A New Terrestrial Analogue for Martian Volcanism; An Unexpected Match for the Shergottite Meteorites.

F. M. Willcocks[1,2], N. R. Stephen[1,2], S. T. Grimes[2], J. T. Mitchell[1], [1]Plymouth Electron Microscopy Centre, University of Plymouth, Devon, PL4 8AA, UK; [2]School of Geography, Earth and Environmental Science, University of Plymouth, Devon, PL4 8AA, UK (francesca.willcocks@plymouth.ac.uk).

Introduction: During preparations for Martian exploration it is important to test the design and functionality of a spacecraft's components with materials that are similar to what they will encounter using terrestrial analogue samples [1], ensuring mission objectives can be met effectively [1]. Geological terrestrial analogue samples focus on the petrological and geochemical similarity of these terrestrial rocks to Mars [1], and are useful for Martian exploration preparations owing to the current absence of directly returned samples from Mars' surface [1,2]. Through satellite imagery, abundant basaltic lava has been observed on the Martian surface [3,4], the morphology of which has been previously likened to terrestrial flood lavas [5,6]. These observations, and a lack of plate tectonics on Mars indicate that regions of terrestrial intraplate volcanism are potential targets for finding accurate analogue samples for Martian volcanism [7]. Here, we present a new terrestrial analogue that best matches petrologically and geochemically to the abundant Martian shergottite meteorites, and may provide a further testbed for Martian exploration technology.

Methodology: Four terrestrial intraplate basalts similar in origin to Martian volcanism were selected; two Hawaiian basalts (H-001 & H-002), a European Space Agency (ESA) analogue from the ESA^2C collection (ESA01-A), and a sample from an intra-rift setting in New Mexico (NM-001). These were compared to Martian meteorites representative of Mars' geochemistry and petrology (North West Africa (NWA) 7397, NWA 1110 and Tissint). All samples were mounted and carbon coated prior to analysis. Petrological and geochemical analyses were carried out using non-destructive scanning electron microscopy (SEM-EDS). Data were collected using the JEOL 7001F SEM within Plymouth Electron Microscopy at 20kV coupled with an Oxford Instruments 50 mm^2 X-Max detector and Oxford Instruments AZtec (V6.0) software, collecting point EDS data and element maps for each sample.

Results and Discussion: H-001 and ESA01-A were both tholeiitic in composition and more similar to the Martian shergottites than the calc-alkaline compositions exhibited by H-002 and NM-001. Petrographically speaking, olivine compositions across the Martian meteorites were similar to their terrestrial counterparts. Olivine in ESA01-A was the most Fe-rich (Fa_{45}) and demonstrated the greatest similarity to NWA 7397 (Fa_{41}), whilst in the remaining terrestrial samples olivine was Mg-rich ($Fa_{22\text{-}30}$) and more analogous to antecrysts in olivine-phyric shergottites ($Fa_{30\text{-}34}$). ESA01-A exhibited extensive plagioclase zoning that is not observed in the Martian shergottites analyzed. High-Ca pyroxene compositions across H-001 ($Ens_{49}Fs_{15}Wo_{37}$), and range of low-Ca to high-Ca pyroxene compositions in NM-001 ($Ens_{20}Fs_{36}Wo_{44}$ average) were similar to the Martian shergottites ($Ens_{32\text{-}53}Fs_{17\text{-}35}Wo_{14\text{-}51}$), but neither were a perfect match.

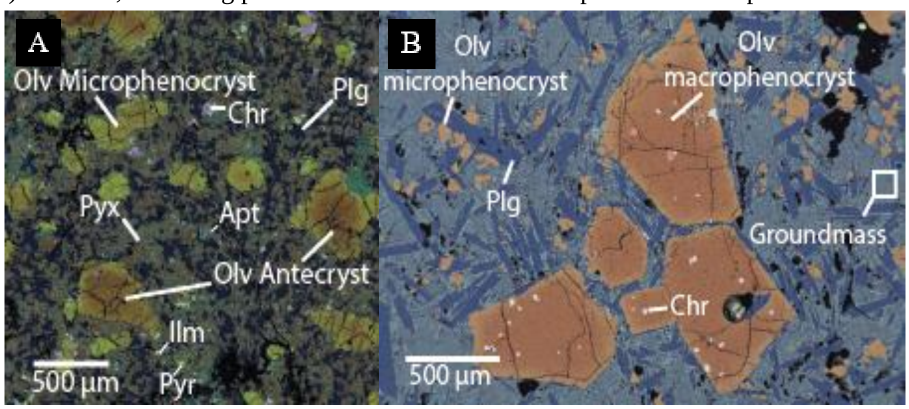

Figure 1 - A) EDS image of NWA 1110 displaying olivine antecrysts and olivine micro-phenocrysts surrounded by a pyroxene and plagioclase groundmass. B) EDS image of NM-001 displaying olivine macro- and micro-phenocrysts and a groundmass of pyroxene and plagioclase. Key = Red = Mg, Green = Fe, Blue = Ca, Pink = Cr, Yellow = S, Dark Blue = Al

None of the terrestrial samples in this study were identical to the Martian shergottites analyzed [8]. With that said however the official terrestrial analogue, ESA01-A, demonstrated the poorest similarity to the Martian shergottites analyzed whereas the intra-rift basalt, NM-001, was petrographically the most similar to Martian shergottites in this study, particularly to olivine-phyric shergottites NWA 1110 and Tissint. The texture of these samples can be seen in Figure 1. Full results will be presented at the meeting.

References: [1] Foucher, F et al. (2021) *Planetary and Space Science*, **197**:105162. [2] Marlow, J. J et al. 2008. *Astronomy & Geophysics*, **49**:2.20-2.23. [3] McSween, H et al. (2009) *Science* **324**(5928):736-9. [4] Dypvik, H. et al. (2021) *Planetary and Space Science*, **208,** 105339. [5] Keszthelyi, L. and McEwen, A. (2007) in Chapman, M. The Geology of Mars: Evidence from Earth-Based Analogs', 5:126-145. [6] Keszthelyi et al. (2006), *Journal of the Geological Society*, **163**(2). [7] Hughes, S. et al. (2019) *Astrobiology*, **219,** 260-283. [8] Willcocks, F. et al. 2021, *LPI Contributions 2609,* **Abstract #6061**