STRUCTURE AND SEDIMENTOLOGY OF THE WESTERN MARGIN OF EREBUS CRATER, MERIDIANI PLANUM, MARS.

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Introduction: The Mars Exploration Rover *Opportunity* landed in Meridiani Planum over 3 years ago and has since been exploring the sulfate-rich bedrock exposed on the plains and in crater walls, which has been interpreted by the MER team to have been deposited in an eolian dune-interdune environment [1,2].

Opportunity has collected many images of Erebus crater, a ~300 m diameter crater located approximately 4 km south of Endurance crater. The outcrop exposures in Erebus crater include a large expanse of outcrop called the Olympia Outcrop (fig. 1), whose sedimentary structures have been previously described and indicate they were deposited in a wet interdune environment [3], and two, more prominent, outcrops along the western rim of the crater. These more prominent outcrops feature ~1 m high vertical exposures of outcrop that are 80 m long from the north end of the northern outcrop ("Payson") to the south end of the southern outcrop ("Yavapi") (fig. 1). Outcrop exposures in Erebus crater show more of the wet interdune facies than outcrops exposed in Eagle and Endurance craters [1,2,3].

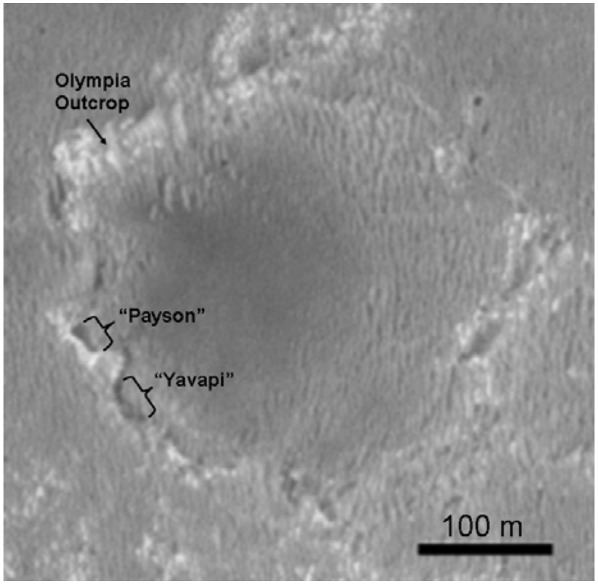

Figure 1. MOC image of Erebus crater. The locations of the Olympia outcrop, Payson, and Yavapi are shown.

Data Set: *Opportunity* drove south from the Olympia outcrop (Fig. 1) and imaged along the face of the northern and southern outcrops between sols 742 and 758. Payson was imaged from three different positions and Yavapi from two locations.

Discussion: The structure, stratigraphy and sedimentology of Payson and Yavapi have been examined and are discussed below.

Structure. Payson strata form a monocline of variable dip in which all of the layers stike in a ESE-WNW direction. Yavapi strata define an open syncline, with the fold axis trending roughly east-west. The lip of the rim is not a bedding plane since the bedding can be seen cutting across the lip in some places. The geomorphic expression of the lip reflects differential lithification, probably the result of diagenesis that post-dates deposition and deformation.

Facies. The facies observed at Payson represent both dune and interdune environments, with some wet interdune facies, while Yavapi contains predominantly dune facies. Spherules were uncommon in the Olympia outcrop, and they are also extremely rare to absent in the Payson and Yavapi outcrops.

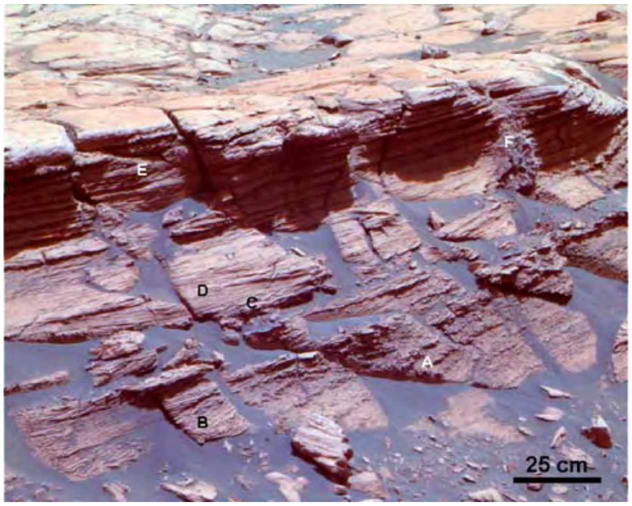

Figure 2. Pancam false color image taken on sol 749 of the northwest section of Payson. The letters A-F indicate the facies described in the text.

The lowest observed facies at Payson (A in fig. 2) is a mottled and poorly stratified unit with a disrupted texture. Beds are ~4-6 cm thick and show palimpsest mm-scale lamination in some areas which suggests that it was laminated at the time of deposition, but may have been recrystallizd at a later time which disrupted much of the lamination.

A second facies (B in fig. 2), which in some places is stratigraphically adjacent to the mottled facies and in other places overlies the mottled facies, is also poorly stratified at the mm-scale but contains evidence of syn-sedimentary deformation including potential rip-up clasts. The potential rip-up clasts would have been laminae that were lithified before being broken up and reworked. Such structures are often found in wet interdune environments [4].

The second facies is overlain by a ~20 cm thick mm-scale wavy-laminated facies (C in fig. 2) also characteristic of wet interdune environments [5]. In some areas further to the south at Payson and at the same stratigraphic level as the wavy-laminated facies, are areas with potential small-scale trough cross-lamination.

A planar- to low-angle cross-stratified facies geometrically arranged in ~3-4 cm thick bed sets showing low angle truncations (D in fig. 2) lies in some areas stratigraphically adjacent to and in others stratigraphically above the wavy-laminated facies. This type of facies probably represents translatent wind ripple strata deposited in a sand sheet [6]. Above the planar laminated facies are fairly regular ~3 cm thick mm-scale cross-stratified bedsets, with shallow trough geometry (E in fig. 2). These cross-strata likely represent the toes of larger dunes deposited during bedform migration. Cutting through the cross-laminated bedsets and oriented perpendicular to bedding is a fracture fill (F in fig. 2).

The facies observed at Yavapi are interpreted as predominantly dune facies. The lowest unit is planar stratified at the cm-scale with a rough weathered texture. Stratigraphically higher than the planar stratified unit is a ~2 m thick unit of predominantly large-scale, high-angle cross-beds characteristic of eolian dunes. The cross-beds within this unit are ~1-2 cm thick. The contact between the two units is obscured by soil.

Alternative Interpretation: Two alternative interpretations have been suggested which propose that the stratification observed at the Opportunity landing site was the result of a base surge processes, alternatively generated by volcanic [7] or impact [8] processes. However, the stratigraphy and sedimentology of the Payson and Yavapi outcrops as a whole are less consisistent with these interpretations. Pyroclastic surges are characterized by the following facies from a vent-proximal to vent-distal direction: decimeter to meter-scale supercritically climbing cross-stratification, massive deposits, and planar, cm-scale stratification [9]. Base surges also are commonly coarse-grained and have poor sorting over meter-scales. Bomb sags are common.

No supercritically climbing cross-strata were observed at Payson or Yavapi. While a mottled and poorly stratified facies was observed, it has palimpsest mm-scale lamination which suggests that it was originally finely laminated during deposition. Therefore, these beds were not deposited as a mass-flow or fall-out, but rather as a result of steady sedimentation. Their mottled appearance is interpreted to result from post-depositional recrystallization. Wavy lamination at the mm-scale and small-scale trough cross-lamination, as observed at Payson, has not been reported in surge deposits. Planar laminated facies are observed at both Payson and Yavapi, and are found in both base surge and dune-interdune deposits. No bomb sags were observed in either Payson or Yavapi (or in any other strata previously studied by *Opportunity* at Meridiani). The facies pattern at Erebus as a whole, given the lack of dm to m-scale supercritically climbing cross-strata and the presence of mm-scale wavy lamination and cm-scale trough cross-lamination, is more consistent with a dune-interdune environment than a base surge deposit. This is further supported by by the consistently fine-grained nature of the Meridiani deposits, and their excellent sorting.

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References: [1] Squyres S. W. et al. (2004) *Sci., 306,* 1709-1714. [2] Grotzinger J. P. et al. (2005) *Earth and Planet. Sci Lett., 240,* 11-72. [3] Grotzinger J. P. et al. (2006) *Geol., 34,* 1085-1088. [4] Mountney N. P. and Thompson D.B. (2002) *Sedimentol., 49,* 805-833. [5] Kocurek G. (1981) *Sedimentol., 28,* 753-780. [6] Kocurek G. and Nielson J. (1986) *Sedimentol., 33,* 795-816. [7] McCollom, T. M. and Hynek, B. M. (2005) *Nature, 438,* 1129-1131. [8] Knauth, L. et al. (2005) *Nature, 438,* 1123-1128. [9] Wohletz, K. H. and Sheridan, M. F. (1979) *GSA Special Paper, 180,* 177-194.