ELEMENTAL MAPPING AND RAMAN ANALYSIS OF MARTIAN REGOLITH BRECCIAS. M. R. M. Izawa[1*], M. A. McCraig[2], J. M. Stomberg[3], R. Gellert[2], [1]Institute for Planetary Materials, Okayama University – Misasa, 827 Yamada, Misasa, Tottori 682-0193, Japan, [2]Department of Physics, University of Guelph50 Stone Road E., Guelph, Ontario, Canada, N1G 2W1, [3]CSIRO Mineral Resources, 26 Dick Perry Avenue, Kensington, WA 6151, Australia; *matthew.izawa@gmail.com

Introduction: The aim of these studies is to investigate the spatial distribution and mineral hosts of minor and trace elements in Martian regolith breccias, with an emphasis on methods that produce data comparable to rover measurements. Recent Mars Science Laboratory Alpha-particle X-ray spectrometer results showing elevated levels of Zn, Ge, and other trace elements in Martian surface rocks have raised many questions about the distribution of such elements [1]. Interpretation of these minor and trace element signatures is hampered by a lack of constraints on the concentration and distribution of these elements within individual phases in Martian surface rocks and soils. Because of the limitations imposed by rover instrumentation, interpretations of Martian surface rock compositions depend greatly on constraints from meteorite analyses. There have been many studies of the bulk chemical compositions of Martian meteorites including the regolith breccia meteorites, however, there have been relatively few studies that report the individual host phases and spatial distribution of trace elements in Martian meteorites, or of their specific host phases. This lack of basic knowledge inhibits the interpretation of data from Martian surface rocks.

Methods: Slabs of NWA 7034 and NWA 8171 were obtained for this study. X-ray fluorescence mapping was conducted at beamline F3 of the Cornell High Energy Synchrotron Source with an excitation energy of 18 keV and 100 micron beam footprint. Selected subregions were mapped at 20 microns. Spectral data were reduced using the PyMca Toolkit. Polished surfaces were investigated using Raman spectroscopy (532 nm excitation wavelength). Future work will included additional elemental mapping with electron microprobe-WDS, SEM and APXS analogue and micro-PIXE, and micro-XRD mineralogical analyses.

Results: Elemental mapping of NWA 8171 slabs reveals several enrichment patterns, some of which are expected and others less so. Zinc commonly correlates with other chalcophile elements such as Cu, and is contained in sulfide-rich assemblages in some cases (Figure 2). Germanium and Ga are commonly hosted in feldspar phases and generally correlate with one another (Figure 3). Chalcophile elements including As, Cu, and Zn show local enrichments in sulfide-bearing clasts (Figure 4). Potassium and Rb are commonly associated with K-feldspar. However, in some cases, K, Rb, and Zn are associated with glassy impact melt rinds (Figure 5).

Figure 1. Visible light maps of slabs of NWA 8171, a typical sample of Martian regolith breccia meteorite consisting of a wide variety of lithic clasts. Four regions of interest are highlighted.

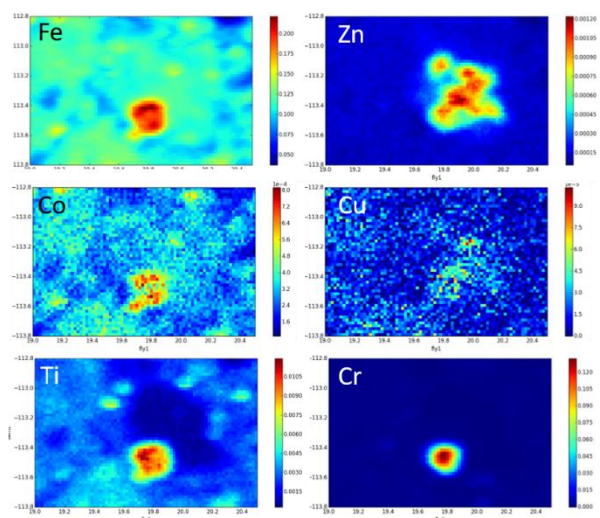

Figure 2. X-ray fluorescence maps of a region of Zn enrichment in NWA 8171. The Zn-rich material also contains elevated concentrations of Cu. Raman spectra of the Zn-rich aterials are consistent with a sulfide phase, pyrite or pyrrhotite. Raman spectra of the Fe- and- Ti-rich, Cr-bearing material are consistent with a spinel phase.

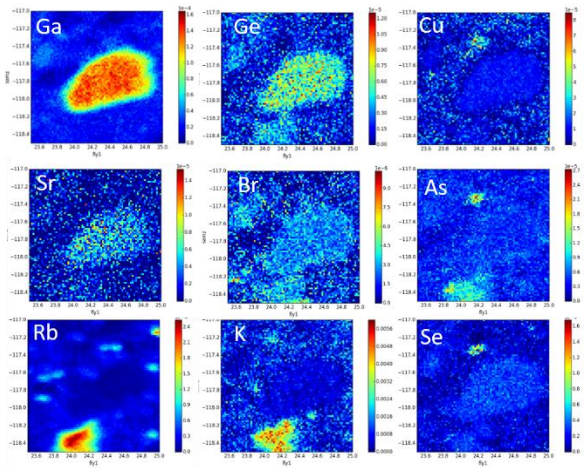

Figure 3. X-ray fluorescence maps of a region of Ga enrichment in NWA 8171, also showing enrichments in Se and Sr. Raman spectra of the Ga-rich object show the presence of plagioclase feldspar. The Rb- and K-rich object has a Raman signature consistent with K-feldspar.

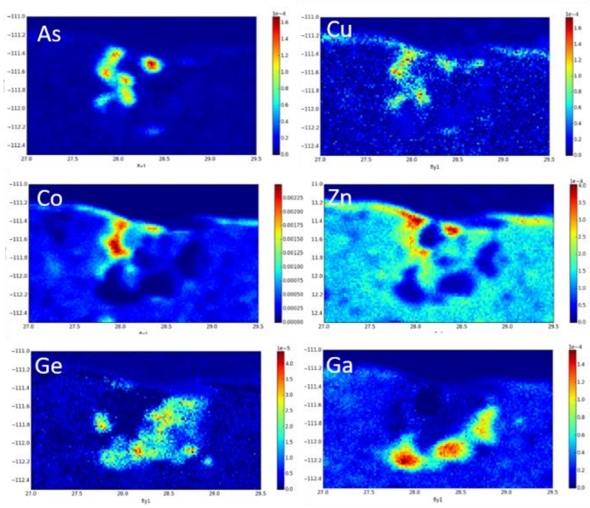

Figure 4. X-ray fluorescence maps of a region of As enrichment in NWA 8171, also showing correlated enrichments in Zn, Co, and Cu.

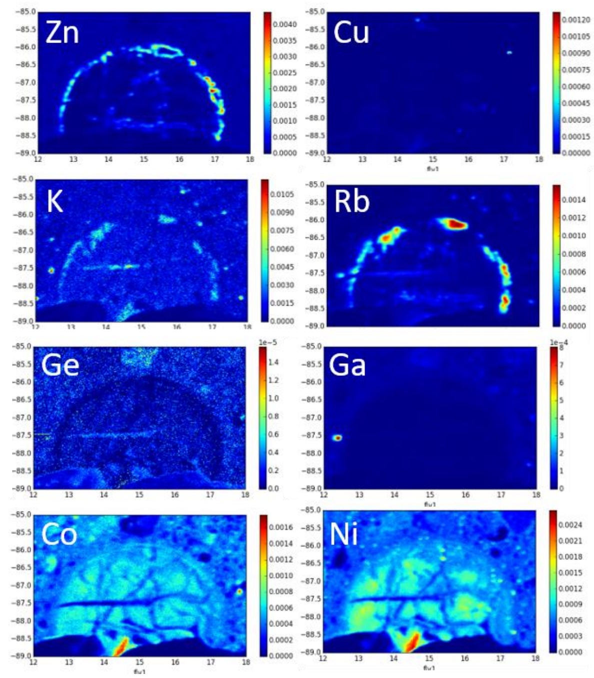

Figure 5. X-ray fluorescence maps of a rounded impact melt particle with a Zn- and- Rb-rich rim. The melt particle contains abundant olivine (Ni-rich) and is surrounded by thin glassy rim. Here, Zn is not correlated with other chalcophile elements and may be hosted as crystallites within glass.

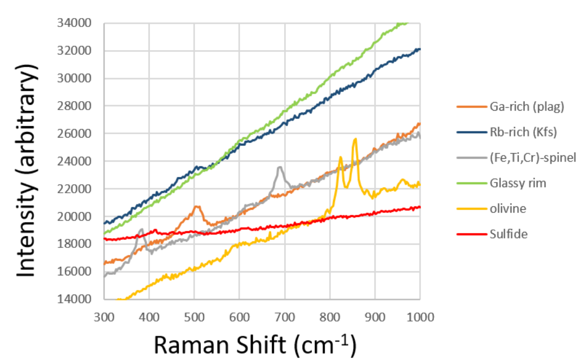

Figure 6: Representative Raman spectra of Ga-rich plagioclase feldspar, Rb-bearing K-feldspar, melt particle olivine, melt particle accretionary glass rim, (Fe,Ti,Cr)-spinel, and pyrite.

References: [1] Berger J.A. et al., JGR Planets 122(8) 1747–1772 (2017); [2] Lorand J.-P. et al. GCA 134-149 (2018); [3] Santos et al., GCA 157 56–85 (2015).

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