the hazards may be in the other areas. The extensive photographic coverage of Chryse Planitia by the Viking Orbiters and Earth-based radar observations has provided 100-m-resolution topography in the vicinity of the Viking 1 lander [2]. Analysis of these data and lander photographs indicate that Chryse Planitia may be unique in that features >50 km away from the lander (such as the rims of Lexington and Yorktown Craters) are visible over the horizon [3]. This type of information could potentially aid in roving-vehicle navigation. However, the most important use of the Viking orbiter data will be in simply determining the location of the Mars Pathfinder spacecraft on the surface. These same data were useful in determining the location of the Viking 1 lander to within ~50 m [4].

A landing site should ideally include access to as many different geologic units as possible. In addition to the materials debouched into the Chryse Basin by the large martian channel complex [5], the Hesperian-age ridged plains covering much of the region [6] represent the single most important geologic unit needed for age-dating materials on Mars. Composing ~3% of the total Mars surface area [7], the ridged plains are fairly widespread in comparison to other geologic units, and, more importantly, are the Hesperian epoch referent [8]. Because the Hesperian epoch represents the interval of time immediately following the period of heavy bombardment (~3.8 Ga [9]), an absolute age determined from a ridged plain sample would allow estimates of the postheavy bombardment impact flux on Mars to be calibrated. It may then be possible to determine the absolute ages of every younger geologic unit on Mars based on crater statistics. Potential Hesperian ridged plains outcrops identified in Viking 1 lander images may represent the only known bedrock exposures on Mars. Mars Pathfinder rover analyses of these materials could provide data to support the hypothesis that these are bedrock materials, which could be crucial for future sample return missions. In addition, materials washed down from the highlands may be present in Chryse Planitia. Although the absolute ages of these materials almost certainly correspond to the period of heavy bombardment, analysis of their composition could provide some insight into the early geologic history of Mars. Also, the distribution of the materials in Chryse Planitia as determined by a long rover traverse may be indicative of the channel formation mechanism. For example, catastrophic flooding would lead to a Bouma sequence deposit in the Chryse basin [10]; in liquefaction, an accretionary lobe in the debouching area results in larger particles dropping out first with smaller particles being transported greater distances [11]. The Mars Pathfinder Meteorology Package (MET) would almost certainly augment the data obtained from the Viking Meteorology Experiment. The Viking Meteorology Experiment was capable of providing information at only one height, which is insufficient for determining the boundary layer profile in Chryse Planitia. However, because the MET will provide information from multiple heights, profiles from the Viking data may be derived.

Because of the likelihood of running water debouching into Chryse Planitia in the past, the Viking 1 landing site was considered an ideal place to look for complex organic molecules [12]. Although the Viking biological experiments did not identify the presence of organic life [13], controversy still exists as to the meaning of the Labeled-Release Experiment [14]. A landing in Chryse Planitia would make it possible to investigate the composition of the same soil samples investigated by the Viking 1 lander. Rocks seen in lander images could also be analyzed, answering questions concerning their compositional and erosional properties. Depending on the exact Mars Pathfinder landing site and the accuracy of rover navigation, it may be possible to examine the Viking 1 lander 1 itself! *In situ* erosional analysis of Lander 1 could allow the current martian weathering rate and eolian deposition to be determined. Such information could also serve as a valuable aid in developing future martian spacecraft materials. Alternatively, it may be possible to navigate from the lander to the crater caused by the jettisoned Viking aeroshell. Ejecta from this fresh crater would represent Chryse stratigraphy to a depth of ~1 m, providing additional information on the nature of the surface materials observed by the Viking 1 lander. Although crater ejecta is frequently suggested as material that should be sampled by a spacecraft during a traverse, such stops are rarely justified. Crater ejecta, especially the outer ejecta blanket, typically has the same composition as the surrounding rock. It is the traverse up to the crater rim crest where material at depth is gradually exposed, the deepest material being exposed directly at the rim crest, typically from a depth equivalent to one-tenth the crater diameter. However, a simple examination of crater ejecta from a larger-diameter crater could potentially provide some valuable information. "Rampart" [15] or "fluidized ejecta" craters [16] have been suggested as forming from the incorporation of volatile material from depth [15] or from the interaction of the ejecta curtain with a thin atmosphere during emplacement [17]. The derived volatile content and/or sediment distribution from a rampart crater (e.g., Yorktown, 7.9 km diameter, ~45 km northwest of the Viking 1 landing site) could provide clues as to which formation mechanism is the most viable.

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RATIONALE FOR ISIDIS PLANITIA AS A BACK-UP LANDING SITE FOR THE MARS PATHFINDER MISSION.

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As discussed previously [1], the present engineering constraints imposed on the Mars Pathfinder mission leave only three broad regions available for site selection: Amazonis, Chryse, and Isidis Planitiae. Because of the knowledge gained by the Viking 1 mission, Chryse Planitia would make an ideal primary landing site. The principal objectives of this mission should be to determine the composition and distribution of surface materials. Analysis of rocks in Chryse Planitia would build upon results obtained by the Viking 1 lander and answers questions concerning composition and origin of these materials. Of particular interest would be determining whether proposed bedrock materials are indeed *in situ* materials and the degree of weathering these materials may have undergone. Because these materials may represent Hesperian-aged ridged plains, they could potentially be the key to understanding the absolute ages of the martian epochs. Results of the Mars Pathfinder could determine whether the bedrock materials are indeed Hesperian ridged plains materials, which could influence the priorities of future sample return missions.

Isidis Planitia also contains material that is Hesperian in age [2]. These materials, however, are from the Late Hesperian epoch and mark the end of this period. Nonetheless, identifying exposed bedrock materials from this unit would also be important as radiometric age dates obtained by future missions could determine which model for the absolute ages of the martian periods is correct (Fig. 1). Analysis of the temperature contrast measured by the Viking Infrared Thermal Mapper [3] suggests that the spatial distribution of rocks in Isidis Planitia may be as high as 20%, similar to that observed at both Viking landing sites. Central and northeastern Isidis Planitia appear to be much smoother, containing <10% rocks. These data suggest that Mars Pathfinder could expect to find similar or perhaps more favorable conditions than observed at the Viking 1 landing site. In addition, extensive Viking orbiter data with resolution ≤50 m/pixel exists for most of Isidis Planitia. Without an additional orbiter imaging system, these data will be critical for determining the location of the lander once on the surface. Similar data were useful in determining the location of the Viking 1 lander to within ~50 m [4].

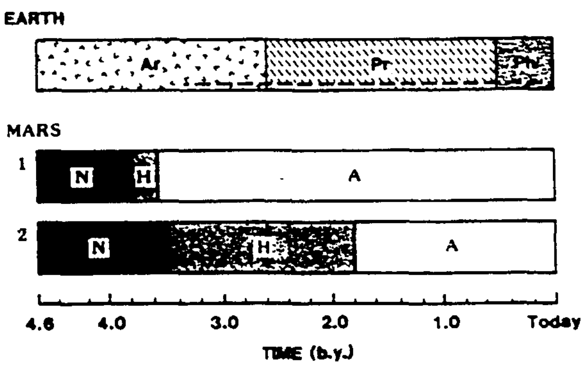

Fig. 1. Geologic time for the Earth can be broken into the Archean (Ar), Proterozoic (Pr), and Phanerozoic (Ph) periods. The dashed line represents the amount of time life is known to have existed on this planet. Geologic time for Mars is divided into the Noachian (N), Hesperian (H), and Amazonian (A) periods. The absolute ages are estimated from two different models of cratering rates. A sample of Hesperian material could determine whether model 1 [17] or model 2 [18] is correct. Because geologic evidence suggests that liquid water existed on the martian surface during both the Noachian and Hesperian, absolute ages based on model 2 imply that microbial life may have also evolved on Mars. (Reproduced from [19].)

The material contained in the interior of Isidis Planitia is frequently interpreted to be an eolian deposit [2,5,6] based on the morphology and relative ages of these units. Examination of high-resolution Viking orbiter images suggest that these materials also exhibit a systematic pattern of terrains from the interior outward to the basin rim [6]. These investigators suggested that Isidis Planitia had been the location of a thick, volatile-rich debris layer that was subsequently removed. Crater statistics and the buried morphology of craters contained within the annulus of material surrounding the basin also suggest some type of resurfacing event. However, it has also been proposed that water may have stood in Isidis Planitia [7], perhaps as part of an ocean covering the northern hemisphere of Mars [8]. Such a hypothesis may also explain the stratigraphy. Examination of the grain size and distribution of surface materials may yield clues as to the viability of either of these hypotheses. Particularly useful may be the analysis of material excavated by the crater resulting from the jettisoned Mars Pathfinder aeroshell, if it could be located. A long rover traverse (i.e., several kilometers and out of the view of the lander), however, may ultimately be required to examine such unit differences on the surface.

A variety of mechanisms has been proposed to explain the enigmatic mounds and arcuate ridges in the interior of Isidis Planitia, including volcanic cinder cones [9–11], pingoes [12], and glacial features [6,12,13]. Because of their close spacing (tens of meters), it is very likely that Mars Pathfinder would land in the vicinity of one of these features. Surface images and compositional analyses of surface material would provide valuable clues as to their origin. Such information is important for understanding the geologic history of Mars and the climatic transition that planet may have experienced from the late Hesperian into the Amazonian.

As in Chryse Planitia, the Isidis Basin contains both lunarlike and rampart craters. "Rampart" [14] or "fluidized ejecta" craters [15] have been suggested as forming from the incorporation of volatile material from depth [14] or from the interaction of the ejecta curtain with a thin atmosphere during emplacement [16]. The derived volatile content and/or sediment distribution from a rampart crater near the Mars Pathfinder landing site could provide clues as to which formation mechanism is the most viable.

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