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MARS SAMPLE RETURN: RECOMMENDED SITES; D. H. Scott, U.S. Geological Survey, 2255 N. Gemini Dr., Flagstaff, Ariz. 86001

INTRODUCTION

Site-selection priorities for a Mars sample return are constrained by the risks due to terrain that affect the successful descent and mobility of the sampling vehicle. At this time, evaluations of terrain roughness can be made only in a very general way. For this reason, the two candidate sites discussed are provisionally recommended primarily on the basis of their scientific value; however, no adverse surface conditions are discernible at these locations at the resolution of Viking images.

SITE-SELECTION RATIONALE

Ideally, the site should be located where a suite of rocks and soil is readily accessible to the sampling vehicle. The rocks should be in place and have a wide range in age, lithology, composition, and mode of origin. They should be correlative with other major geologic units in the global time-stratigraphic system. Some of the materials should be associated with important volcano-tectonic episodes and magmatic histories, others with fluvial, eolian, and polar processes that are indicators of climate and atmospheric history. Ultimately, the ideal site would also be in an area where evidence of present or former biological activity would most likely be found.

With our present knowledge of Mars, we have found no single locality where such optimum conditions exist. On the other hand, many areas are known where rock samples would resolve specific problem-oriented questions. Such a narrow focus, however, would leave untouched the broader aspects of Mars geology and history.

The two sample sites considered represent a compromise between broad-based objectives and specific, but highly important, problems that cannot be resolved without material samples. They were selected on the basis of information gained during the global geologic mapping of Mars (1,2,3). Locations are biased toward the western equatorial and polar regions, with which this investigator is most familiar.

SITE 1 (Fig. 1) Tharsis-Olympus Region. The location is about lat 12.5° N., long 125.5°, within the relatively flat, smooth-appearing plains member of the Olympus Mons Formation (unit Aop_1). This Upper Amazonian member is composed of some of the youngest lava flows on Mars. It extends for more than 2,000 km around the eastern and southern parts of the basal scarp of Olympus Mons. The flows embay a large block of old (Hesperian) fractured crust (unit Hf) as well as the lowermost member (unit Aoa_1) of the Olympus Mons aureole deposits of Early Amazonian age. The site is within 15 km or less of both of these older units. Sample ages and compositions of these three units would (1) reveal stages in the volcano-tectonic history of one of the largest and most geologically important regions of Mars, (2) provide an upper time limit on the cessation of major faulting in the western hemisphere, (3) closely define the time of occurrence of the last major volcanic episode of both Olympus Mons and Tharsis Montes, (4) answer controversial questions on the composition and origin of aureole deposits around Olympus Mons, (5) provide an upper limit on the time of major flooding in Kasei Valles, and (6) determine indirectly, by enabling correlations of geologic units (possibly supplemented by crater counts), the times of formation of other materials in a large area.

MARS SAMPLE SITES

Scott, D.H.

SITE 2 (FIG. 2) Chasma Boreale (North Polar) Region. The location is about lat 82° N., long 57°, within polar ice and layered terrain materials (units Api, Apl) of probable very late Amazonian age. The dusty ice surface appears smooth and flat to gently sloping; gentle slopes are also suggested by a broad streaked appearance such as would occur where a slightly inclined surface transects nearly horizontal layers of contrasting albedo. Samples could be obtained here from four different types of materials ranging in age from probably very recent to Hesperian: (1) Interbedded ice and dark material (silicate dust?) surrounding the landing site for tens of kilometers. (2) Grooved and polygonally patterned material (unit Hvg) underlying the layered terrain and within 25 km or less from the landing site; this material occurs in patches throughout the northern plains and south of lat 40° S. in Mare Acidalium. (3) Ejecta from a sharp-rimmed, 5-km-diameter crater within 20 km of the site; the crater (unit c) lies on grooved material (unit Hvg) and is partly embayed by layered terrain materials. (4) Cliff-forming material, appearing as a thick, massive layer, within 15 km of the site; this material of unknown age, origin, and composition underlies some layered deposits but may be interbedded with others. It appears to overlie the Hesperian grooved unit. The geological interpretation shown in Fig. 2 was made from a photomosaic (1:500,000 scale) compiled from Viking 2 images taken at approximately LS 53° (spring). A visit to this site during late northern summer would probably reveal geologic material units covered by less ice and frost.

Geological and geochemical data from these sampled materials would contribute to understanding climatic and atmospheric changes and processes affecting the development of Mars' polar caps. They would also unlock some geologic secrets of the vast northern lowlands that presently elude observation.

Other Mars sample-return sites have been investigated (4, 5, 6) that would also yield valuable data, but the two sites discussed above are believed to be among the best at this stage in our understanding of the geologic history of Mars.

(1) Scott, D.H., and Tanaka, K.L. (in press), U.S. Geol. Survey Misc. Inv. Map 1802A.
(2) Tanaka, K.L., and Scott, D.H. (in press), U.S. Geol. Survey Misc. Inv. Map 1802C.
(3) Greeley, R., and Guest, J.E. (in press), U.S. Geol. Survey Misc. Inv. Map 1802B.
(4) Masursky, H., and others, 1986, NASA TM 88380, p. 459.
(5) Masursky, H., and others, 1987, Lunar and Planet. Sci. Conf. 18, p. 600-601.
(6) Scott, D.H., and Tanaka, K.L. (Abstract, this volume).

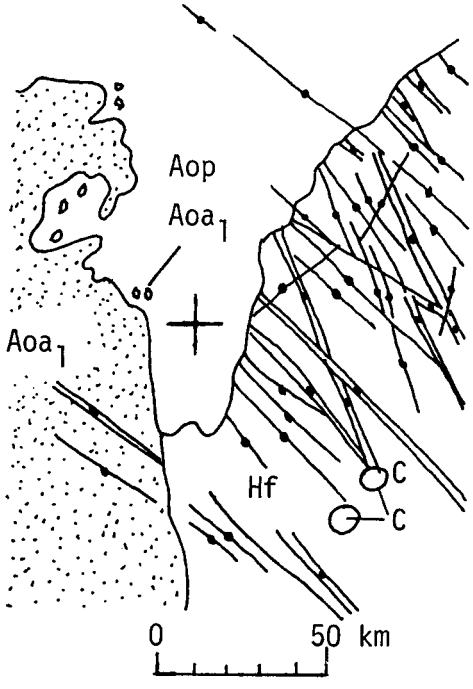

Fig. 1 Site #1 Tharsis-Olympus Region
Location: lat 12.5°N., long 125.5°

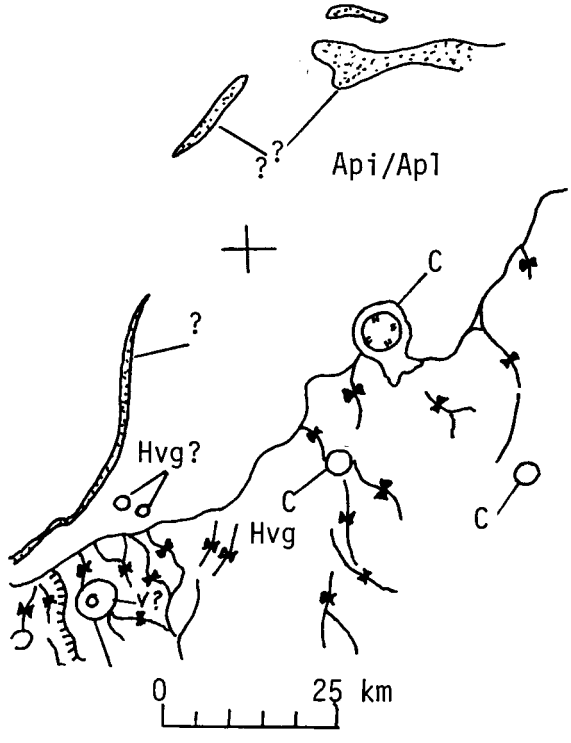

Fig. 2 Site #2 Chasma Boreale
(North Polar) Region
Location: lat 82°N., long 57°