

**AN APRON AROUND THE BASE OF THE ENDEAVOUR RIM INSELBERGS: EVIDENCE OF COASTAL PROCESSES AT THE OPPORTUNITY LANDING SITE.** T. J. Parker<sup>1</sup> and B. G. Bills<sup>1</sup>, and the MER Science Team,<sup>1</sup> Jet Propulsion Laboratory, California Institute of Technology, ([timothy.j.parker@jpl.nasa.gov](mailto:timothy.j.parker@jpl.nasa.gov), [bruce.bills@jpl.nasa.gov](mailto:bruce.bills@jpl.nasa.gov)).

**Introduction:** The Endeavour rim mountains are bounded by an apron of reworked surfaces and sediment onlaps resembling terrestrial lakeshores that are tilted into the crater.

**Observations:** Opportunity is currently working its way south along the west rim of the 22-km Endeavour Crater at Cape Tribulation. The rim and interior of the crater is partly obscured by the familiar sulfate sandstones and mudstones of Meridiani Planum. The contact between the plains and the rim inselbergs is defined by an apron, typically about 15-20 meters in width and elevated slightly above the surrounding plains. In monoscopic orbiter images, this bench suggests a horizontal surface at the base of the inselbergs. However, digital elevation models made from CTX and HiRISE stereo images show these aprons define approximate planar surfaces sloping downward into the crater interior by several degrees (Fig 1).

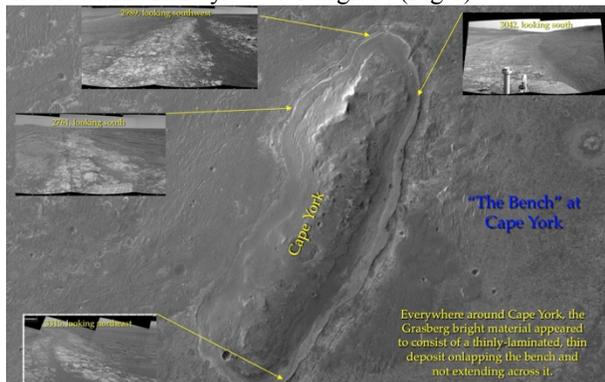


Figure 1: Cape York, with examples of bench morphology observed by the Opportunity rover. Scene width ~1400m.

The bench is best exposed along the west and east rim mountains. From orbit, it exhibits four principal elements. From the plains, upslope, they are: 1, a basal scarp up to a few tens of centimeters high; 2, a margin of bright outcrop that appears to either onlap or protrude from beneath 3, a smooth darker slope extending from the bright outcrop up to 4, a low escarpment or “berm” at the base of the rougher-looking surface of the Endeavour rim and a few meters upslope from the basal scarp.

Cape York (Figs 1, 3) was the first of the west rim mountains visited by Opportunity, followed by Sutherland Pt./Nobbys Head, Solander Pt, and finally Cape Tribulation (at time of this writing). Opportunity has imaged the bench at several locations around these

inselbergs with the navigation and panorama cameras (navcam and pancam). From the ground, the basal scarp does appear to be an erosional feature, as does the berm separating the bench or apron from the Endeavour rim surfaces. The bright outcrop margin (the “Grasberg unit”) is the most prominent of several successive onlaps of thinly-laminated sulfate sediments onto the crater rim inselbergs.

**Coastal Interpretation:** Morphologically and stratigraphically, these onlaps are strikingly similar to terrestrial beachrock, but are sulfate rather than carbonate (Fig 2). If the bench, berms and onlaps once defined horizontal erosional and depositional surfaces, then a mechanism must be found to explain the tilt of both the plains margin and the inselbergs inward toward the crater interior. The crater seems to be too small a feature for a tectonism to be the cause of the tilt. Perhaps sediment dewatering and compaction over time could have caused the tilt at the rim. This might also suggest that the sediment is thicker or was deposited more rapidly inside the crater interior than outside, which might be expected in partially-buried cratered highland topography.



Figure 2: Terrestrial “beachrock” analogs. Upper left, Pyramid Lake, Nevada. Upper right, Normanby Island, Queensland. Lower Left, Salar de Uyuni, Bolivia. Lower right, southern Arabian Gulf. A II but the Bolivian example are composed of carbonate cements. The Bolivian example is salt. Queensland image from Jessica Winder photo blog: <https://natureinfocus.wordpress.com/category/places/australia/queensland-coast/cape-tribulation/>.

**References:** [1] Benson L. (2004) *USGS Circ* 1267. [2] Alsharhan A. S. and Kendall, C. G. St. C. (2003) *Earth-Sci. Rev.* 61, 191-243.

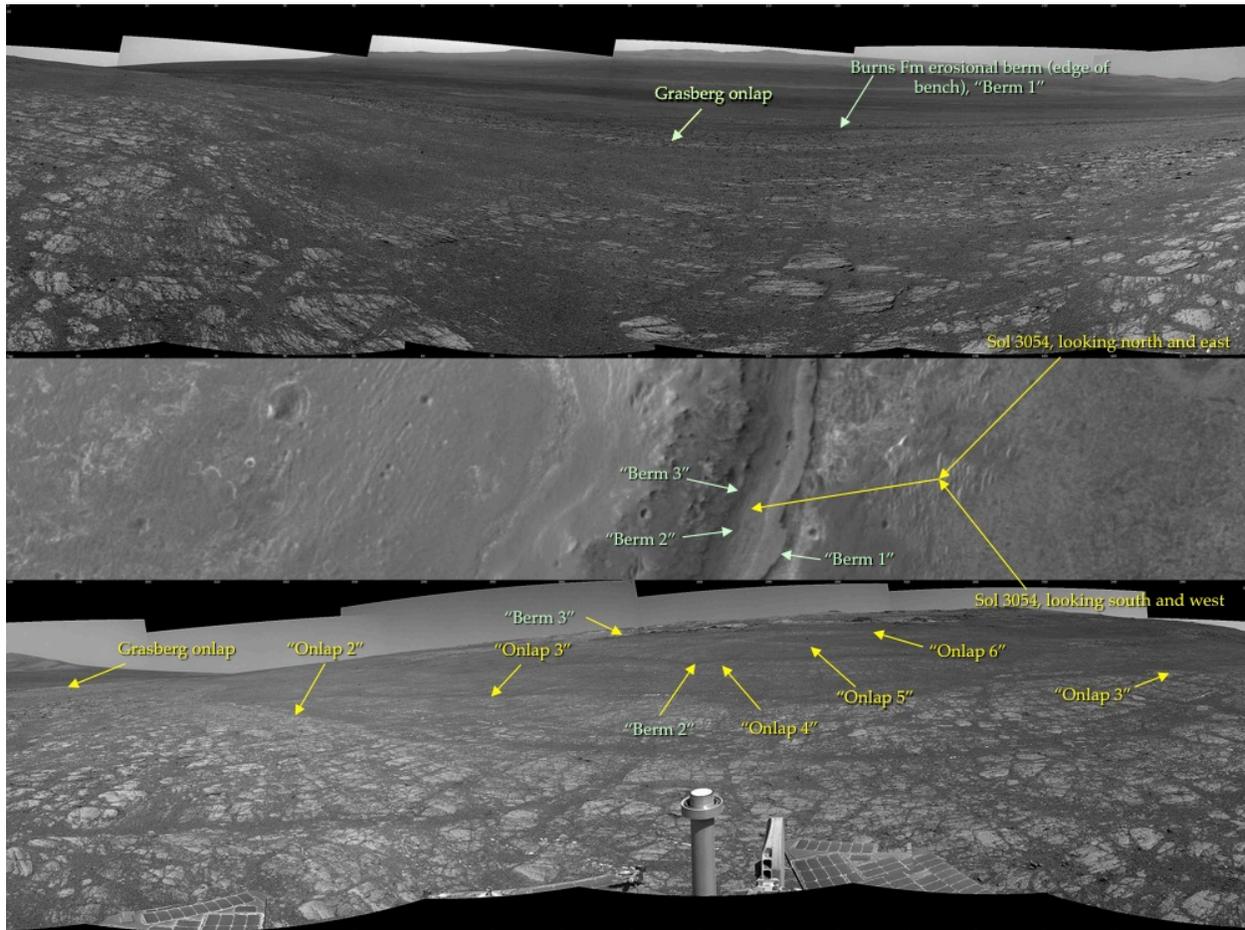


Figure 3: Navcam 360° panorama taken from apron on east side of Cape York by the Opportunity rover on Sol 3054. Burns Fm. is beyond “Berm 1” in top scene (viewing east). The rover is located on one of the Grasberg units, which appear to onlap Cape York in a series of as many as 6 flaps (indicated in yellow) – similar to shingles installed backwards on a roof. The sulfates are thinly-laminated, with the laminations dipping downslope away from Cape York. In green, 3 berms are interpreted as erosional features of the apron. The surface of the apron is smoother than that of the Shoemaker Fm rim materials comprising the Cape York rim inselberg. Thus both erosional reworking and sediment deposition is implied.