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SCIENTIFIC RATIONALE FOR SELECTING NORTHERN EUMENIDES DORSUM (9°–11°N LATITUDE, 159°–162° LONGITUDE) AS A POTENTIAL MARS PATHFINDER LANDING SITE. T. J. Parker, Jet Propulsion Laboratory, California Institute of Technology, Pasadena CA 91109, USA.

The proposed site is the northernmost occurrence of the Medusae Fossae Formation (MFF), and lies at or below the –2-km contour. The MFF is the famous radar "stealth" deposit that extends from south of Olympus Mons westward across southern Amazonis Planitia to southern Elysium Planitia. The MFF appears to be composed of some kind of wind-eroded friable material, the origin of which is very problematic. It appears to be a radar-absorbing material [1], whereas Mars' south polar layered deposits appear bright in the same scenes. Synthetic aperture radar images of young terrestrial ash deposits in the Andes also appear relatively bright. The MFF's radar signature appears to require a uniformly fine-grained material (on the order of dust-sized to fine sand-sized) at least several meters thick, in order not to transmit reflections off underlying terrain or internal reflective horizons. A number of very different hypotheses have been proposed over the years to explain this formation. It has been interpreted as either a large, wind-blown volcanic ash deposit [2] or other wind-blown material trapped along the escarpment between highlands and lowlands [3,4]; ancient polar layered deposits [5] requiring a massive change in the planet's rotation axis; and finally as carbonate platform deposits [6] or banks of low-density volcanic material deposited in an ocean [7].

Accumulation of tens to thousands of meters of unwelded, friable ash blankets, necessary to avoid formation of internal reflectors, would seem to require a large number of discrete, relatively thin deposits. The radar signature, therefore, seems inconsistent with the volcanic ash and polar layered material interpretations. The "stealth" requirement may be met by an uncemented sand or loess material, thus supporting the suggested eolian hypothesis. It might also be met by inferring chemically precipitated but largely uncemented carbonates. If correct, this last model would have important implications with regard to search strategies for fossil organic materials or the environments that might be conducive to their development. In 1991, I suggested that the surface morphology of the MFF is comparable to terrestrial carbonate platform deposits [6]. The best modern analogs would be oolitic deposits, such as found over large regions of the Bahama Banks. To fit the observed morphologies and radar signature, a process akin to inorganic oolite precipitation and transport by oceanic currents or agitation by waves [8,9], with little cementation, was proposed. An oolitic grain size is necessary both to provide the "stealth" radar signature and to allow the development of sand wavelike bedforms visible in some high-resolution images of the deposit. A largely uncemented state is also needed to explain the radar signature, requiring relatively rapid deposition and little to no subsequent cementation or diagenesis.

This requirement probably can be met because ocean transgressions on Mars were likely short-lived and separated by long periods with temperatures below freezing, thus preventing dissolution and cementation through rain or groundwater migration within the deposit. Finally, carbonate precipitation would have taken place fairly rapidly when liquid water was present due to the planet's high atmospheric CO_2 content. Surface science that can address the chemical/mineralogical composition and physical properties of this material would be very important to understanding a relatively recent (Amazonian) volcanic or paleoclimatic process that resulted in a 2,700,000-km^2 deposit along the martian equator. Based on assumptions about the average thickness of this deposit, this area corresponds to a total volume of material on the order of 27,000–2,700,000 km^3. The proposed Pathfinder landing site lies on a relatively smooth, "unmodified" portion of the MFF, more than 100 km away from its northern and western edges, which exhibit evidence of eolian etching in the form of closely spaced yardangs. There are no large craters or steep slopes within a few hundred kilometers of the landing site.

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SCIENTIFIC RATIONALE FOR SELECTING NORTHWEST ISIDIS PLANITIA (14°–17°N LATITUDE, 278°–281° LONGITUDE) AS A POTENTIAL MARS PATHFINDER LANDING SITE. T. J. Parker[1] and J. W. Rice[2], Jet Propulsion Laboratory, [1]California Institute of Technology, Pasadena CA 91109, USA, [2]Department of Geography, Arizona State University, Tempe AZ 85282, USA.

The northwest Isidis Basin offers a unique opportunity to land near a fretted terrain lowland/upland boundary that meets both the latitudinal and elevation requirements imposed on the spacecraft. The landing site lies east of erosional scarps and among remnant massif inselbergs of the Syrtis Major volcanic plains. The plains surface throughout Isidis exhibits abundant, low-relief mounds that are the local expression of the "thumbprint terrain" that is common within a few hundred kilometers of the lowland/upland boundary. These typically occur in arcuate chains, often with a summit pit or trough. They have been variously interpreted as volcanic cinder cones or psuedocraters [1], pingos [2], or eolian deposits that formed at the edge of a sublimating ice sheet [3]. We have used photoclinometry to measure similar mounds in Cydonia, using photoclinometry, at no more than a few tens of meters high, implying very gentle slopes. Cinder cones should exhibit slopes determined by the ballistic emplacement of unconsolidated material, and so they commonly approach the angle of repose.

Pingos are typically conical-shaped ice cored hills up to 100 m high and 600 m in diameter [4]. Many pingos often exhibit dilation cracks radiating from the apex of the hill. These fractures are created as a result of the growth of the ice core. This process exposes the ice core and allows it to thaw out, thereby producing a collapsed summit area. Pingos are usually located in lowland areas, especially lake beds and deltas. Lander and rover observations should be able to confirm whether these landforms are pingos or cinder cones based on the presence of dilation cracks or slopes approaching the angle of repose. The discovery of pingos would be of high importance to future missions to Mars, both robotic and "folked." The pingo ice core could contain relatively pure water ice within several meters of the surface.

The massif inselbergs are not as numerous nor as massive as those in fretted terrains to the northwest, so local slopes are not expected to be steep. Neither feature should pose a serious threat to the lander. Landing on or adjacent to one of these features would enhance the science return and would help to pinpoint the landing site in Viking and subsequent orbiter images by offering views of landmarks beyond the local horizon.

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CERBERUS PLAINS: A MOST EXCELLENT PATHFINDER LANDING SITE. J. B. Plescia, Jet Propulsion Laboratory, California Institute of Technology, Pasadena CA 91109, USA.

Introduction: The Cerberus Plains in southeastern Elysium and western Amazonis cover $>10^5$ km^2, extending an east-west distance of ~3000 km and a north-south distance of up to 700 km near 195°. Crater numbers are 89 ± 15 craters >1 km/10^6 km^2, similar to values obtained by [2,3], indicating a stratigraphic age of Upper Amazonian and an absolute age of 200–500 Ma [1]. The material forming the surface is referred to as the Cerberus Formation. The unit's origin is controversial; two ideas have been postulated, fluvial [4,1] and volcanic [5]. Regardless of which interpretation is correct, the Cerberus Plains is an important candidate for a Pathfinder landing site because it represents the youngest major geologic event (be it fluvial or volcanic) on Mars.

Geology: The unit exhibits lobate albedo patterns and embayment relations with older terrane. These patterns suggest flow eastward across Cerberus, then northeastward through the knobby terrane into Amazonis (exploiting a series of older channels carved into knobby terrane and ridged plains). Albedo patterns in the east are regionally organized into bands up to 40 km wide; in the west, albedo patterns are complex and intricate with digitate boundaries. Small-scale surface texture is variable. Near 19°N, 174°W, where the unit fills a channel, the floor appears smooth, whereas the surrounding terrane has significant texture. The southern margin exhibits pressure ridges, flow fronts, and flowage around obstacles.

The morphology of the Cerberus Plains is interpreted to indicate that it is an example of flood-basalt volcanism (e.g., Deccan Traps, Columbia Plateau); the morphology of the western part indicates plains-style volcanism (e.g., Snake River Plains). Terrestrial flood basalt provinces [6,7] are characterized by flows 5–45 m thick extending over large areas having little relief. Eruption rates are very high with fissure vents tens to hundreds of kilometers long in zones several kilometers wide. Six low shields have been identified in the western plains. Some of the Cerberus shields are elongate, having elliptical vents; others are more symmetric.

Pathfinder Mission Implications: The Cerberus Formation occurs between longitudes 165° and 220° and latitudes 5°S and 30°N, although the material does not completely cover this area. The largest expanse occurs at 180°–210°W and 5°S–10°N. Thus, the area of exposure is within the Pathfinder constraints (0°–30°N). Elevations [8] are at altitudes <–1 km; a northeast-trending band from 5°N, 197°W toward 10°N, 180°W has elevations <–2 km. These altitudes are within the Pathfinder range (<0 km). A 100-km × 200-km ellipse along a N74°E trend is easily found within the unit; a target for the center of the landing ellipse is 6°N, 183°W, a location ensuring landing within in the unit. The Cerberus region has low thermal inertia [9] ($<4 \times 10^{-3}$ cal cm^{-2} s$^{-1/2}$ K^{-1}), interpreted to indicate a low rock fraction exposed at the surface [10], <10%. This suggests the area would be relatively safe for landing, but still offers the potential for finding exposed rock.

Possible Scientific Implications: The first question to be resolved is whether the Cerberus Formation is of volcanic or fluvial origin. This alternative is testable with both imaging and elemental data. A volcanic flood basalt terrain should show a level, possibly slightly rolling surface; flow fronts and pressure ridges may be present. Rock analysis, both spectral and elemental, should show a relatively uniform composition. A fluvial environment should show channels and a scoured surface, and evidence of erosion should be abundant at all scales. Since debris on the surface would be from many sources, significant heterogeneity would be expected in the spectral and elemental analysis of the rocks.

It can be postulated that the Cerberus Plains are the source for some of the SNC meteorites, specifically shergottites, on the basis of age and volcanic style. Shergotty, Zagami, ALHA 77005, and EETA 79001 have ages of 160–180 Ma [11,12]. Only the Cerberus Formation is of sufficient size and age to be a statistically significant source region. Major-element chemistry for the shergottites is SiO_2 at 43–51%, FeO at 18–20%, Al_2O_3 at 3–9%, MgO at 9–28%, and CaO at 3–11%. The apx unit will provide key elemental data at the percent level. Shergottites are dominated by pigeonite (~26–40%), augite (11–37%), and plagioclase-maskelynite (10–29%). The presence of these minerals may be detectable by the filters in the imaging system, depending on the choice of band passes. These two instruments should provide sufficient data to determine whether the Cerberus Formation is the unit from which the shergottites were derived.

The interpretation that Cerberus Plains results from flood volcanism late in martian history carries implications for martian thermal history. Although central vent volcanism has been recognized as occurring late, flood volcanism has not. Flood volcanism in the period <700 Ma indicates that, at least in the Elysium region, sufficient heat remained to generate large volumes of low viscosity lavas.

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