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SAMPLING THE ANCIENT VOLATILE-RICH AREAS OF MARS. A. F. Chicarro, Department of Geology, National Museum of Natural Sciences, 28006 Madrid, Spain.

Viking images clearly show areas with a high density of fluidized craters that also display a significant number of wrinkle ridges. Fluidized crater ejecta morphology may indicate that the target material was rich in volatiles at the time of the impact. Therefore, these areas are of the utmost importance in deciphering both the martian tectonic evolution and the amount of subsurface water, at times when more favorable conditions for life to evolve did exist on Mars.

Distribution of Martian ridges: Although a large number of extensional features are associated with Tharsis (I) and Elysium (2) geologic activity, the planet-wide distribution of ridges (3) suggests that Mars' tectonic history is far more complex than the Tharsis-dominated scenario (4) indicates. Like on the Moon and Mercury, ridges on Mars were formed under compressive stresses (5), probably as a result of thrust-fault mechanisms (6), although surface expressions and direct causes vary (7). Martian ridges are most easily seen on smooth plains of volcanic origin (8), but the majority of the I6,000 mapped and classified compressive features are located in the old terrains, far beyond Tharsis influence (9). In addition to Tharsis tectonic control (I0, II), Martian ridge distribution and orientations have also been influenced by the stresses related to the formation of large impact basins (I2). Compressive tectonics on Mars not only affect the upper layers but the whole lithosphere, However, the presence of subsurface volatiles contributes to form a low viscosity material, where compressive stresses are best expressed as ridges. Therefore, sampling the geologic environment of Martian ridges would prove most useful in determining the planet's tectonic evolution.

Fluidized craters and volatile content: Fluidized craters seem to be good indicators of subsurface volatiles in the target material at the time of the impact (I3). Although the exact volatile phase, water or ice, is still debatable (I4), changes in ejecta morphology indicate a different subsurface volatile content, each geologic unit having a different volatile storage capacity. Also, altitude control of crater morphology reflects a decrease in plain material thickness (and thus, volatile content)(I5). Fluidized craters on smooth ridged plains are slightly younger than the ridges they overlap. These terrains are of Lower Hesperian age (about 3.5 billion years)(I6). A comparison of ridge (Fig. I) and fluidized crater distribution (Fig. 2) shows that all areas with a high density of fluidized craters display a large number of ridges. Thus, smooth ridge plains have had a high volatile content. Ridge length, such as in Coprates or Hesperia Planum, seems to be related to the duration of the low viscosity state (I7), which also controls the density of fluidized craters, since they were formed when the meteoritic flux was about constant. Therefore, major ridge formation episodes did not occur without a long period of low viscosity. Thus, compressive tectonics have induced ridge formation at times and in areas of low viscosity and high volatile content.

Sampling sites and strategy: The lower parts of Coprates, Lunae Planum, and Hesperia Planum, are believed to be good sampling sites for determining water content in Lower Hesperian terrains, at times when atmospheric conditions, climate, geologic activity, etc., were very different than today (e.g., I8). It is in these areas that the most favorable conditions for ancient life to have evolved could be found, and not in the present water-rich regions. As an example, it is proposed to sample both the regolith and the bedrock on a 50 Km. traverse (Fig. 3), starting away from a 30 Km. crater and going towards the crater rim , where the bedrock could be easily sampled. This itinerary would cross at least one major ridge and the fluidized ejecta. A drilling device on the rover vehicle for subsurface sampling of the fluidized ejecta and ridge vicinity should be present. Both regolith and rock samples should provide new clues in determining Mars' geologic history. Sampling of any of the proposed landing sites on a sample return mission to Mars would allow several major scientific questions to be addressed: tectonic evolution, ancient water content, and the possibility of ancient life.

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References: (I) Plescia J.B. and Saunders R.S. (I982). J. Geophys. Res. 87, p. 9775-979I. (2) Hall J.L., Solomon S.C. and Head J.W. (I986). J. Geophys. Res. 9I, p. II377-II392. (3) Chicarro A.F. and Schultz P.H. (I982). Lunar Planet. Sci. XIII, LPI, p. 88-89. (4) Wise D.U., Golombek M.P. and McGill G.E. (I979). J. Geophys. Res. 84, p. 7934-7939. (5) Banerdt W.B., Phillips R.J., Sleep N. H. et al. (I982). J. Geophys. Res. 87, p. 9723-9733. (6) Plescia J.B. and Golombek M.P. (I986). Geol. Soc. Am. Bull. 97, p. I289-I299. (7) Maxwell T.A. and Gifford A.W. (I980). Proc. Lunar Planet Sci. Conf. IIth, p. 2447-2462. (8) Greeley R., Theilig E. et al. (I977). J. Geophys. Res. 82, p. 4093-4I09. (9) Chicarro A.F., Schultz P.H. and Masson P. (I985). Icarus 63, p. I53-I74. (I0) Maxwell T.A. (I982). Proc. Lunar Planet. Sci. Conf. I3th, J. Geophys. Res. 87, p. A97-AI08. (II) Raitala J. T. (I987). Earth Moon Planet. 38, p. 285-297. (I2) Chicarro A.F., Schultz P.H. and Masson P. (I983). Lunar Planet. Sci. XIV, LPI, p. I05-I06. (I3) Mouginis-Mark P.J. (I979). J. Geophys. Res. 84, p. 80II-8022. (I4) Mouginis-Mark P.J. (I987). LPI Tech. Rept. 87-0I, LPI, p. 8I-83. (I5) Horner V.M. and Greeley R. (I987). Proc. Lunar Planet. Sci. Conf. I7th, J. Geophys. Res. 92, p. E56I-E569. (I6) Tanaka K.L. (I986). Proc. Lunar Planet. Sci. Conf. I7th, J. Geophys. Res. 9I, p. EI39-EI58. (I7) Thomas P.G. and Masson P. (I986). Earth Moon Planet. 34, p. I69-I76. (I8) Schultz P.H. (I986). LPI Tech. Rept. 86-07, LPI, p. 38-39.

Figure I.

Computer-based map of all ridges on Mars, between latitudes of ±65°.

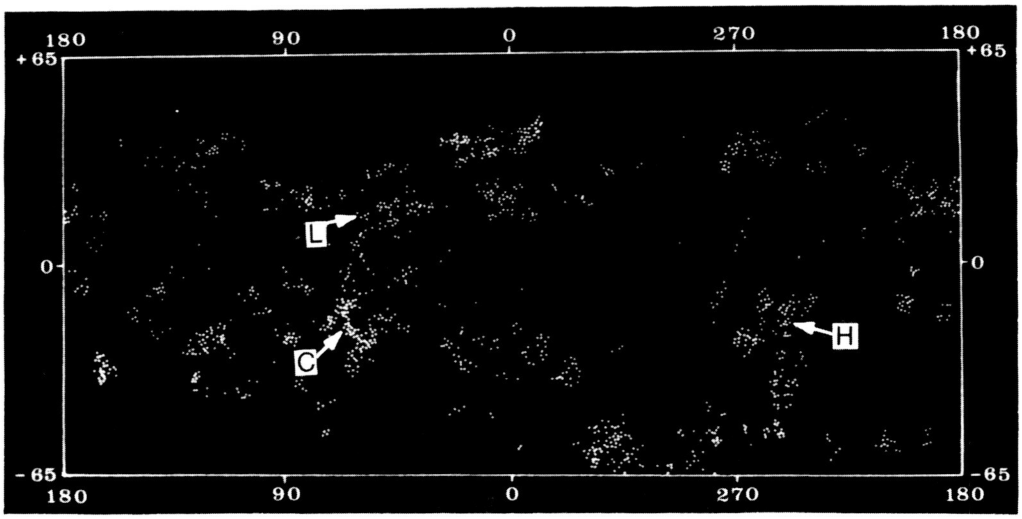

Figure 2.

Map of fluidized craters on Mars (revised from Mouginis-Mark, 1979), showing the three proposed sampling sites : Coprates (C), Lunae Planum (L), and Hesperia Planum (H).

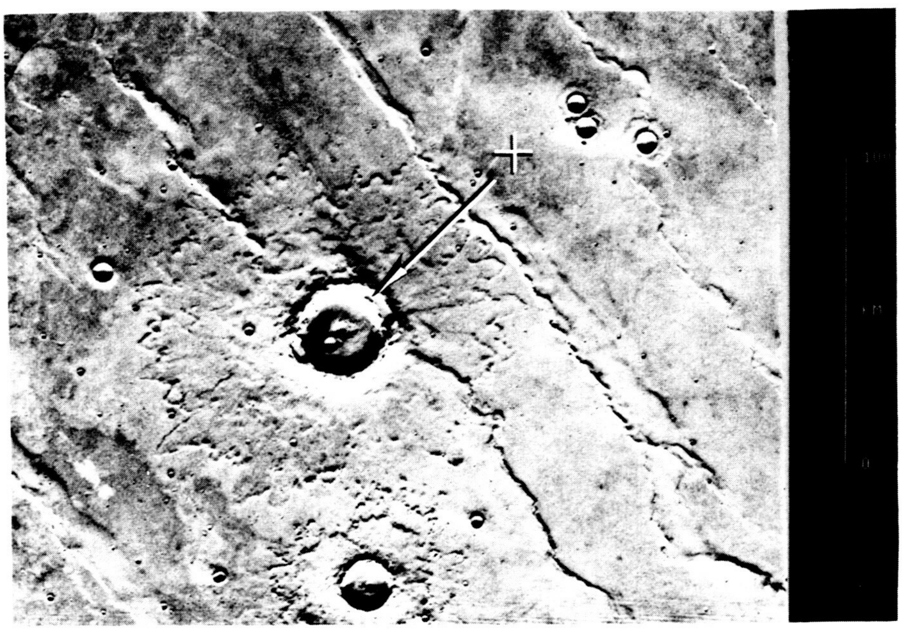

Figure 3.

Ridges and fluidized craters in the Coprates region of Mars. Suggested landing site (+) and sampling traverse (arrow) are shown.
(Viking frame # 608A45).