Crater 1 is 11.6 km in diameter, located at 10.8°N, 135.2°W (1.5 km elevation) on Upper Amazonian lava flows (Unit Aop [7]) around Olympus Mons. This unit is composed of some of the youngest lava flows on Mars with crater densities suggesting ages of less than 250 or 700 m.y. (depending on crater-absolute age timescale [4]), which makes the crater a candidate ejection site for the shergottites. A 200-km × 100-km landing ellipse would easily fit in this unit. From the crater, the Olympus Rupes scarp is about 1° above the horizon and Olympus Mons is about 1.5° above the horizon, which would register on 15 and 26 pixels respectively in the Imager for Mars Pathfinder (IMP). Landing on unit Aop directly adjacent to Olympus Rupes would result in 9° of scarp above the horizon (or ~160 IMP pixels). As a result, imaging of a large scarp (and any exposed stratigraphy) and volcano (and clouds referenced to an altitude) should be possible at this landing site, provided they are not obscured by local obstacles or topography.

Crater 2 is a 29.2-km-diameter oblique impact crater located at 24.8°N, 142.1°W (0 km elevation) on Upper Amazonian Olympus Mons aureole material (unit Ae [7]). This unit is also very young, although the origin of the aureole material is quite uncertain. Landing on unit Ae directly adjacent to Olympus Rupes (100 km away due to landing uncertainty) would result in ~5° of scarp above the horizon (or 85 IMP pixels), although Olympus Mons would not be in view.

Two other craters 26 km and 28 km in diameter located at 29.5°N, 153°W and 23.5°N, 152°W (elevations between –1 km and –3 km) respectively are located in Middle Amazonian lava flows (unit Ae3 [7]) in Amazonis Planitia, northwest of Olympus Mons. These craters, originally proposed for the SNC meteorites by Jones [8], were dismissed by Mouginis-Mark [6] due to their mantling by smooth plains of apparent windblown origin. Nevertheless, geological relations nearby indicate this smooth material is underlain by lava flows, so that impacts into this unit by these two fairly large craters could have easily excavated underlying lavas.

Pathfinder is equipped with three instruments that could help identify the rock types near the landing site. The alpha proton X-ray spectrometer (APXS) will determine the elemental abundances of most light elements except hydrogen. This instrument, mounted on the rover, will measure the composition of rocks and surface materials surrounding the lander. In addition, the cameras on the rover will take millimeter-scale images of every APXS measurement site, so that when combined with the spectral images from the lander IMP, the basic rock type and its mineralogy should be decipherable. For the most part this data should be enough to determine if the rocks at the Pathfinder landing site are consistent with SNC mineralogy; i.e., are the rocks mafic to ultramafic cumulates or fine-grained lavas? If the answer is affirmative, the observation significantly strengthens the interpretation that the SNC meteorites do, in fact, come from Mars. Unfortunately, this does not by itself establish that the SNC meteorites came from the Pathfinder landing site. Establishing this may be difficult if not impossible for a remotely operated lander on Mars. The kinds of tests required might include minor- and trace-element chemistry, as well as oxygen and carbon isotopes, and it is not clear that these measurements, by themselves, uniquely identify that the SNC meteorites came from a particular site as opposed to coming from Mars in general. In addition, most lava flow fields are heterogeneous on a local scale, exhibiting a variety of mineralogies in close proximity. Thus, landing on a flow that has a mineralogy closely matching that of a SNC meteorite would be serendipitous.

Geologic units that contain four potential impact craters from which SNC meteorites could have been ejected from Mars are accessible to the Mars Pathfinder lander. Determining that SNC meteorites came from a particular spot on Mars raises the intriguing possibility of using Pathfinder as a sample return mission and providing a radiometric age for the considerably uncertain martian crater-age timescale. Pathfinder instruments are capable of determining if the rock type at the landing site is similar to that of one or more of the SNC meteorites, which would strengthen the hypothesis that the SNC meteorites did, in fact, come from Mars. Unfortunately, instrument observations from Pathfinder (or any remotely operated landed vehicle) are probably not capable of determining if the geologic unit sampled by the lander is definitively the unit from which a SNC meteorite came from as opposed to Mars in general or perhaps a particular region on Mars.

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**STRATEGY FOR SELECTING MARS PATHFINDER LANDING SITES.** R. Greeley[1] and R. Kuzmin[2], [1]Department of Geology, Arizona State University, Box 871404, Tempe AZ 85287, USA, [2]Vernadsky Institute of Geochemistry and Analytical Chemistry, Russian Academy of Sciences, Kosygin Street, 19, Moscow, 117975, Russia.

Many feasibility studies have been undertaken for martian roving vehicles. Most studies assumed rovers that would be capable of traversing tens, hundreds, or even thousands of kilometers over diverse terrains. Such capabilities are scientifically desirable but operationally unrealistic with current budget limitations. Instead, attention must focus on rovers traversing less than a few hundred meters and involving a relatively limited scientific payload. Consequently, a strategy for Pathfinder site selection must be developed that is fundamentally different from most previous considerations. At least two approaches can be identified.

In one approach, the objective is to select a site representing a key geologic unit on Mars, i.e., a unit that is widespread, easily recognized, and used frequently as a datum in various investigations. An example is a site on Lunae Planum (20°N, 61°W; +1 km elevation). This site is on Hesperian-aged ridged plains, a unit that is widespread on Mars and serves as a key datum for geologic mapping. This material is of very high priority for a future sample return in order to obtain an absolute age for the base of the Hesperian system. Although ridged plains are inferred to be volcanic and interpreted to be basaltic lava flows, this interpretation is based on analogy with lunar mare units and is open to question. Compositional measurements and observations of rocks at the site via a rover would address the origin of ridged plains and contribute substantially to understanding martian history. For example, should ridged plains not be basalts or other igneous rocks, the interpretation of the volcanic evolution on Mars would be very different from current models. The disadvantage to the approach of landing on a homogeneous unit, such as the ridged plains, is that the measurements would be primarily for a single rock type (but of known geologic context) and would not address questions of compositional diversity on Mars.

The second approach is to select a site that potentially affords access to a wide variety of rock types. Because rover range is limited, rocks from a variety of sources must be assembled in a small area for sampling. Sedimentary deposits, such as channel deltas, derived from sources of various ages and rock types, potentially afford this opportunity. For example, a site in southeast Chryse Planitia (19.3°N, 35°W; –1.5 to –1.0 km elevation) is on outwash plains from Ares, Tiu, Shalbatana, and Simud Valles. Headwind regions for these channels include assemblages of ancient crust (Noachian plateau material) and Hesperian ridged plains, as well as modern eolian deposits indicated by local wind streaks. This general approach is demonstrated in Death Valley, where landing site studies were conducted, simulating Mars. A randomly located "touch down" was made on the Furnace Creek alluvial fan. Within a 1-m radius of the landing site, samples of rock included basalt, rhyolite, diorite, quartzite, limestone, and siltstone; within a 2-m radius, additional rocks included sedimentary breccia, carbonate siltstone, and gabbro. All these rocks were transported from the surrounding mountains. Although Death Valley is not a complete analog to Mars, the area shows that alluvial fans and river mouths may be good sites to collect a wide variety of rocks. The disadvantage of this approach on Mars is that the geological context of the rocks in the deposit is not known, and the compositions of the potential contributing source units must be inferred.

Regardless of the approach taken in site selection, the Pathfinder site should include eolian deposits and provisions should be made to obtain measurements on soils. It is important to note the fundamental difference between dust (known to exist on Mars) and sand (suggested to exist). Martian dust is <10 µm in diameter and is settled from suspension. The dust is probably derived from a wide variety of sources and is thoroughly mixed through repeated cycles of global dust storms. As such, dust represents a global "homogenization." In contrast, sand is deposited from transport in saltation and reflects mostly local and regional sources upwind from the site. Sand grains are probably a few hundred micrometers in diameter or larger. Wind streak orientations and general circulation models of the atmosphere provide clues to the sources for sand. In addition to sand and dust, soils may include material derived from local weathering. Thus, it is desirable to be able to handle and analyze all three potential components of martian soil: dust, sand, and locally weathered material.

Tests conducted in March 1994 at Amboy lava field in the Mojave Desert with the Russian Marsokhod rover provide insight into the scientific use and operation of small rovers. The range was <100 m and the imaging system was limited in resolution. "Descent" images (a series of progressively higher-resolution images from orbital scales down to ~20 cm/pixel) were available for planning the science tests and rover operations. Initial results indicate (1) without the context provided by the descent images, the geologic setting of the site would have been difficult or impossible to determine (Pathfinder, for example, will not have descent imaging); (2) the low height (~1 m) of the stereo camera on the rover gives a different perspective of the terrain than is obtained from standing in the field; (3) the stereo imaging system developed for navigation by the rover was inadequate for most science analyses; and (4) the use of a simulated hand lens (×10) and microscope (×100) was extremely valuable for analysis of sand, dust, and rock samples.

Based on these considerations, a recommended approach for selecting the Mars Pathfinder landing site is to identify a deltaic deposit, composed of sediments derived from sources of various ages and geologic units, that shows evidence of eolian activity. The site should be located as close as possible to the part of the outwash where rapid deposition occurred (as at the mouth of a channel), because the likelihood of "sorting" by size and composition increases with distance, decreasing the probability of heterogeneity. In addition, it is recommended that field operation tests be conducted to gain experience and insight into conducting science with Pathfinder.

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**OBSERVATIONS BY THE MARS '94 ORBITER AND POSSIBLE CORRELATIONS WITH MARS PATHFINDER.** H. U. Keller, Max-Planck-Institut für Aeronomie, D-37189 Katlenburg-Lindau, Germany.

The Mars '94 spacecraft will still be operational when Mars Pathfinder begins its observations. While it will probably not be possible to detect the lander directly, the terrain, including the landing error ellipse, can be covered in high resolution (10 m) in various color bands. The stereo capability of the high-resolution camera will provide a three-dimensional terrain map. The landing site of Pathfinder could possibly be chosen so that correlated observations of IMP and the remote sensing instruments onboard Mars '94 may be possible. We will discuss this scenario based on the presently adopted Mars '94 orbit and resulting enhancements stemming from correlations of data obtained by both spacecraft.

N95- 16193

**POTENTIAL LANDING SITES FOR MARS PATHFINDER.** R. Kuzmin[1], R. Landheim[2], and R. Greeley[3], [1]Vernadsky Institute of Geochemistry and Analytical Chemistry, Russian Academy of Sciences, Kosygin Street, 19, Moscow, 117975, Russia, [2]Departments of Botany and Geology, Arizona State University, Box 871404, Tempe AZ 85287, USA, [3]Department of Geology, Arizona State University, Box 871404, Tempe AZ 85287, USA.

The last successful landing on Mars occurred in 1976 with the Viking mission. In the ensuing years, much has been learned about Mars and the characteristics of its surface. In addition to a better understanding of the geological evolution of Mars, new techniques for processing available data have emerged, new data have been acquired, and the engineering approaches for placing spacecraft on the surface have evolved. Selection of the Mars Pathfinder landing site must take these issues into account, along with mission constraints. In addition, consideration should be given to complementary sites chosen for the Russian Mars '94/'96 lander. The Mars '94 mission will establish a network of two small stations and two penetrators (Table 1) in Arcadia Planitia. Sedimentary and volcanic deposits are characteristic of the northern and southern regions respectively.