RECENT ATHENA MICROSCOPIC IMAGER RESULTS. K. E. Herkenhoff[1], J. W. Ashley[2], J. R. Johnson[3], T. J. Parker[4], and the Athena Science Team, [1]USGS Astrogeology Science Center, Flagstaff, AZ 86001 (kherkenhoff@usgs.gov); [2]ASU; [3]JHU/APL; [4]Caltech/JPL.

Introduction: The Athena science payload [1] on the Mars Exploration Rovers (MER) includes the Microscopic Imager (MI), a fixed-focus camera mounted on the instrument arm. The MI acquires images at a scale of 31 µm/pixel over a broad spectral range (400 to 700 nm). The MI acquires images using only solar or skylight illumination of the target surface. Early results of the MI experiment on both MER rovers (Spirit and Opportunity) have been published previously [2-5]. Radio signals from Spirit have not been received since March 2010, so attempts to communicate with the rover were ceased in mid-2011. The dust contamination of the Opportunity MI optics that has been present since the 2007 global dust storm continues to reduce the contrast of MI images, and is being monitored by occasionally imaging the sky. Whenever possible, multiple MI images are acquired of the same scene and added together to increase signal/noise. Highlights of more recent Opportunity results are described below.

Opportunity (MER-B) results: As Opportunity traversed across Meridiani Planum, the MI observed multiple outcrops and cobbles. Four of the cobbles, dubbed "Barberton," "Santa Catarina," "Santorini," and "Kasos," show textures that are consistent with the interpretation, based on chemical data, that they are members of a meteorite strewn field [6]. Opportunity also studied four iron-nickel meteorites. MI images of "Block Island" show triangular features that are interpreted as Widmanstätten patterns, commonly observed in iron-nickel meteorites and detected previously on the Meridiani Planum iron-nickel meteorite [7]. The MI also imaged skeleton-like metal protrusions on Block Island that appear to be the result of preferential weathering of interstitial material. Smooth patches of material with lobate margins have been interpreted as oxidized weathering rinds or coatings [7, 8]. To date, Opportunity has found only one cobble that is similar to basaltic shergottites, "Bounce Rock" [9]. Other cobbles have brecciated textures and appear to be ejecta blocks, mixtures of sulfate outcrop and a basaltic component [10]. The block most recently studied by Opportunity, "Ruiz Garcia," shows less angular clasts (Fig. 1), implying a less energetic origin and greater transport distances, perhaps involving water.

Opportunity arrived at exposures of Endeavour crater rim rocks in August 2011, on a hill dubbed "Cape York." These rocks have been the goal of Opportunity for the past few years because phyllosilicates were observed here from orbit. The ejecta block "Tisdale_2" was well imaged by the MI, showing brecciated textures in many places (e.g., Fig. 2). Such textures are expected in the rim of 22 km-diameter Endeavour crater and are evidence of impact emplacement/modification of the rim rocks. This interpretation is consistent with other Opportunity observations of Tisdale_2.

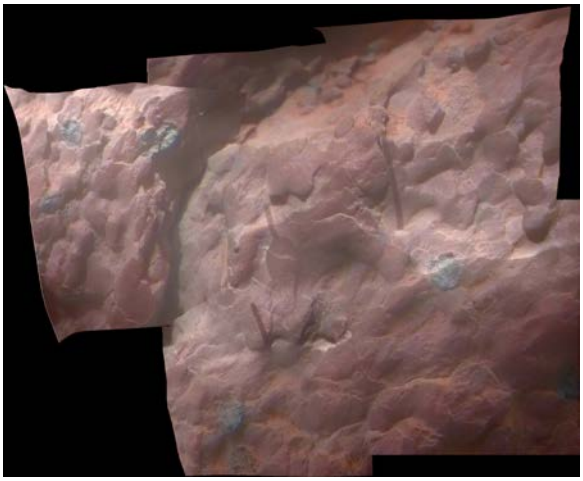

Figure 1. Merge of Pancam color with MI mosaic of "Ruiz Garcia" acquired on Sol 2524-7. Area shown is about 5 cm high. Note subangular to subrounded clasts in fine-grained matrix.

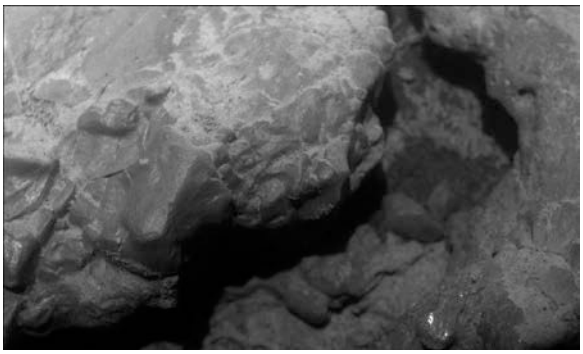

Figure 2. Section of sum of MI images of target "Timmons H" on block "Tisdale_2" acquired on Sol 2695 with illumination from top. Breccia-like texture is evident in this 3 cm-wide view, with dark, poorly-sorted clasts in a brighter matrix.

Opportunity has also examined apparent bedrock exposures such as "Chester Lake." This outcrop is

generally finer-grained than Tisdale_2 but angular to subangular, poorly sorted clasts are resolved by the MI when exposed by Rock Abrasion Tool (RAT) grinding and brushing (Fig. 3).

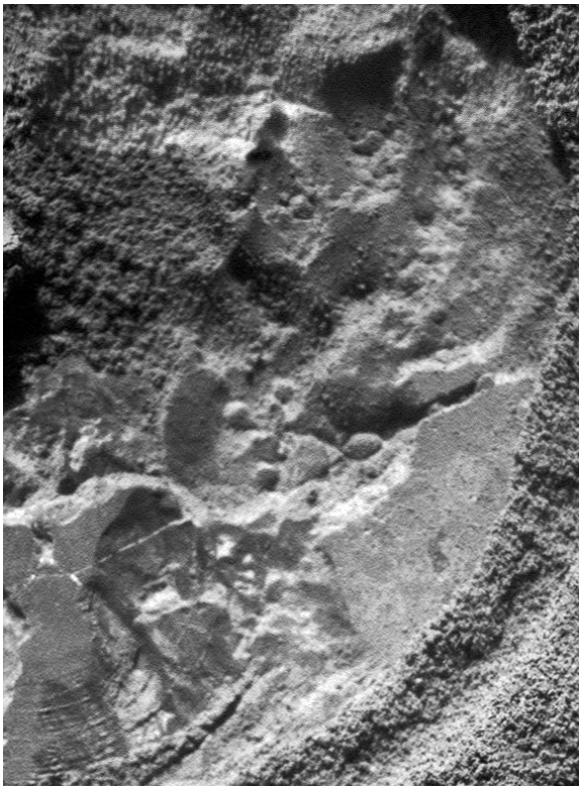

Figure 3. Subarea of MI mosaic of target "Salisbury_1" on outcrop "Chester Lake" after RAT grinding and brushing, illuminated from upper left. Area shown is about 2 cm across; smooth area below right of center has been ground flat and shows breccia-like texture.

Opportunity discovered multiple bright linear features along the periphery of Cape York that have been interpreted as veins of minerals injected into the bedrock of Cape York. MI images of one of these veins, dubbed "Homestake," show linear textures that resemble the fibrous crystals seen in the "satin spar" variety of gypsum (Fig. 4). This interpretation of calcium sulfate is consistent with APXS measurements of elemental chemistry and indicates that the fluids that formed this vein were less acidic than those that formed the bulk of the Meridiani Planum rocks. These and more recent MI results will be presented at the conference.

References: [1] Squyres, S. W. *et al*. (2003) *JGR 108*, 8062. [2] Herkenhoff, K. E. *et al*. (2004) *Science 305*, 824. [3] Herkenhoff, K. E. *et al*. (2004) *Science 306*, 1727. [4] Herkenhoff, K. E. *et al*. (2006) *JGR 111*, doi:10.1029/2005JE0022574. [5] Herkenhoff, K. E. *et al*. (2008) *JGR 113*, doi:10.1029/2008JE003100. [6] Schröder, C. *et al*. (2010) *JGR 115*, doi:10.1029/2010JE003616. [7] Ashley, J. *et al*. (2011) *JGR* doi:10.1029/2010JE003672. [8] Johnson, J. R. *et al*. (2011), *LPS XLII*, abstract #1929. [9] Zipfel, J. *et al*. (2011), *Meteoritics & Planetary Science 46*, 1-20. [10] Fleischer, I. *et al*. (2010) *JGR 115*, doi:10.1029/2010JE003621.

Figure 4. Merge of Pancam enhanced L257 color and summed MI image mosaic of target "Homestake," taken on Sol 2766 when fully shadowed. Area shown is about 3 cm across; note subtle linear texture on bright vein.