***OPPORTUNITY* MICROSCOPIC IMAGER RESULTS FROM THE WESTERN RIM OF ENDEAVOUR CRATER.** K. E. Herkenhoff[1], R. E. Arvidson[2], D. W. Mittlefehldt[3], R. J. Sullivan[4], and the Athena Science Team, [1]USGS Astrogeology Science Center, Flagstaff, AZ 86001 (kherkenhoff@usgs.gov); [2]Dept. of Earth and Planetary Sciences, Washington University, St. Louis, MO, USA; [3]Astromaterials Research Office, NASA Johnson Space Center, Houston, TX, USA; [4]Cornell University, Ithaca, NY, USA.

Introduction: The Athena science payload [1] on the Mars Exploration Rovers (MER *Spirit* and *Opportunity*) includes the Microscopic Imager (MI), a fixed-focus close-up 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) using only natural illumination of target surfaces [*e.g.*, 2-5]. Radio signals from *Spirit* have not been received since March 2010, so attempts to communicate with that rover ceased in mid-2011. The *Opportunity* MI optics were contaminated by a global dust storm in 2007. That contamination continues to reduce the contrast of MI images, and is being monitored by occasionally imaging the sky.

***Opportunity* at Endeavor crater**: *Opportunity* has been exploring exposures of Noachian-age rocks along the rim of Endeavour crater since August 2011, motivated by orbital spectral evidence for phyllosilicates at multiple locations along the crater's rim. As reported previously, *Opportunity* discovered multiple bright linear features at "Cape York" that have been interpreted as veins of Ca sulfate deposited in bedrock fractures. In-situ measurements are consistent with the presence of smectite clays in rocks and veneers on the east side of Cape York. The inferred neutral pH and relatively low temperature of the fluids involved in multiple phases of alteration would have provided a habitable environment. Because *Opportunity* can no longer directly sense phyllosilicate mineralogy with the MiniTES or Mössbauer spectrometers, the rover mission is focusing on characterizing outcrop multispectral reflectance with Pancam, chemistry with the Alpha Particle X-ray Spectrometer and microtexture with the Microscopic Imager (MI) of potential phyllosilicate host rocks. Highlights of recent *Opportunity* results are described below.

Recent *Opportunity* MI results: While traversing the western side of Murray Ridge, *Opportunity* found outcrops of breccia that are similar in texture and chemical composition to the Shoemaker Formation rocks exposed at Cape York. MI images of the breccias show cm-size angular clasts in fine-grained matrix, consistent with an impact origin. At "Cook Haven," the rover wheels overturned a few rocks, exposing dark Mn-rich coatings and halos on brighter sulfates (Fig. 1), which suggest aqueous precipitation of S-rich coatings followed by partial dissolution and reaction with a strong oxidant [6].

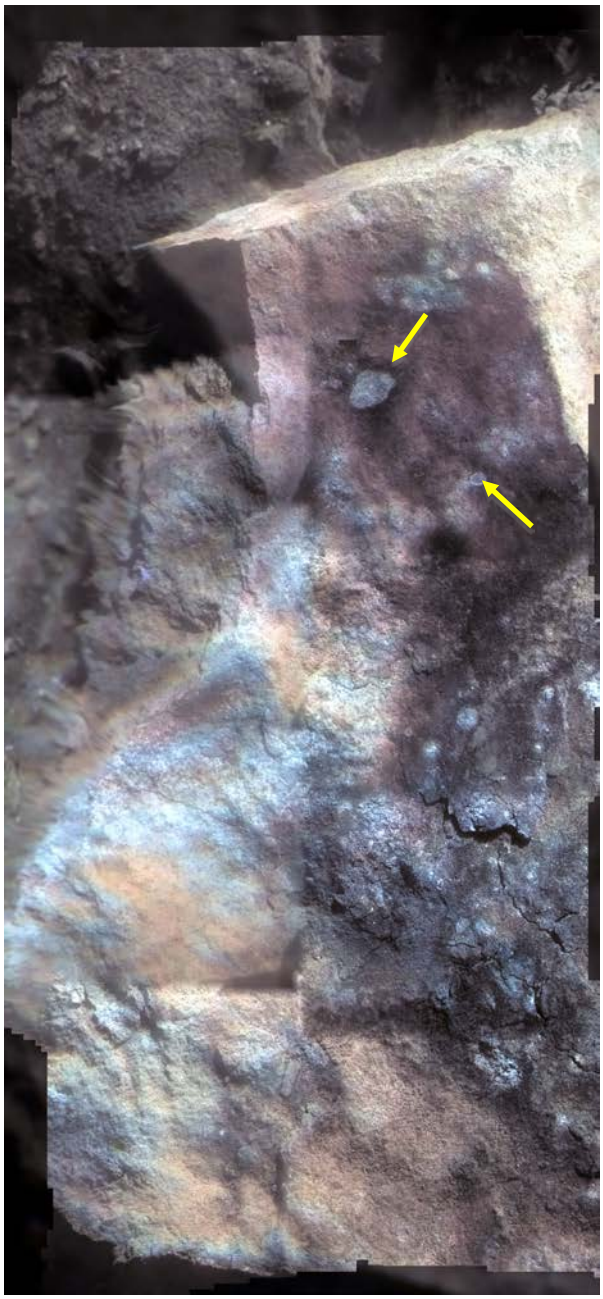

Figure 1. Merge of orthorectified mosaic of MI images acquired on Sols 3573-3576 and Pancam L257 enhanced color of "Stuart Island," illuminated from upper right. Area shown is about 5 cm across; note dark halos around brighter clasts, one with a darker core (arrows).

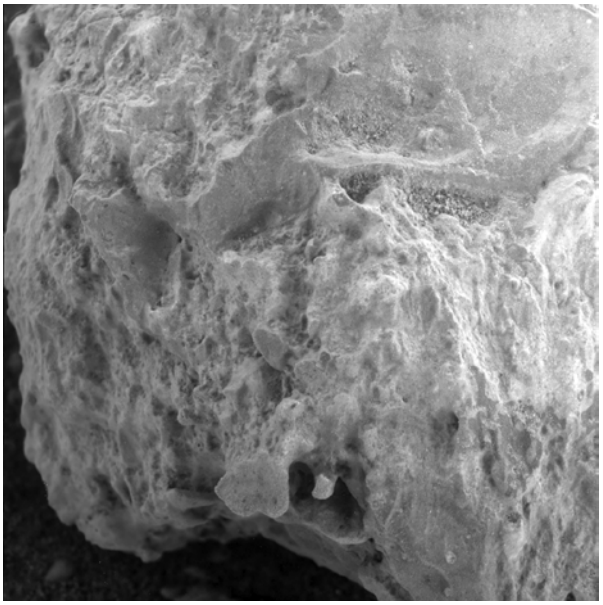

Figure 3. Merge of MI images of "Private Pierre Cruzatte" acquired on Sol 4075 when target was fully shadowed.

Dark, sulfate-rich coatings were observed at the "Espérance" target on the east side of Cape York. MI stereo images show that these coatings are very thin (<0.1 mm) and resistant, mostly occurring on topographically higher surfaces. The unique chemical composition of these materials indicates at least two episodes of precipitation from aqueous fluids that may have provided a habitable environment and favored precipitation of organic material [7]. Similar dark coatings that were observed more recently on "Thessaloniki" are also very thin, barely resolved in places by MI stereogrammetry. As at Espérance, these coatings appear to be relatively resistant to erosion, mostly occurring on topographic highs (Fig. 2). Unlike Espérance, this outcrop has a composition like that of typical Shoemaker Formation breccias and does not have the high Si and Al contents that characterize Espérance from the Matijevic Formation.. These observations suggest that the Thessaloniki coatings also formed by precipitation of aqueous fluids.

Rocks exposed in the "red zone" partly bounding the "Spirit of St. Louis" feature are breccias, with dark coatings, pits and other textures (Fig. 3) suggestive of secondary mineralization, consistent with the increased Al and Si compositions observed by APXS [8].

Conclusion: *Opportunity's* mission continues, with the rover exploring more exposures of phyllosilicates detected from orbit on "Cape Tribulation." The latest MI results, including observations in "Marathon Valley" [9], will be presented at the conference.

References:

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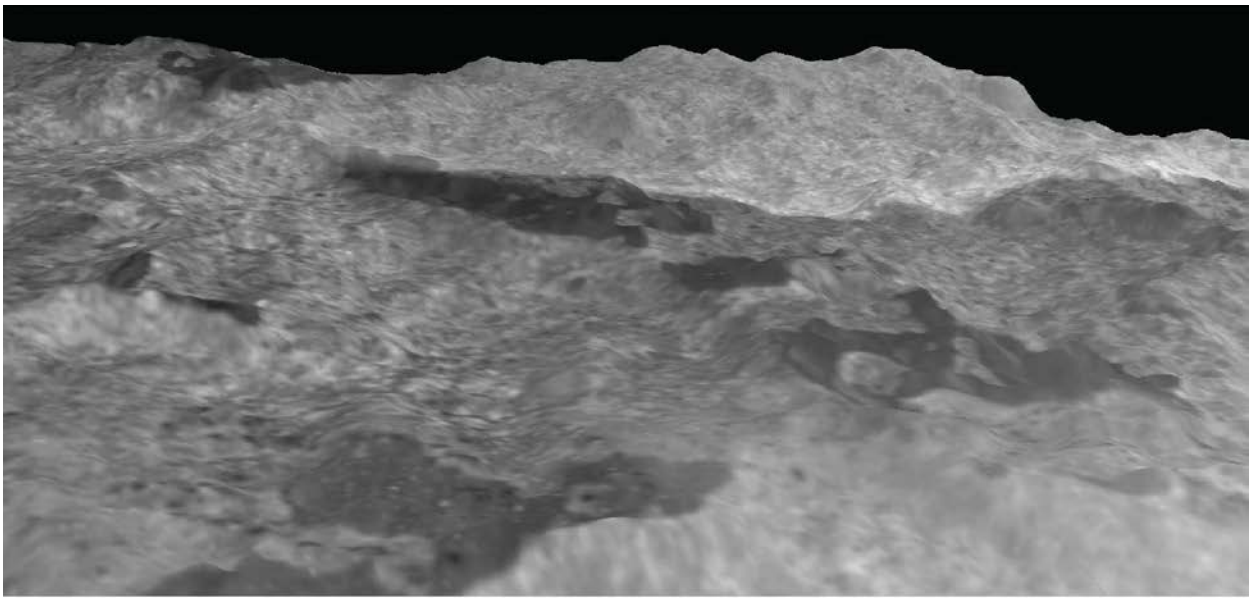

Figure 2. Oblique view of MI image of Thessaloniki, orthorectified onto digital elevation model generated using stereo MI frames acquired on Sol 3975 when the surface was completely shadowed. Area shown is about 4 cm across. Note thin (typically < 0.1 mm) dark coating on brighter, less resistant material.