

N94-16200

MARS ANALOG SITE STUDY (MASS); R. Greeley, *Arizona State University, Tempe, AZ*; R. Kuzmin, *Vernadsky Institute, Russia*; F. Costard, *Centre de Geomorphologie, France*; and F.S. Anderson, M.A. Geringer, R. Landheim, M.L. Wenrich, *Arizona State University, Tempe, AZ*

Many proposed missions to Mars involve landed vehicles, including the Mars 94/96 (Russia), Mars Environmental Survey (MESUR, US), and the Marsnet (ESA) missions. Most landers involve *in situ* measurements of rock and soil compositions, study of local geology by imaging, and establishment of seismic and meteorological networks. The selection of landing sites on Mars is a complex process that must meet engineering constraints and scientific objectives, using available and anticipated data. The goal of the MASS project is to conduct an "end-to-end" test of the site selection process using Earth analogs.

Approach. Criteria for landing site selection can be divided into two groups: 1) *a priori* criteria and 2) selection criteria. The first group includes factors such as elevation constraints (e.g., some landings must occur at <4 km elevation to enable sufficient atmospheric drag on parachutes) and geographic requirements (e.g., "network" science such as meteorology requires certain geographic placement of stations). The second group includes the selection of sites that have a high probability of meeting specific scientific and engineering goals. An example would be to identify a place on Mars that consists of ancient igneous rocks and has a flat, smooth surface. The MASS Project was aimed toward understanding this second group of selection criteria. The concept was to use remote sensing data of the southwest United States, apply the scientific objectives of the MESUR and Mars 94 missions, and identify analog sites in a "blind" test conducted by individuals unfamiliar with the area. This phase was followed by field work to assess the results and to collect data on rock and slope distributions and other characteristics of interest to mission engineers.

Specific types of sites included young volcanic terrains with different stages of surface modification, sedimentary deposits, aeolian terrains, sites that meet goals for exobiologic science, and others that are appropriate for most Mars landing missions. Objective criteria for the identification of these site types using remote sensing data were established. Data used in the analysis included low resolution ERTS images, higher resolution Landsat frames (color and monochromatic bands), Shuttle Large Format Camera images, conventional aerial photographs, and radar images. These data sets were selected because they are comparable to some existing and anticipated data for Mars. Data were analyzed in stages of increasing resolution, using the objective identification criteria for each type of site. In addition, site surfaces were assessed in terms of rock size and distribution, slopes, and discontinuities based on geological interpretations. At each stage, the "value added" of increased image resolution, color, and radar backscatter was assessed.

Preliminary Results. In the initial stages of study, ~45 sites were tentatively identified in Nevada and southern California. Because of limited data coverage for some sites and time constraints, the number of sites was narrowed to 10, 7 of which were examined in the field. Specific locations for field study in the general site were randomly chosen, somewhat analogous to the uncertainty in landing ellipses for Mars. The general geology was assessed and compared to the remote sensing results. A 20 by 20 m grid (2 by 2 m cells) was centered at the randomly selected target for each field site. The maximum rock size, slope, relief, and percent "bedrock" was noted for each cell as well as block size distribution (e.g., Fig. 1-3). In addition, surface characteristics at the precise "touch down" spot were noted. The collected information represented a simulated landing of a "small lander" as for the Mars 94/96 and MESUR missions, and is useful for planning operations by small rovers of limited capabilities.

Preliminary results from MASS include the development of criteria for the identification of sites by type, establishment of the potential value of specific image resolutions, and types for site identification, assessment of the ability to use geological interpretations for surface characteristics, and establishment of values for rock sizes, slopes, etc. as a function of specific terrains. Identification criteria for sites such as young volcanic terrains are relatively easy to establish, but criteria for sites such as ancient crust and exobiology are more difficult to develop. Within the context of MASS, image resolution was the single most important

parameter (in comparison to color and radar) for site identification; ~35 m/pixel resolution marked the threshold for the identification of most diagnostic features. Color, however, was important for defining unit boundaries which enabled subdivisions of materials to be identified within the site. Some of these results have been known intuitively, but MASS now documents them. Field examination showed that most sites were correctly identified by type. The qualitative assessments of surface characteristics based on geological interpretations of remote sensing data were essentially correct.

In conclusion, it must be noted that the results of MASS are limited to the analog data and terrains of Earth, and that there are significant differences in comparison to Mars. However, the general process of establishing identification criteria for each site type and recognition of the "value added" for specific remote sensing data sets are appropriate for Mars. Moreover, field measurements of surface characteristics which vary as a function of terrain provide general input for the development of engineering models.

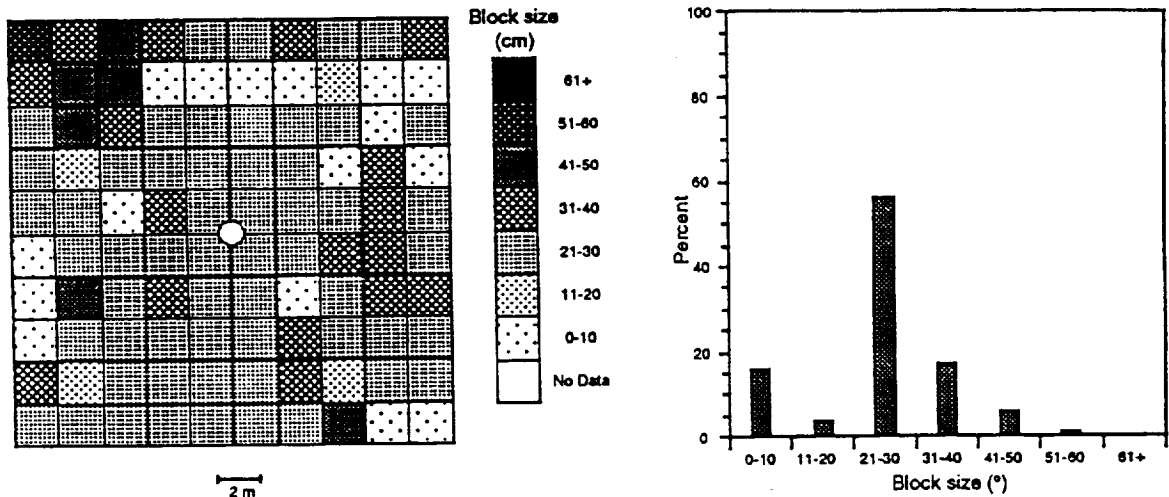


Figure 1. Block distribution and block size histogram in Site V12, Pisgah volcanic field. North is located at the top of the map. The center of the MASS landing site is located at the O.

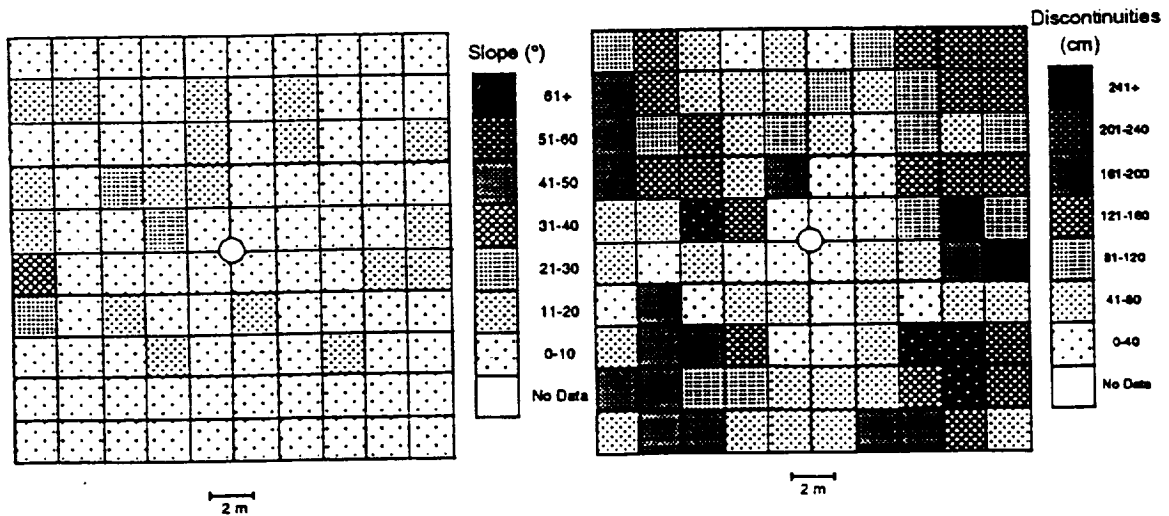


Figure 2. Slope distribution in Site A6, Kelso dunes.

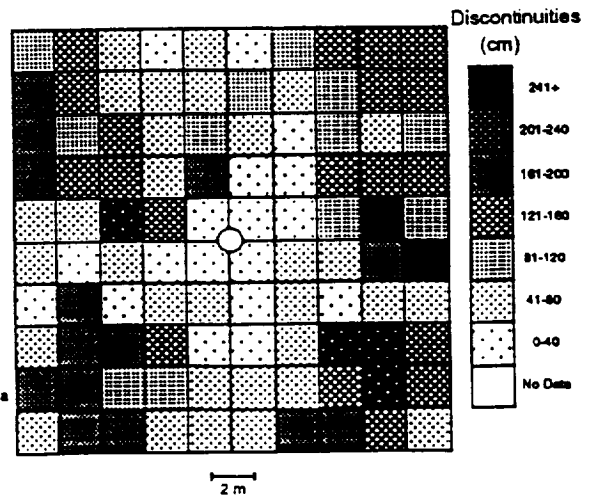


Figure 3. Relief discontinuities map in Site V11, Pisgah volcanic field.