WEATHERING IN TERRESTRIAL SAMPLES FROM THE MILLER RANGE AND ELEPHANT MORAINE REGIONS OF ANTARCTICA: COMPARSIONS WITH WEATHERING IN ANTARCTIC MARTIAN METORITES. L. J. Hallis[1,2]. [1]Hawai'i Institute of Geophysics and Planetology, Pacific Ocean Science and Technology (POST) Building, University of Hawai'i, 1680 East-West Road, Honolulu, HI 96822, United States. lydh@higp.hawaii.edu. [2]UH, NAI Astrobiology program.

Introduction: Martian meteorites found in the Antarctic have been reported to contain numerous secondary alteration phases, including gypsum, jarosite, Fe-oxides, and various clay minerals[1-4]. The deformation of iddingsite-like alteration veins by fusion crust formation in the nakhlite group of martian meteorites has proven that these veins have a pre-terrestrial origin[5]. However, the degradation of fusion crust in many of these meteorites, and its presence only at the very surface of each stone, has resulted in significant debate as to the source of various other alteration phases in the nakhlites and other Antarctic martian meteorite finds. We aim to compare the secondary alteration assemblages present in terrestrial Antarctic samples, collected from the Miller Range (MIL) and Elephant Moraine (EET) regions, with those present in the Miller Range nakhlite martian meteorites. This comparison will give significant insight into the type of terrestrial secondary alteration produced at these locations, thus enabling a better distinction between probable terrestrial and pre-terrestrial alteration phases in the Antarctic martian meteorites.

Previous studies of the products of weathering in terrestrial Antarctic samples have revealed varying results. Most secondary alteration in the Ferrar dolerite consists of (oxy)hydroxides[6], whereas anhydrite has been reported in basanite flows and tuffs from Ross Island[7]. However, the Ross Island study did not observe sulphates in hawaiites (which are more similar in composition to the nakhlites) from the same area[7]. In fact, hawaiites were reported to contain mostly zeolite secondary alteration phases, along with some K-feldspar, calcite and phyllosilicates. Secondary alteration assemblages in basaltic rocks from Victoria Land were found to contain mostly illite and poorly crystalline quartz (95 %), thought to be converted from silica gel[8]. The remaining 5 % of these assemblages consisted of sulphate salts, hematite and leucoxene particles (a poorly defined, microcrystalline form of TiO_2) in varying proportions. The variability of alteration phases in different Antarctic basaltic lithologies, even those from the same locality, suggests the alteration assemblages produced in this cold, dry environment is highly dependent on rock composition.

Methodology: We were allocated two rocks chips each of EET 96400, EET 96401 (both dolerites) and MIL 05031 (unclassified) by the NASA Johnson Space Center. One chip of each sample was sourced from the exterior part of the stone and the other chip was sourced from the interior. Thin-sections were subsequently produced from these chips at the University of Hawai'i, without the use of water (using polishing oil and petroleum ether to clean). We were also allocated two thin-sections (one external, one internal) of MIL 090030(23 and 25), MIL 090032(24 and 25) and MIL 090136(21 and 25), prepared at the NASA Johnson Space Centre without the use of water, as well as four thin-sections of MIL 03346 (126,128,173 and 174).

We utilised the JEOL JSM-5900LV scanning electron microscope at the University of Hawai'i to produce backscatter electron images and elemental X-ray images at × 250 magnification (20 µm pixel size) for each thin-section, in order to locate areas of interest. These areas were subsequently imaged at higher resolutions, with various pixel sizes (approximately 1–5 µm). The major- and minor-element chemistry of mineralogical phases were analysed with a JEOL JXA-8500F electron microprobe, at the University of Hawaii.

Results: The Miller Range nakhlites contain both gypsum and jarosite sulphate veins, as well as secondary Fe-oxides. The strong association of sulphate veins with terrestrially exposed surfaces in MIL 03346,173 and 174, and MIL 090032,25, and their rarity (or absence in the case of jarosite) in thin-sections cut from the internal regions of all four Miller Range nakhlites, indicates gypsum and jarosite are terrestrially derived phases in these meteorites. However, some narrow veins of gypsum are present in the internal thin-sections from the Miller Range nakhlites, and it is possible that these have a pre-terrestrial origin - gypsum has been widely reported on Mars, both from orbit and from surface-based exploration Rovers[9-15]

MIL 05031 consists of approximately 35 % feldspar (plagioclase and orthoclase), 15 % quartz, 5 % pyroxene and 45 % Fe-rich mesostasis with rare Ti-Fe-oxide grains. One edge of the external thin-section consists of an S-rich alteration layer, containing K and Fe, but no Si (Fig. 1). Parts of this layer are also enriched in Cl. Future electron microprobe analysis will reveal if

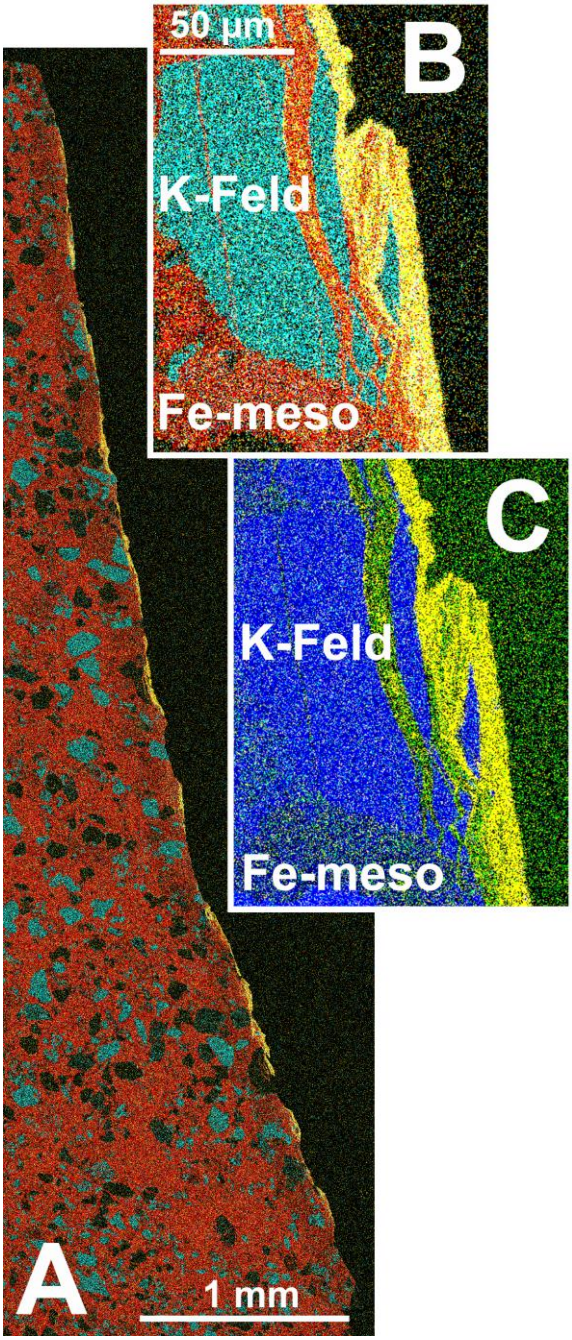

Fig. 1: False colour X-ray images of altered edge of MIL 05031, showing (a and b) the whole edge and a detailed veiw, where Fe = red, K = cyan, and S = yellow, and (c) the same detailed view where Si = blue, S = yellow and Cl = green.

this layer consists of jarosite. EET 96400 also shows alteration on one of its external edges, part of which appears to be Ca-sulphate (Fig. 2). The possible presence of jarosite and gypsum in these terrestrial samples enhances the theory that the sulphates in the Miller Range nakhlites are, at least primarily, terrestrially derived.

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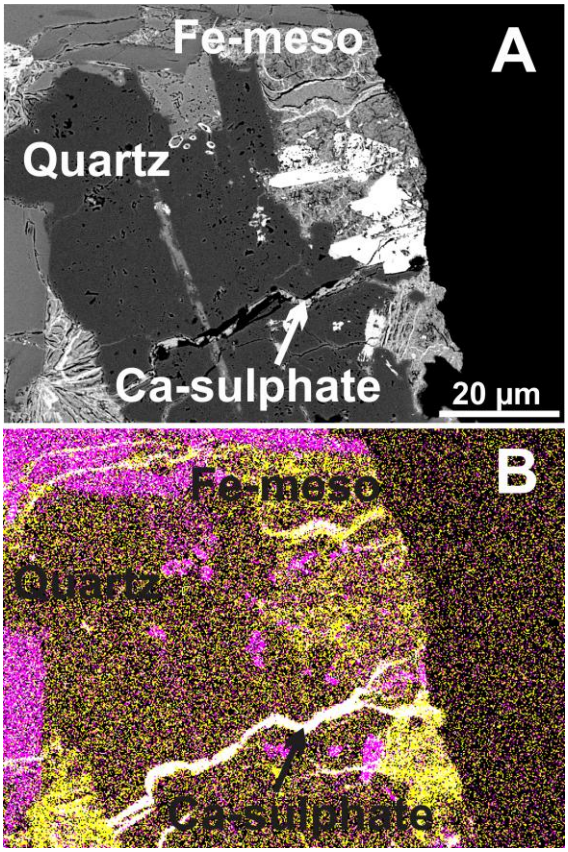

Fig. 2: BSE (a) and flase colour X-ray images (b), where Ca = pink and S = yellow, of alteration in EET 96400. Ca-sulphate veins are evident.