TESTABLE HYPOTHESES FOR OPPORTUNITY'S TRAVERSE FROM SANTA MARIA TO THE RIM OF ENDEAVOUR CRATER. A. A. Fraeman[1], R. E. Arvidson[1], S. L. Murchie[2], F. P. Seelos[2], and J. A. McGovern[2], [1]Washington University in St. Louis, Dept. of Earth and Planetary Science, St. Louis, MO (afraeman@wustl.edu), [2]Johns Hopkins University Applied Physics Laboratory, Laurel, MD

Introduction: As of January 2011, the Mars rover Opportunity was located at Santa Maria crater, ~6 km away from the closest rim segment of the ~20 km diameter Noachian-aged impact crater Endeavour (Fig. 1). Endeavour predates the sedimentary rocks examined by Opportunity for the past 7 years, and Compact Reconnaissance Imaging Spectrometer for Mars (CRISM) data indicate that Fe-Mg smectites are present on the rim of this highly degraded crater [1].

The purpose of this abstract is to present working hypotheses to help guide the acquisition and analysis of continued Mars Reconnaissance Orbiter (MRO) coverage and Opportunity observations as the rover departs Santa Maria, traverses across the plains, and ascends Endeavour's rim. In particular, MRO coverage includes a new observing scheme for CRISM in which the gimbal is commanded to oversample the pixels in the along track direction (Fig. 2), thereby providing more spatial detail than the typical 18 m/pixel full resolution targeted (FRT) observations. The combination of orbital and rover investigations provides field-based exploration and measurements of the geomorphology, composition, and mineralogy of soils and rocks at Endeavour and the surrounding area. The work we present here is the basis for continued discussion by the Athena science team.

Traversing the plains: The path that Opportunity will take from Santa Maria to Endeavour's rim will allow the rover to drive across a number of light-toned exposures of bedrock that form a complex pattern aligned roughly parallel to the rim (Fig. 1). We hypothesize that these patterns represent stratigraphic contacts and present two working hypotheses for their order: (1) Older rocks will be encountered as Opportunity traverses toward the east, or (2) Opportunity will be traveling up the stratigraphic section. The latter situation might be due to an onlap of late stage lacustrine deposits centered about the topographically low Endeavour crater. Detailed imaging by Opportunity at key locations chosen with the help of HiRISE data will allow testing of these two and other hypotheses. Further, CRISM data suggest that these outcrops are spectrally dominated by the same nanophase iron oxide signatures seen elsewhere at locations traversed by Opportunity [2]. We therefore expect to continue encountering dehydrated and/or coated material during the majority of this traverse, another hypothesis that can be tested using Opportunity's capabilities.

Botany Bay and the southern tip of Cape York: In contrast to the plains, CRISM normal [1] and oversampled FRT data show signatures of hydrated phases, including hydrated sulfates, present throughout Botany Bay and the southern point of Cape York (Fig. 3). These phases have not been detected from orbit at any other location along Opportunity's ~26km traverse (with the exception of a small group of CRISM pixels on the SE rim of Santa Maria crater [3]), and suggests a change in mineralogy occurs, probably at a stratigraphic contact within Botany Bay. Opportunity's ground-truth observations will be essential in determining the nature of these phases as the rover approaches Cape York, the closest rim segment.

Cape York and Beyond: HiRISE and CTX images show that Cape York is surrounded by a set of terraces that extend ~10-20 m from the rim (Fig. 3). We hypothesize that these features are erosional remnants of the upper portion of the sedimentary rocks that covered the Meridiani plains. Based on HiRISE morphological analyses and CRISM data, it appears that these terraces are mantled by wind-blown deposits and thus do not exhibit distinctive spectral signatures. Field-based data from Opportunity are therefore necessary to assess the true nature of these terraces, and to test the working hypothesis regarding their formation.

Previous CRISM observations [1] and newly acquired over-sampled data (Fig. 2) indicate the presence of Fe-Mg smectites in Cape Tribulation and perhaps even in Cape York. The formation of these minerals usually requires neutral water with a relatively high water to rock ratio. The field-based verification of these minerals and characterization of their geologic settings by Opportunity at Cape Tribulation and perhaps Cape York will significantly add to our understanding of the aqueous evolution of Mars. Opportunity could be the first landed mission to characterize conditions that prevailed during early Mars, when phyllosilicates formed, and the transition to the formation of massive accumulations of layered sulfate deposits [4].

References: [1] Wray, J.J., et al. (2009) *GRL*, *36*, L21201. [2] Arvidson, R.E. et al (2010) *JGR*, in press, doi :10.1029/2010je003746. [3] Arvidson, R.E. et al, (2011) *LPS XLII*, this volume [4] Bibring J.-P. et al. (2006) *Science*, *312*, 400–404.

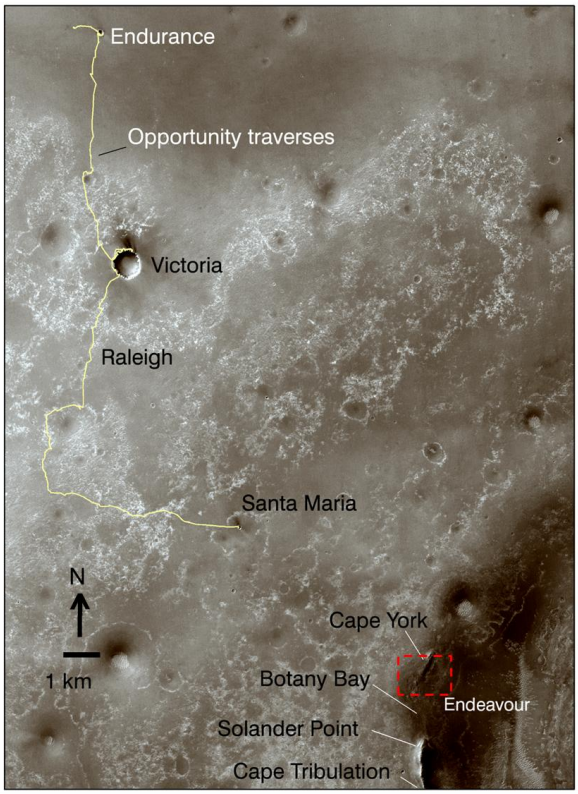

Figure 1: Opportunity traverse (yellow) overlain on CTX image. Endeavour Crater is located on the bottom right. The area for the geologic map in Fig. 3 is indicated by the dotted red box.

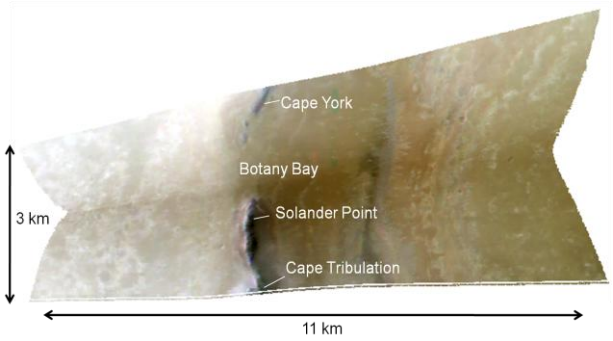

Figure 2: Projected false-color CRISM oversampled image FRT00019B17 showing Cape York and Botany Bay. This image has been oversampled in the along-track direction, resulting in a distinctive footprint compared to normal FRTs. The false color shown is R - 2.5 μm, G - 1.5 μm, B - 1.1 μm

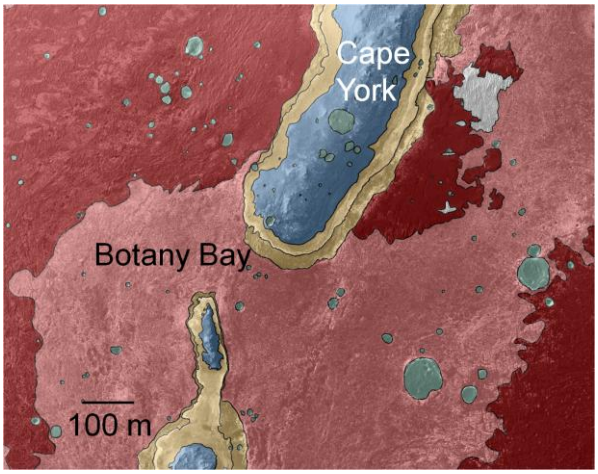

Figure 3: Detailed geologic map of Cape York overlain on CTX image. Rim rock is shown blue, surrounding terraces of erosion-resistant deposits are shown in yellow, and hydrated sulfates and other hydrous phases are shown in light red.