VALLES MARINERIS, MARS: AN OPTIMUM SCIENCE-SAMPLE SITE; B.K. Lucchitta, U.S. Geological Survey, Flagstaff, Ariz. 86001

The Valles Marineris troughs offer a unique sampling opportunity because they expose a thickness of upper crustal rocks as great as 7 km. Also, because of their long and varied history, the troughs give insights into a number of processes that are critical to deciphering the history of Mars.

Ideal sample sites on Mars would yield information on rocks in close proximity having a range of ages and compositions. The Valles Marineris fulfill these requirements. Very old units of Noachian age (1) are exposed in the lower walls that would give us data on compositions and ages of rocks that are deep below the surface at most other places. The most commonly accepted hypothesis is that these rocks are lunar highlands-type breccia (2). The landslides of the Valles Marineris, also, furnish excellent sites to sample these ancient rocks, because the slides fell from trough walls and thus incorporated wall rock. Additionally, most landslide materials contain some cap rock of the plateau, thus offering an opportunity to sample material of intermediate age (Early Hesperian) (1). The cap rock is commonly interpreted as flood basalts (3), but other compositions cannot be excluded. Younger intermediate-age rocks (Late Hesperian) (1) form part of the layered interior deposits. Their origin is uncertain; they have been considered to be volcanic flows, fluvial deposits (4) or wind drifts trapped in ice-covered lakes (5). Samples of these rocks would illuminate an important segment of Martian mid-history and shed light not only on the composition of these materials but also on the processes that operated at that time.

A second suite of interior deposits occurs on the Valles Marineris floors, resting unconformably on all other units and reaching thicknesses of as much as 3,000 m in western Candor Chasma (6). These rocks are young, of Late Amazonian age, and are most likely of volcanic origin. They are locally composed of very dark materials that are easily reworked by the wind and may have come from young volcanic vents (7). Elsewhere these deposits are of varied albedo and rugged, and they may be composed of volcanic rock of unknown composition. Sampling these rocks and obtaining their precise compositions and ages would be an important contribution to unraveling the thermal evolution of Mars.

Samples from the Valles Marineris would also give insights into a number of Martian processes. The effects of tectonism could be assessed by sampling materials on both sides of young faults that cut the trough floors. Mass-wasting processes resulted in talus slopes and landslides. Whether the landslides were wet or dry is not entirely resolved; this question could be addressed by sampling the matrix of landslide deposits. Furthermore, a large channel appears to have emerged from one of the slides and caused a catastrophic flood (8); sampling of the channel-floor material might confirm this origin. The composition of the channel material may also establish whether ice was involved in the flooding. Water or ice in the channel must have come from the trough walls, and the discovery that either was present would confirm the existence of the hypothetical ground-ice reservoir on Mars.

Wind deposits are abundant on the channel floors. Dark barchan dunes consist of reworked dark material that appears to have come from volcanic vents in the troughs; samples of this material would give compositions and

ages, and thus they might confirm the existence of such vents. Establishing grain sizes of the dune material would also shed light on the mechanism of emplacement and, by analogy, on the origin of many similar dunes elsewhere on Mars, particularly those trapped inside craters. Light-colored, reddish dust from atmospheric fallout is also abundant in the troughs and might be sampled to obtain its composition, thus resolving the controversy of whether dust-storm material is composed of smectite clay (9) or palagonite (10).

Overall, the Valles Marineris offer an opportunity to sample rocks that reflect various ages and compositions, giving insight into important processes on Mars. Most of the samples would be located within reasonable proximity and could be easily reached by rovers or balloons. Although landing a spacecraft on the floor of the Valles Marineris may be too dangerous for the first sample-return mission to Mars, the scientific rewards would be so great that such a landing should be considered for later flights.

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