AN OPPORTUNITY TO INSPECT A MARTIAN GULLY UP CLOSE. T. J. Parker[1], M. P. Golombek[1] [2]M. Lamb. M. C. Palucis and The Athena Science Team, [1]Jet Propulsion Laboratory, California Institute of Technology, timothy.j.parker@jpl.nasa. [2]California Institute of Technology, Pasadena, CA 91109

Introduction: Opportunity is 1 km from the first Martian gully visited by a spacecraft from Earth. and will investigate the gully for evidence of water or dry sediment flow.

What we Know from HiRISE: The gully feature was first identified in HiRISE images taken of the west rim of Endeavour crater in 2009, prior to Opportunity's arrival at Cape York. A digital elevation model (www.uahirise.org/dtm/dtm.php?ID=ESP_018701_1775) is being used for rover traverse planning and preliminary assessment of the gully[1].

The gully begins at -2.33° lat., 354.65° lon., and trends downslope into Endeavour crater for 180 meters. The gully begins at -1458 meters elevation and terminates at -1513 meters elevation. The slope over the length of the gully averages just over 17°. Topographic profiles across the gully don't appear to quite resolve the feature in the 1 meter-posting DEM, suggesting the depth is either much less than a meter or the DEM is too coarse to resolve it.

In the HiRISE plan view (Fig 1), the gully has multiple branches that merge and split, giving it an anastomosing appearance for all but the first 30 meters of its course. It is incised into one of the dark surficial units of the Endeavour rim that experience has shown is likely to be a sandy or granular regolith. In a few places within the anastomosing segment of the gully, it appears to have exposed a brighter surface that might be subjacent outcrop material. About midway downslope is a prominent elongated island, that appears streamlined. Numerous similar but smaller forms are also present in the anastomosing reach of the gully.

The gully appears to cut across the crest of the rim of Endeavour crater, although a bright narrow ridge may be at the gully head. This ridge resembles aeolian bedforms encountered by Opportunity at prominent breaks in slope, such as Duck Bay at Victoria crater. The head of the gully coincides with a local "notch" in the crater rim (Figs 1,2).

The gully terminates abruptly downslope at the edge of a ramp or apron of smooth dark material that extends upslope from the "Grasberg Bench" of bright Burns Formation outcrop that appears to onlap the apron from the east. There is no apparent fan or delta form at the end of the gully, suggesting that it was active prior to and eroded by the process that formed the apron surface.

What are the Possibilities? Martian gullies have been the subject of debate as to their origin. Do they indicate water flow? Debris flows? Brines? If fluvial, do they derive from local springs, or small lakes or by precipitation? Could they be formed by dry avalanches of fine, dry sediment that doesn't require unusual, wet conditions?

The HiRISE topography shows the gully is on a 17° slope. In general, this is below the angle of repose necessary for debris flow of dry material. Is this steep enough to allow a dry avalanche to initiate? Is it shallow enough to enable a fluvial channel or debris flow to anastomose? If not, does this suggest the paleoslope was lower and has been steepened by subsidence due to groundwater withdrawal or sediment compaction [2]? By "flooding" the topography to an elevation of -1455 meters (Fig 2a), we find that the flooded interior and exterior of the crater meet at the point in the crater rim where the gully begins. That the source of the gully is at the crest of the crater rim may indicate spillover from a small lake to the west of the rim, and rapid draining through the channel into the crater interior. Alternatively, the gully head may have progressively retreated upslope, cannibalizing its own source area. Or a steeper source area at the crater rim may have been eroded away by eolian abrasion.

What to look for on the ground? The Opportunity rover can make a number of useful observations to address the origin of the gully. First, 360° Navcam stereo panoramas acquired at each end of drive position can enable compilation of high resolution orthomosaics and digital elevation models (ORR/DEMs) that can be mosaicked to produce continuous maps at centimeter scales of the gully. In addition, Pancam color stereo at each rover location can provide millimeter to centimeter-scale detail of select features within the broader Navcam coverage. Sedimentary fabrics and textures, such as imbricated clasts, pebble or cobble "trains", or interchannel bar deposits, fluvially-sorted clast distributions, and streamlined erosional and depositional forms might be identifiable. Alternatively, if the gully were formed by a dry avalanche or debris flow, poorly sorted, and matrix-supported deposits might be expected.

References: Arvidson R. E. et al., (2017) LPS 48.

Parker T. J. and Bills B. G. (2014) LPS 45, Abstract #1554.

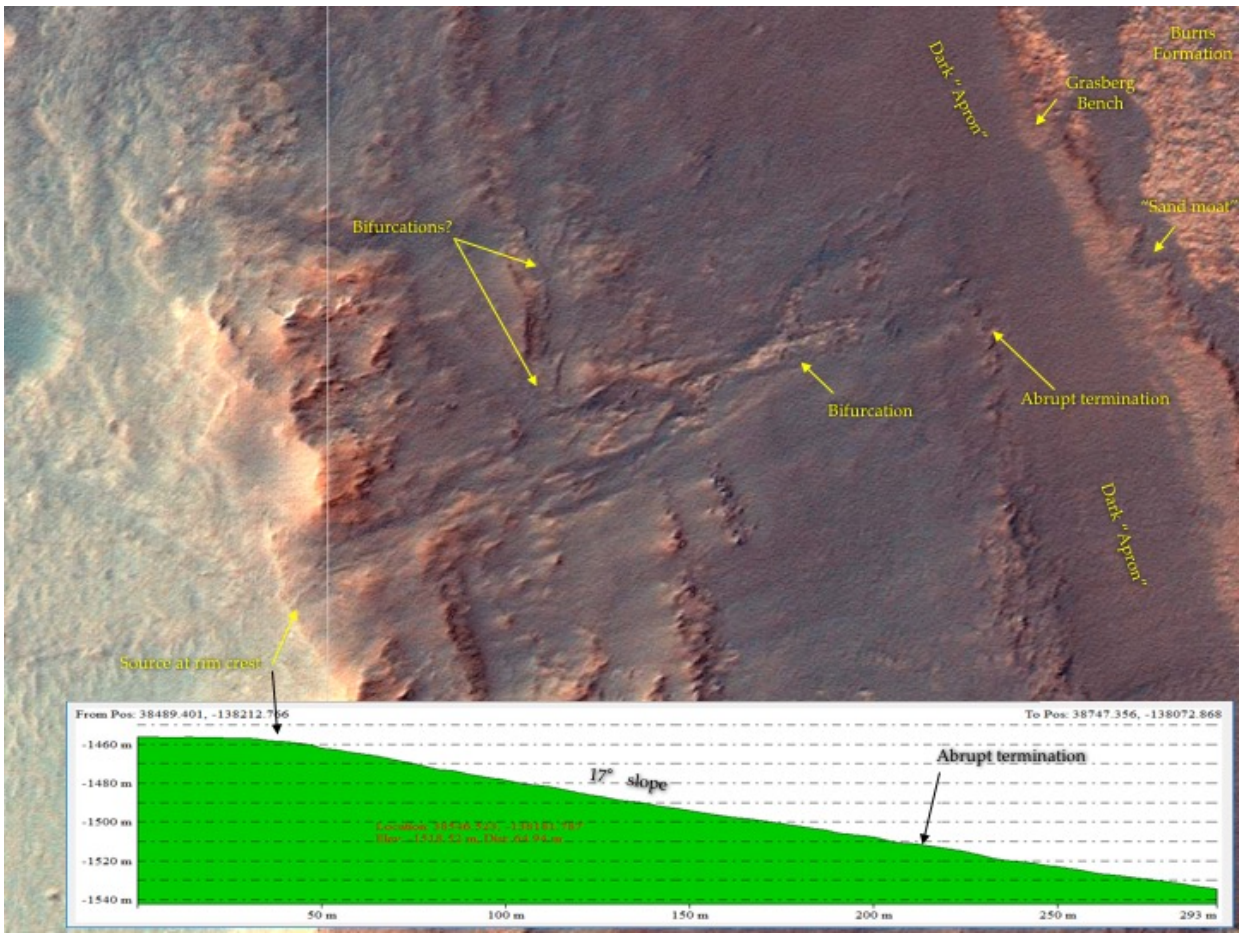

Fig 1: HiRISE map view of gully feature indicating source at Endeavour rim crest, anastomosing gully, and abrupt termination upslope from Grasberg Bench. Gully is 180 meters long and less than 1 meter deep. Scene is 300x225 meters.

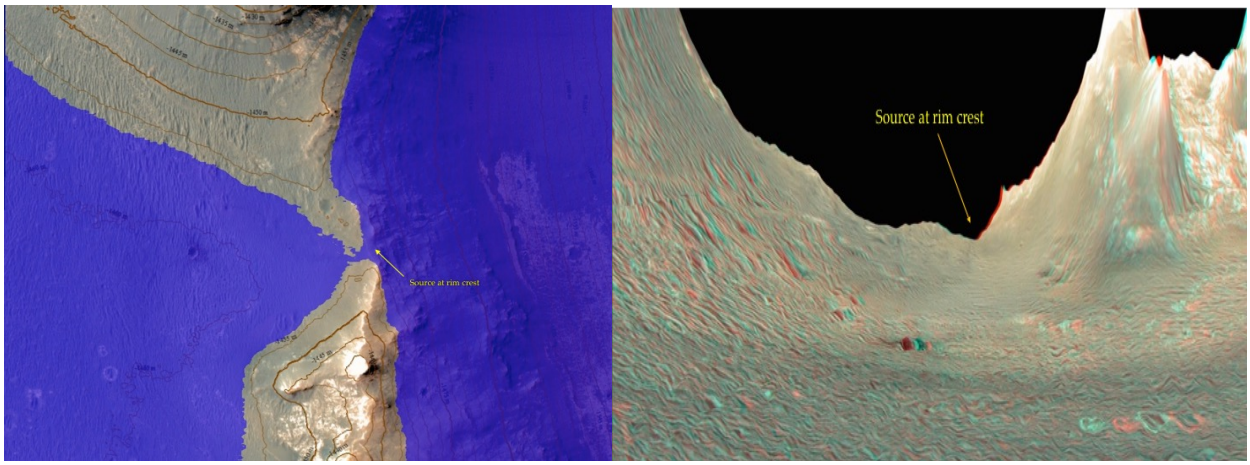

Fig 2: a) When terrain is flooded to an elevation of -1455.15 meters, plains west of Endeavour Rim connect with crater interior exactly at the source of Gully. Scene 900x700 meters. b) Anaglyph of orthoimage draped over HiRISE DEM, viewing east from west of channel source. Large vertical exaggeration to highlight "notch" position relative to gully source.