IMP provides the geologist, and everyone else, a view of the local morphology with millimeter- to meter-scale resolution over a broad area. Accurate ranging to local features is obtained with the stereo separation; at a distance of 5 m we can locate a rock to 1–2 cm by cross-correlating edge features. In addition to the general morphology of the locale, IMP has a large complement of specially chosen filters to aid in both the identification of the mineral types and their degree of weathering. Dr. Robert Singer will present both the filters and the scientific goals for this part of the IMP experiment in his talk.

The IMP team plans to study the atmosphere in several ways. Our baseline filter set includes three solar filters for viewing the solar disk. One of these filters is specially designed to be centered on the deepest lobe of the 935-nm water absorption band; an adjoining continuum filter provides calibration reference. The ratio of the two filters is obtained many times during the course of the day, especially when the Sun is low in the sky and the absorptive path is longest. Although the ratio is estimated to be only 0.98–0.99 for nominal water vapor values, we have gone to great pains to minimize systematic errors, and it is anticipated that the water vapor mixing ratio can be obtained to within 20%.

An additional solar filter at 425 nm has been added for studying the optical depth of the atmospheric dust. The wavelength baseline when combined with the 925-nm continuum filter is a factor of 2; sizes can be accurately obtained for dust particles less than 1.4 µm in diameter by comparing the ratio of optical depths in the two colors to Mie scattering models. The nonsolar filters can also be used for studying the scattering of sunlight from the sky. In this way, the phase function of the dust can be determined and the sizes of larger particles can be estimated. These experiments can be continued into the night by observing Phobos. Other experiments to learn about the atmospheric dust can be easily imagined.

Not only can IMP observe the dust in the sky, we can trap the magnetic portion of that dust onto a series of magnetic targets of varying strength. Dr. Jens Martin Knudsen of the University of Copenhagen in Denmark has developed a special set of targets for the Pathfinder Mission and has shown in the laboratory the usefulness of imaging these targets with the IMP spectral filters to identify which magnetic mineral he has captured. In addition to the spectral information, the magnetic strength of the material can also be determined by seeing which targets have trapped the dust. We currently plan for two sets of targets at different heights: close to the surface and about 0.5 m above the surface.

A final aspect of IMP related to atmospheric studies is the windsock experiment. Dr. Ronald Greeley of Arizona State University is developing and testing small telltales to be place at varying heights between the surface and 0.5 m on one of the antennae. By imaging these targets, both the direction and velocity of the wind can be estimated. Calibration is being done at the Ames Martian Wind Tunnel, where pressure and wind speeds can be simulated; of course, the gravity must be scaled. By including wind socks at several heights the local aerodynamic roughness of the terrain can be determined and the winds can then be accurately extrapolated above the lander site. Viking landers had wind measurements at 1.6 m above the surface only; extrapolation to other heights was very uncertain.

TABLE 1.

Parameter	IMP	Viking
IFOV (1 pixel)	0.057° (1 mrad)	B&W: 0.04° Color: 0.12°
Frame size	14.4° × 14.4°	line scan
Depth of field	0.6 m - inf	1.7 m - inf
Exposure time	0.5 ms - 32 s	0.4 ms or 25 ms
Pointing	–65° < elevation < +90° All azimuth angles	–60° < elevation < +32° 2.5° < AZ < +342.5°
Stereo	15 cm horizontal 76 cm vertical	80 cm horizontal limited field
Height above surface	1.4 m	1.3 m
Bits per pixel	12	6
Filters	12 per eye	6
Filter bandpass	40 nm typ	100 nm
Camera step size	1.125° both EL and AZ	
Pointing repeatibility	0.09° at any step position	

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MELAS CHASMA: A MARS PATHFINDER VIEW OF VALLES MARINERIS. A. H. Treiman and S. Murchie, Lunar and Planetary Institute, 3600 Bay Area Boulevard, Houston TX 77058-1113, USA.

A Mars Pathfinder landing site in Melas Chasma (Valles Marineris) would yield significant science return, but is outside present mission constraints. In Melas Chasma, Mars Pathfinder could investigate minimally altered basaltic material, sedimentary deposits, chemical weathering, tectonic features, the highland crust, equatorial weather, and Valles mists. Critical issues include (1) nature and origin of the Valles interior layered deposits, important for understanding water as a sedimentary and chemical agent, and for the past existence of environments favorable for life; (2) compositions of little-altered basaltic sands, important for understanding magma genesis and weathering on Mars, and the martian meteorites; and (3) structure and composition of the highland crust, important for understanding Mars' early history. Data from Melas Chasma would provide ground truth calibration of remote sensing datasets, including Phobos ISM.

Mission Constraints I: In the first workshop circular, the landing site was to be "roughly between the equator and 30°N" with a "landing . . . uncertainty of roughly 150 km." In the final circular, the landing site is restricted to "0°N and 30°N . . . within a 100-km × 200-km ellipse along a N74E axis around the targeted site . . ." No hazard-free nominal site in Melas Chasma satisfies these later criteria. However, a hazard-free restricted site to 85 × 170 km at the same orientation can be accommodated (Fig. 1).

Site. The proposed landing site is at 9.75S 72.75W in Melas Chasma, the widest portion of Valles Marineris [1–3]. The restricted site (Fig. 1) is a flat, smooth surface, –2 to +1/2 km in elevation, mapped as younger massive material [1,2]. This surface is probably composed of basaltic sand, very slightly hydrated and oxidized. A thermal inertia of 8–10 × 10^{-3} cal $cm^{-2}s^{-1/2}K^{-1}$ [4] and block abundances of 5–10% [5] suggest sand with scattered blocks (fewer than at VL1) and little dust. A surface of slightly altered basalt or basaltic glass [6] is suggested by its dark (albedo 0.18–0.2) and slightly reddish color [4,7], its abundance of high-Ca pyroxene [8], and the presence of H_2O but little structural OH [7].

North and east in the restricted site are rough floor material and landslide material [1], the smooth distal tongues of landslides. In the nominal site, but not the restricted site, are mesas of layered material, probably volcanic or lacustrine sediments [1,9]. Mesa elevations are to 2.5 km, and some are bounded by cliffs.

Surface. Imagery of the landing surface will help elucidate recent surface-atmosphere interactions (wind) and past geological processes in Valles Marineris (sedimentary or volcanic deposition, erosion by wind and water). Characterization of the landing surface will provide ground-truth calibration for remotely sensed data from Viking color and IRTM, Phobos 2 ISM, and Earth-based spectroscopy and radar.

Sand, rocks, and dust should be accessible. The sand has little adhering dust [6], so IMP and APXS analyses of sand will include little dust component. Data on the sand, if basaltic, will help explain martian magma genesis and volcanic processes, provide tests of the origins of "martian" meteorites (via element abundance ratios [10]); and provide clues to aqueous alteration processes (especially from IMP spectra). Rocks on the landing surface probably represent local types, including basalt, sediment (layered material), and highland material from Chasma walls. Chemical and spectral data on rocks will be important in elucidating the geologic history of the Valles Marineris area, and will be relevant to all sedimentary, highlands, and volcanic terrains on Mars. There will likely be local concentrations of dust for analysis.

Scene. The IMP will have spectacular views of Chasma walls to the north (~5.5° vertical angle, 101 IMP pixels, 60 m/pixel) and mesas of layered material to the southwest (~1.5° vertical angle). Spectra from IMP will help reveal the mineralogies and compositions of highland crust (in Chasma walls), Lunae/Syria Planum resurfacing units, layering at tops of the Chasma wall, and the sedimentary layered material. IMP and synthetic stereo imagery will help clarify structures, material properties, and slope processes of the Chasma walls; tectonic structures in and around Melas; and stratigraphic, depositional, and exobiological implications of layered Valles fill.

Atmosphere. Meteorological data from Melas Chasma would be the first from an equatorial site, but local effects could be significant. Valles mists could be studied directly, and the Chasma wall and mesas could provide some calibration for airmass optical depths as a function of elevation, at least to the wall heights.

Mission Constraints II: To investigate Melas Chasma requires landing at 10°S, entailing decreases of ~10–15% photovoltaic power (vs. 15°N), and ~1 hr/day line-of-sight with Earth (vs. 0°N) [11]. To maintain safety, a landing ellipse with an aspect ratio of 2:1 and elongation on N74E must be < ~170 × 85 km. Ellipses of 100 × 200 km aligned between east-west and ~S30°E can be accommodated in Melas Chasma with no elevation above about 1 km.

Fig. 1. Nominal and restricted landing ellipses (100 × 200 km and 75 × 150 km) proposed for Melas Chasma. Scene is 8 to 12S, 67.5–80W; ellipses centered near 9.75S, 72.75W.

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CLIMATOLOGICAL TARGETS FOR MARS PATHFINDER.

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Major Climatological Questions: Did Mars have a wet, warm climate early in its history? There is evidence that water flowed across the martian surface during the Noachian [1], and a hydrologic cycle was probably required [2]. However, surface temperatures early in martian history are predicted to have been too low for liquid water [3]. An atmospheric greenhouse, with CO_2 as the major constituent, has been postulated as a mechanism to raise surface temperatures. The subsequent fate of that CO_2 remains a puzzle; 2–5 bar would have been required, equivalent to a global layer of calcite 46–115 m thick. Although bulk carbonates have recently been reported in martian meteorites [4], it is important to search for *in situ* martian carbonates.

Did the discharge of martian outflow channels produced a large ocean in the northern plains, and Hesperian and Amazonian periods of clement climate? It has been hypothesized [5] that return of CO_2 to the atmosphere could have occurred during the creation of the outflow channels, and that subsequent higher surface temperatures could have permitted a global hydrologic cycle that was responsible for formation of a vast Austral ice sheet. The outflow would have formed a northern ocean that would eventually have reprecipitated the CO_2 into carbonates, thereby ending the warm, wet periods.

Is chemical weathering proceeding at present on Mars? The reactive nature of regolith materials suggests either that reactive oxidants are present in the soil [6], or, more likely, that heterogeneous chemistry is taking place between surface materials and photochemically produced oxidizing compounds in the atmosphere [7].

Target Considerations: The ability to look into the past means the ability to look down the sedimentary sequence. The ideal landing site is one in which sedimentary units are exposed. Ideally, a mixture of clastic and chemical sediments will be present; decimeter-scale coherent igneous rocks would provide the opportunity to examine chemical weathering processes. A near-shore deposit, where local channels show evidence of having dissected units of a variety of ages, would be ideal.