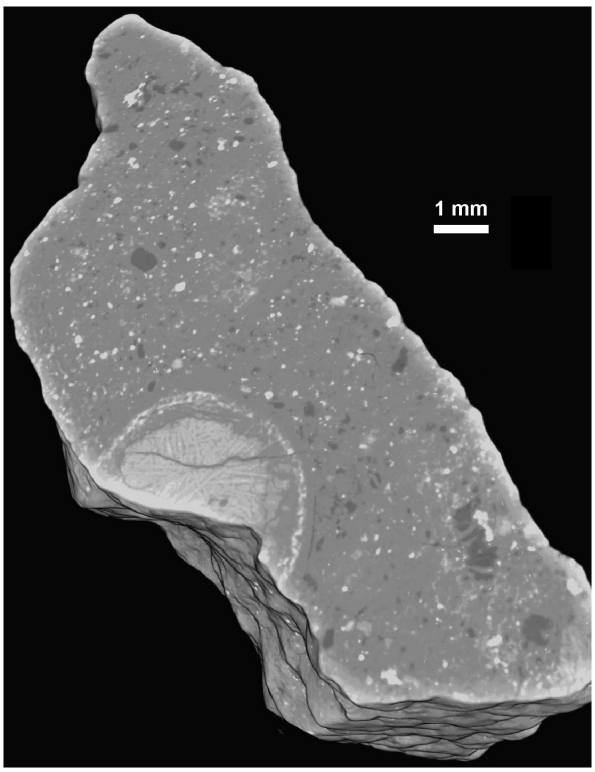

Figure 3: X-ray micro-CT scan of the meteorite (while it was an intact 3.2 g piece), taken on a slightly different slice to the SEM image (Fig. 2). This image emphasizes the large impact melt clast with prominent rim, located in the center-left. Other clasts are present in the lower right of the image, while feldspar (dark grey) and pyroxene (light grey) crystals are dispersed through much of the meteorite.

Mineral chemistry of the major phases was determined via electron microprobe (Fig. 3), with the following compositional ranges: labradorite (n=26): $Ab_{53.7\pm6.0}An_{44.1\pm0.7}Or_{2.2\pm6.6}$; alkali feldspar cluster-1 (n=5): $Ab_{71.5\pm6.5}An_{7.2\pm2.3}Or_{21.2\pm8.7}$; alkali feldspar cluster-2 (n=5): $Ab_{31.0\pm4.5}An_{6.2\pm2.3}Or_{62.5\pm4.7}$; low-Ca pyroxene (n=35) $Fs_{32.3\pm6.4}Wo_{7\pm4.4}$ with Fe/Mn = 32.0±4.6; augite (n=17) $Fs_{21.4\pm5.7}Wo_{40\pm5.9}$ Fe/Mn = 30.3±c2.9. A single olivine grain was analyzed at $Fa_{57.1}$.

Despite the fact that NWA 11522 is a polymict breccia, the apatite volatile ratio (Cl:F:OH) is uncharacteristically uniform. This uniformity indicates that some form of post-crystallization processing has overprinted the original apatite volatile contents.

Ongoing analyses: We are currently undertaking the following analyses on this meteorite: $^{40}Ar/^{39}Ar$ geo- and thermo-chronology, additional SEM investigations, including electron backscatter diffraction and grain detection to search for sulfur, zircon, and PGEs. These results will be reported elsewhere.

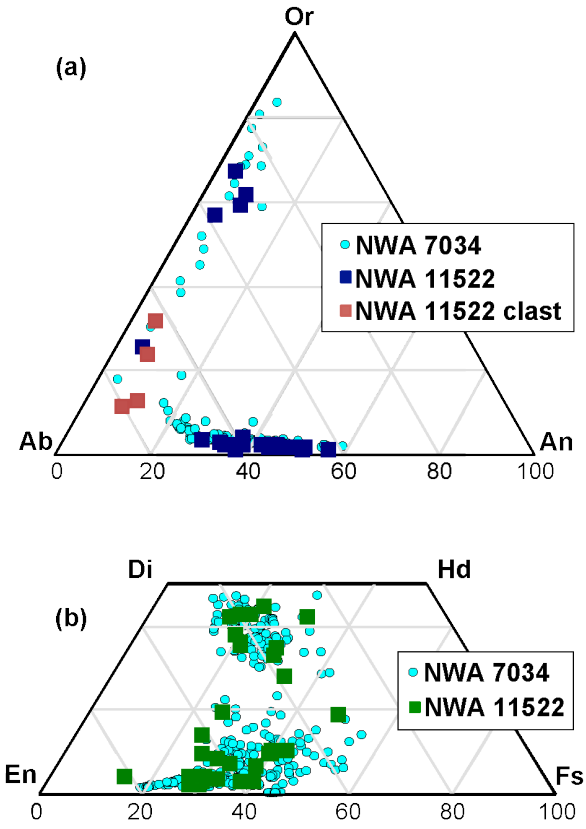

Figure 3: (a) Feldspar and (b) pyroxene compositions in NWA 11522 show close similarities to NWA 7034. NWA 7034 data are from [1]. Like NWA 7034, NWA 11522 has a wider range in feldspar compositions than most Martian meteorites – in line with the fact that NWA 7034 and pairs are regolith breccias comprising clasts from a wide variety of Martian protoliths.

References: [1] Agee C. B. et al. (2013) *Science, 339,* 780-785. [2] Humayun M. et al. (2013) *Nature, 503,* 513-516. [3] Santos A. R. et al. (2015) *GCA, 157*, p56-85.

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