HORIZON VIEWING OF LOCAL TOPOGRAPHIC FEATURES FROM THE MARS PATHFINDER LANDING SITE. T. J. Parker, Mail Stop 183-501, Jet Propulsion Laboratory, 4800 Oak Grove Dr., Pasadena, CA 91109, e-mail: timothy.j.parker@jpl.nasa.gov, and P. Smith, Lunar and Planetary Laboratory, University of Arizona, Tucson, AZ 85721, e-mail: psmith@lpl.arizona.edu.

INTRODUCTION

Mars Pathfinder will touch down in southern Chryse Planitia within a 100x200 km ellipse in the vicinity of the mouths of Ares and Tiu Valles on the Fourth of July this year. Long-wavelength topography across the entire landing ellipse is generally flat to within a hundred meters or so of -2 km elevation (1). Large topographic obstacles were avoided in selecting the landing site for safety reasons (2). Several large streamlined islands and two modest-size craters, with relief on the order of a few hundred meters, lie at the margins of the landing site. Smaller features, such as knobs and small craters, typically with relief on the order of tens to, rarely, a few hundred meters, are present throughout the landing ellipse. These smaller features should pose minimal hazards to landing (2), and may enhance our ability to quickly locate the landing site and possibly offer interesting science imaging targets if they are visible well above the horizon. This work will describe our efforts to predict the likelihood that one or more of these features might be visible using the IMP camera once surface operations begin in July.

RELIEF MEASUREMENTS

For this exercise, we will assume that the horizon is perfectly flat at the lander scale, since we cannot anticipate the local topography in advance of the landing. Most of the knobs and craters within the landing ellipse are too small to show well at the scale of the photogrammetrically-derived topographic map by Howington-Kraus et al. (1). We are measuring these features on the Viking Orbiter images using symmetric and asymmetric photoclinometric profiling. The heights of the larger features will be corroborated using stereo parallax measurements (e.g., 3).

FEATURE RECOGNITION

In order for a feature to be visible to the IMP camera, it must be tall enough and/or close enough to project above the local horizon (Fig 1). We used simple trigonometry to determine the distance to the local horizon from the IMP's nominal 2 m elevation above the ground

Horiz. = (Mars'radius + IMP height) x tan(α) = 3.68 km

Similarly, we can determine the distance beyond the horizon that the summit of a distant hill or crater rim will be tangent to the horizon or at some height above it

$$\text{Dist.} = 3.68+(3390+h_1+h_2)*\tan(\cos^{-1}(3390/(3390+h_1+h_2)))$$

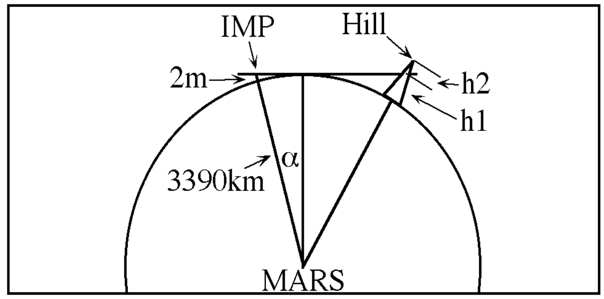

Figure 1: Geometry of IMP-Horizon-Feature Visibility described in text.

We have chosen 3 pixels (3 mrad) as the minimum height an object must project above the horizon for recognition (Fig 2). At this height, the object is useful only for triangulation measurements.

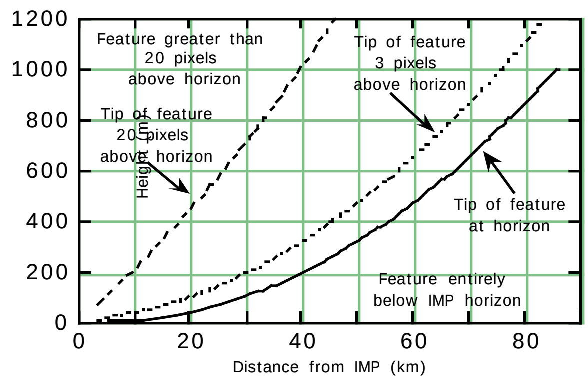

Figure 2: Plot of visibilty of features beyond the local horizon.

GEOLOGIC INVESTIGATION

Even though it is formally possible to detect the presence, and therefore the direction vector, of a distant hill or elevated crater rim when only 2 or 3 pixels of the feature extend above the horizon, the proper study of a hillside (e.g., looking for stratigraphy, terraces, flood high-water lines and shorelines, or other interesting geologic features), requires much greater areal coverage on the CCD. Experience with satellite images using HST and images of local mountains in the Tucson valley taken with IMP lead us to choose 20 pixels as the desired minimum height for the scientific study of a hillside. At a resolution of 1 mrad/pixel, color differences and stepped topography should be easily visible for the types of layering or terraces that were imaged by Viking on the streamlined islands in the vicinity of the landing site; whereas changes of the shadowing with sun angle should provide slope information. The width of the knobs in the Pathfinder landing ellipse is comparable to or greater than their height. Therefore, because some of the height will likely lie below the horizon, they should subtend 30-40 pixels across, yielding a total number of pixels on the hillside of 600-800. A 200 m high object would satisfy this criterion at a distance of 10 km (a resolution of 10 m/pixel) and a 500 m high object could be studied at 22 km distance (a resolution of 22 m/pixel) (Fig 2).

Based on these results, we are compiling a map of the landing ellipse that will illustrate how near the actual landing site would have to be to a knob or elevated crater rim (for craters larger than 1 km in diameter) for it to be studied by the IMP camera (Fig 3).

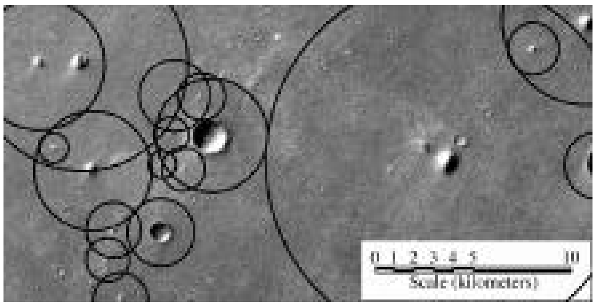

Figure 3: Sample map showing distances from various knobs and craters that Pathfinder would have to land in order for the feature to extend at least 20 pixels above the horizon. The largest knob in this view is 195 m tall. Portion of Viking Orbiter image 004a24. North is toward top of image.

There are problems with the more distant objects: the atmospheric haze will tend to obscure the features of interest and the Viking orbiter imagery already allows one to study these objects at ≥38 m/pixel resolution, although the resolution on steep slopes is much poorer due to the foreshortening. For this reason, trying to maximize the chances of landing within 10 km of interesting vertical structures gives the best scientific return.

REFERENCES: (1) Howington-Kraus et al. 1995, LPI Tech. Rpt 95-01, 39-40. (2) Golombek et al. in press, JGR Mars Pathfinder Special Issue. (3) Parker 1995, LPI Tech Rpt. 95-01, 23-24.