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COMPARATIVE PLANETOLOGY OF THE INNER SOLAR SYSTEM; USING FLOOD BASALTS ON THE MOON (LUNAR MARIA), MARS (THARSIS & ELYSIUM), AND EARTH TO INVESTIGATE THE MAGMATIC EVOLUTION OF OUR SOLAR SYSTEM.

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METEORITICS & PLANETARY SCIENCE

COMPARATIVE PLANETOLOGY OF THE INNER SOLAR SYSTEM; USING FLOOD BASALTS ON THE MOON (LUNAR MARIA), MARS (THARSIS & ELYSIUM), AND EARTH TO INVESTIGATE THE MAGMATIC EVOLUTION OF OUR SOLAR SYSTEM.

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Introduction: Basaltic volcanism has occurred on at least seven planetary bodies in our solar system, including the Earth, the Moon and Mars [1]. Flood basalt volcanism in particular has been prominent throughout Earth's geological history, with millions of cubic kilometres being produced in < 3 Ma [2] during continental break-up and mass extinctions events [3]. Through satellite imagery and, in the Moon's case, sample acquisition during the Apollo missions, the morphological and physiological properties of flood basalts have been observed on both the Moon [1] and Mars [4; 5]. Despite this, few studies have compared the geochemistry's of these flood basalts, and those on Earth.

This new study focuses on the geochemical and petrological observations of meteorites from Mars and the Moon. The analyses of these samples will then be compared to terrestrial analogs from Hawaii, New Mexico and Northern Ireland, as well as data from literature for flood basalts (specifically the Deccan Volcanic Province (DVP), and the Columbia River Flood Basalts (CRFB)).

Samples & Analytical Techniques: Terrestrial analogs were chosen from the University of Plymouth's collection, all of intraplate tectonic origin similar to that of Martian and Lunar geological settings. A Martian analog from the ESA analog collection was also used (ESA-01A). Bulk geochemical data from literature (collected by XRF and ICP-MS) were utilised for both the DVP and CRFB, as well as mineral compositions for the DVP. Lunar and Maritan meteorite samples were selected from the University of Plymouth's meteorite collection. Martian Shergottites were selected due to their larger petrographic similarity to terrestrial basalts than Chassignites and Nakhlites [6], with impact melt breccias selected as they are petrographically similar to the Lunar Mare unlike the feldspathic breccias that are representative of the Lunar Highlands [7].

Twelve samples were analysed in total, with an additional five datasets taken from the literature. Samples were prepared for analysis by mounting & polishing of resin blocks, followed by carbon coating. Geochemical analysis was conducted using a JEOL-7001F field emission Scanning Electron Microscope (SEM), equipped with Oxford Instruments AZtec software and an X-Max 50mm^2 EDS detector at Plymouth Electron Microscopy Centre, University of Plymouth, UK.

Terrestrial				Lunar			Martian				
Hawaii 1	Hawaii 2	New Mexico	ESA-01A	NWA 3160	NWA 11444	NWA 6721	NWA 7397	NWA 11369	NWA 1110	Dhofar 019	Tissint

Table 1: *samples selected for analysis including terrestrial lavas alongside Lunar & Martian meteorites. Hawaii samples are two separate flows at Kilauea; New Mexico from the Sierra Madre Occidental, & ESA-01A from County Antrim, Ireland..*

Results: Geochemically, the samples from the Moon and Mars were similar to their terrestrial counterparts in that their Ca-rich pyroxene compositions are geochemically similar to the terrestrial pyroxenes analysed. Data collated from their olivine phenocrysts formed very constrained trends when plotted on Harker diagrams. Most bulk geochemistry data fell within the 'basalt' and 'pico-basalt' classifications, with Hawaii 2 and New Mexico as 'trachy-basalt' in composition. There were some differences observed within plagioclase, where Lunar samples comprised of anorthite, whilst Martian and terrestrial samples comprised of mostly labradorite/andesine. Petrologically speaking, textures observed within the basalts were similar, but not identical. Shock features were observed within meteorites that were not present in terrestrial analogs, however, one terrestrial sample, New Mexico, looked texturally very similar to Martian Shergottite basalts (see figure 1).

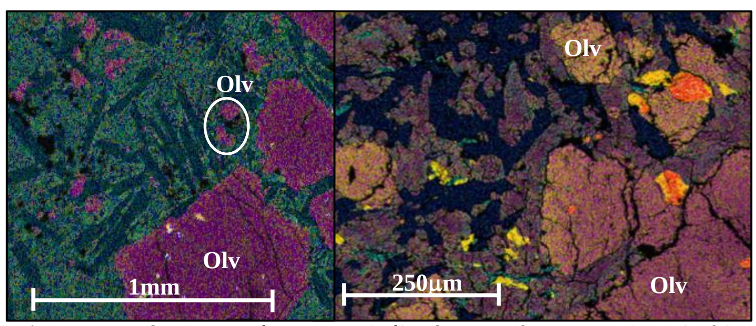

Figure 1: *Layered EDS image of New Mexico (Left) and Martian Shergottite NWA1110 (Right). Both samples display large zoned (Mg-centres to Fe-rich rims) olivine ('Olv') phenocrysts, surrounded by smaller Fe-rich olivine phenocrysts. Pink – Magnesium, Teal – Calcium, Yellow – Iron, Dark blue – Aluminium, Orange – Titanium, Red - Chromium*

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