MULTISPECTRAL MICROIMAGING AS A TOOL FOR IN SITU PETROGRAPHIC ANALYSIS AND SELECTION OF SAMPLES FOR POTENTIAL RETURN TO EARTH. R. G. Sellar[1], J. D. Farmer[2], and J. I. Nuñez[2], [1]Jet Propulsion Laboratory, California Institute of Technology (glenn.sellar@jpl.nasa.gov), [2]School of Earth and Space Exploration, Arizona State University.

Introduction: Achievement of the astrobiological goals of a proposed Mars Sample Return program would depend on the ability to correctly select, prioritize and cache target rocks for potential return to Earth, according to two driving criteria: (1) indications of formation in a *habitable environment*; (2) high potential for long-term *preservation* of biosignatures. Combination of microtextural analysis of rocks with microscale, co-registered, mineralogical information constitutes a powerful dataset for assessing the origin of a rock. Armed with such information, a trained geologist can assign a rock to one of three basic petrogenetic categories (igneous, sedimentary or metamorphic) and can begin to interpret past geological processes based on microtextural and compositional information.

Successful acquisition of microtextural information at the hand-lens scale on planetary surface missions has been demonstrated by the Microscopic Imager (MI) on the Mars Exploration Rovers (MER) [1] and the Robotic Arm Camera on Phoenix [2]. However, while much of the basic information needed to interpret the paleoenvironmental context of a rock can be obtained with such images, mineral identifications require more sophisticated lab analyses, such as petrographic microscopy or x-ray powder diffraction (XRPD). While these are common capabilities of many terrestrial geology labs, their robotic counterparts for *in situ* exploration of other planetary environments are limited by the need to be small, lightweight and flight-ready. A petrographic microscope requires complex and precise sample preparation; i.e. mounting of rock slices on glass slides and grinding to a thickness so that they are transparent to visible light. XRPD (such as the Chemin instrument on the Mars Science Laboratory) requires powdered samples, the preparation of which destroys important microstructural information.

Contact instruments that can analyze the both texture and mineralogy of rocks and soils at the microscale have a clear advantage over other *in situ* methods, in requiring little, if any, sample preparation. This approach preserves important microspatial information (microtextures and phase distributions), considered crucial for interpreting the petrogenesis of a rock.

Multispectral Microscopic Imager: The Multispectral Microscopic Imager (MMI) provides microtextural an mineralogical information similar to that provided by a petrographic microscope, but without the need to prepare a thin section. This instrument employs multi-wavelength light-emitting diodes (LEDs), a focal-plane array (FPA) detector, and no moving parts, to provide multispectral, microscale images in 21 wavelength bands extending from 0.47 µm (blue) to 1.7 µm (shortwave infrared). LED illumination wavelengths are activated singly, in succession, as images are acquired by the FPA, providing a dataset comprised of spatially co-registered microimages. Similar to its predecessor, the MI onboard the MERs [1], the MMI provides a spatial resolution (62 µm), field of view (40 x 32 mm), and depth of field (5 mm) comparable to that provided by a geologist's hand lens.

Results: Multispectral microimaging in the 0.47 to 1.7 µm spectral range can identify major Fe-bearing silicates and oxides, detect hydrated minerals, place minerals in a microtextural context, and support petrogenetic interpretations. Fig. 1 illustrates one example of data acquired by the MMI.

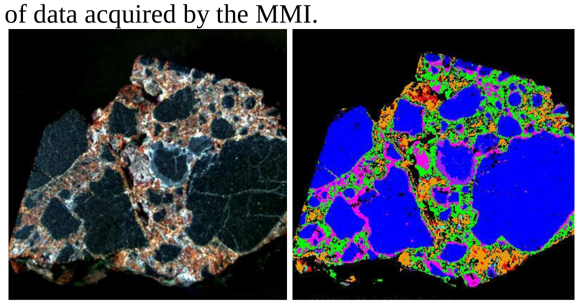

Fig. 1: 30 x 30 mm subframes acquired with the MMI with 62 µm/pixel. **Left:** Natural-color composite of three MMI bands (470, 525, 660 nm);.**Right:** Mineralogical map based on 21-band reflectance spectra. **Spectral matches:** hydrated mineral (green); nontronite (Fe-bearing clay; ochre), augite (light blue); Fe-oxide (red); hydrated mineral (magenta); basalt (dark blue).

Interpretation: Volcanic breccia composed of basaltic clasts cemented by Fe-oxides and possibly amorphous silica and/or crystalline clays. Angular to subrounded clast shapes indicate moderate transport from the source. The uniformity of clast texture and composition (monolithologic) is consistent with derivation from a single volcanic source. The composition of the alteration mineral assemblage is consistent with palagonitic alteration of basalt at hydrothermal temperatures.

References: [1] Herkenhoff, K. E. et al. (2008) *J. Geophys. Res.* **113**, E12S32. [2] Keller, H. U., et al. (2008), *J. Geophys. Res.* **113**, E00A17.