HIGH PRESSURE EXCURSIONS IN THE MATRIX OF MARTIAN METEORITE NORTH WEST AFRICA (NWA) 11522.

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Introduction: North West Arica (NWA) 11522 is a new pair of NWA 7034 [1], a martian polymict regolith breccia colloquially known as '*Black Beauty*'. NWA 7034 and pairs are important specimens that contain a variety of martian lithologies. Despite preserving a complex impact history involving ≥2 events, only moderate to low shock pressures (5-15 GPa) have been reported; e.g., feldspar is present but maskelynite is absent [2]. However, as this sample is a breccia, individual clasts or matrix constituents may sample lithologies that experienced quite different shock histories. Here we apply atom probe tomography (APT) and electron backscatter diffraction (EBSD) to a region of matrix in the vicinity of a baddeleyite-bearing clast, to evaluate any nanoscale microstructures that are present.

Methods: EBSD data were acquired from the region of interest in NWA 11522 using a scanning electron microscope (SEM) at Curtin University. However, due to the fine-grained texture of the matrix, only the baddellyite and associated zircon could be indexed. An APT needle was extracted and prepared from the matrix of NWA 11522 using a Ga Focused Ion Beam (FIB) at Curtin University and the University of Sydney following the approach of [3]. The specimen was analysed on a CAMECA Local Electrode Atom Probe (LEAP) 4000X Si atom probe at the University of Sydney. Approximately 8 million ions were collected from the specimen and the 3D atomic distribution of these ions were reconstructed using the IVAS software package.

Results: EBSD data reveal complex microstructures in the baddeleyite that are described in [4]. The APT specimen is heterogeneous with 1 × 5 nm tubular structures of a Ca-Al-silicate (CAS) in two principal orientations within a silicate matrix (Fig. 1c, d). The boundary between the two phases is diffuse over a 1 nm length scale (Fig. 1d). The composition of the Ca-Al silicate is most similar to a (Ca)-hexaluminosilicate [$(Ca_xNa_{1-x})Al_{3+x}Si_{3-x}O_{11}$] described by [5]. The silicate matrix is therefore likely to be stishovite, a high pressure polymorph of SiO_2.

Discussion and Conclusions: The APT needle is texturally similar (albeit on a much smaller scale) to CAS-stishovite assemblages observed in shock melt pockets in Zagami, a heavily shocked martian shergottite [5]. This assemblage is stable at pressures of > 25 GPa and temperatures >2000 °C [5], which is ~10 GPa higher than estimates for the shock recorded by NWA 7034 and its pairs [2]. It is possible that the matrix and clasts experienced a different shock history, in fact, models and observations of impacts involving heterogeneous materials such as chondrites indicate that the matrix experiences larger pressure excursions than clasts [6-7]. Further work is underway to evaluate the variability in shock histories between the clasts and matrix of NWA 7034 and its pairs.

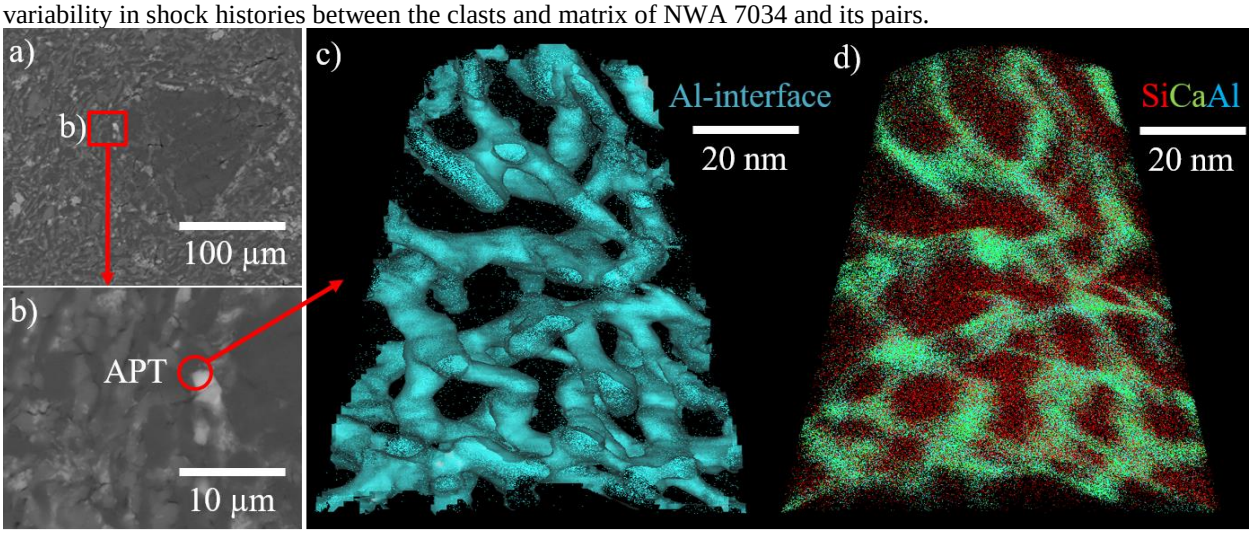

Figure 1. SEM and APT data. a-b) Backscattered electron SEM images of NWA 11522. c) APT of the interface between CAS and stishovite. d) APT atom cloud, reveal CAS and stishovite have a diffuse boundary.

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