SEDIMENTARY GEOMORPHOLOGY OF THE MARS PATHFINDER LANDING SITE. J. W. Rice, Jr., M.T. Lemmon, P.H. Smith, R.A. Yingst, Lunar and Planetary Laboratory, University of Arizona, Tucson, AZ 85721-0092, USA; (jrice@lpl.arizona.edu).

Introduction

The successful landing of Mars Pathfinder near the confluence of Ares and Tiu Valles on July 4, 1997, has prompted new interest in understanding the nature of the geomorphology of the outflow channels around the margins of the Chryse Basin. However, investigators [1, 2, 3] still do not agree upon which mechanisms (catastrophic flood, debris flow, glacial flow) created the landscape.

Twin Peaks

Previous work [5] regarding Twin Peaks indicates that the two hills, due west of the lander, are less than 50 m in height. The distance from the lander to North Twin was stated to be 860 m and the distance to South Twin 1,000 m [6]. However, new cartographic analysis [7] suggests that the distance to North Twin is 780 m and the distance to South Twin is 910 m. We have used these new refined distances to calculate the respective heights of the Twin Peaks. These are relative not absolute heights because the lander could not "see" to the base of the Twin Peaks due to the intervening ridge and trough topography. North Twin is 28 m above the local lander horizon and the height of South Twin is 38 m.

Initial morphologic studies [5] stated that South Twin is taller and conical and that North Twin is shorter and has a more broad flat top. We suggest that the resultant morphology of North Twin is due to being topped by the flood waters. If so, then flow depths may have exceeded 30 m rather than the 10 - 20 m stated by [5]. For our calculations here, we use a depth of 30 m and the same gradients as in [5] to calculate a flow velocity of 12 m/s. The size of the largest clasts moved as bedload is computed to be 2.3 m intermediate diameter.

It was also noted that North Twin is banded. These bands were interpreted to be possible terraces [5]. Our work suggests that this interpretation is correct. For the sake of clarity we define a terrace as an abandoned surface which records a former level of the water surface. The proper term for the type of terrace we propose for the Twin Peaks is a strath terrace. Strath terraces are cut into preexisting topographic highs and are veneered with a layer of floodplain alluvium. Terrace morphology is a steplike landform consisting of a flat tread and steeper riser commonly of fluvial, lacustrine, or marine origin. We have identified six terraces on North Twin (TABLE 1). We have also discovered six terraces on South Twin; this is the first mention of terraces on South Twin. Some other observations that we have noted: indicate that there (1) appears to be a lateral continuity of the terraces from one peak to the other and (2) that perched boulders appear to be sitting on the tread of some of the terraces.

Rock Garden

Imbricated rocks are visible throughout the landing site but the type location for this sedimentary fabric is in the Rock Garden (rocks: Wedge, Shark, Moe, Half Dome, Frog, Pumpkin). Imbrication is a fabric of maximum stability and is commonly used to indicate paleoflow direction, where clasts dip upstream [8]. The imbricated rocks located in the rock garden indicate flow from Ares Vallis (SE to NW imbrication).

Ridge and Trough Topography

The landscape of the landing site is also dominated by ridges and troughs running parallel to flow directions and is attributed to catastrophic floods [5]. The ridge and trough topography at the landing site has amplitudes up to 5 m and are commonly spaced 15 - 25 m [5]. On Earth, high velocity flows often generate corkscrew vortices that create ridges and troughs oriented parallel to the direction of flow. The wavelength of these vortices is typically 2 - 4 times the height [8]. This relationship accurately describes the ridge and trough topography at the landing site.

Conclusions

The Mars Pathfinder landing site is replete with landforms and textures that indicate a rich complex fluvial history on both a regional and local scale. On a regional scale the geomorphology displays a comprehensive collection of both erosional and depositional landforms created by multiple catastrophic floods. Locally we have noted the existence of terraces, perched boulders, abundant imbricated clasts, shadow zones, pebble clusters, and percussion marks. All of this evidence provides strong credence to the hypothesis that catastrophic floods formed this landscape.

References

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TABLE 1.

Twin Peaks
Terrace Elevations

South Twin Peak	***North Twin Peak***
T_1 = 4.5m (±.45m)	T_1 = 4.3m (±.43m)
T_2 = 7.7m (±.77m)	T_2 = 7.0m (±.70m)
T_3 = 14.6m (±1.6m)	T_3 = 11.3m (±1.1m)
T_4 = 19.6m (±1.6m)	T_4 = 15.0m (±1.5m)
T_5 = 23.6 (±2.6m)	T_5 = 19.0m (±1.9m)
T_6 = 30m (±3.0m)	T_6 = 21.5m (±2.1m)

Distance and Height
of Peaks from MPF

D_S = 910m (±91.0m) D_N = 780m (±78.0m)

H_S = 38m (±3.8m) H_N = 28m (±2.8m)

Based on Stereo Images
Distances from Oberst et. al, 1998
Elevations measured above Local Level Horizon