PRIMARY SEDIMENTARY STRUCTURES AND THE INTERNAL ARCHITECTURE OF A MARTIAN SAND BODY IN SEARCH OF EVIDENCE FOR SAND TRANSPORT AND DEPOSITION. Abhijit Basu, Department of Geology, Indiana University, Bloomington, IN. 47405.

Our lunar experiences show that unmanned sample return missions, despite limitations on sample size, can produce invaluable data to infer crustal processes, regolith processes, regolith-atmosphere/ionosphere interaction processes, etc. Drill cores provide a record of regolith evolution as well as a more complete sample of the regolith than small scoops and/or rakes. We assume that a Mars sample return mission would include provisions for obtaining one drill core of at least one martian sand body. This is a good assumption because landing is likely to be on a sand dune [1] and coring is necessary for tracing past climatic imprints [2]. However, because the suspected processes of sediment production and sediment accumulation on Mars are unlike those on the Moon, but include some that are akin to terrestrial processes, it is necessary to devise new sampling strategies. Strategy should include experiments and sampling plans to acquire information on primary sedimentary structures and the architecture of sedimentary fills.

The expected scales of these structures are a few orders of magnitude smaller than the geomorphic features observed with earth and satellite based instruments. We submit that the pragmatic scale of sampling in the first few Mars sample return missions will be of limited value in answering large scale geomorphic questions. On the other hand, bed forms at mm and cm scales, and internal architecture of sand bodies at m scales, are amenable to sampling even on the first mission. Study of such bed forms are likely to provide information on the processes of transport and deposition. And, any interpretation of the origin of Martian sand would be vastly improved if petrologic and sedimentologic data are combined.

We propose that (a) a hole be drilled in a sand body to obtain continuous oriented cores; a depth of about 10m would be compatible with what we know of bed form hierarchy of terrestrial stream deposits, (b) two trenches, at right angles to each other and close to the drill-hole, be dug and the walls scraped lightly such that primary/internal sedimentary structures of the sand body become visible, (c) the walls of the trenches be made gravitationally stable by impregnation techniques, (d) acetate or other peels of a strip on each wall be taken, and (e) appropriately scaled photographs of the walls be taken at different sun-angles to ensure maximum ease of interpretation of sedimentary structures; and, to correlate these structural features with those in the core at different depth levels of the core.

Martian sand bodies to be sampled are likely to be of either fluvial and/or of aeolian origin. If fluvial, the sands are likely to have been transported in sinuous, or in anastomosing, or in braided channels, or, as debris flows. If the sand body chosen for sampling is indeed an alluvial fan deposit from a debris flow, it is likely to exhibit disorganized chaotic internal structures at the scale of sampling; only if the trenches are deep enough (≈10m) inverse grading etc. associated with such deposits may be deciphered. If the sand body represents, for example, a bar form in a braided channel then a sequence of internal structures may be seen both in the walls of the trenches, as well as in the corresponding drill core [3]; investigating a ≈10m section seems reasonable. If the sand body is of aeolian origin, perhaps a dune or an interdune deposit in a drying up environment, various internal structures would show up in the walls of the trenches depending upon the location of the trenches with respect to dune geometry [4]. However, if wind ripples and associated translational bed forms are preserved on Mars, then these small scale (a few mm to cm) structures should be visible in the drill core with coarser grains at the crest of these ripples [5,6]. This feature contrasts with sand ripples formed under water; there are other criteria as well to distinguish fluvial deposits from aeolian deposits [7]. A combination of trench photographs, detailed structural analysis of acetate peels, and the petrology of corresponding drill core samples would be helpful in interpreting all small scale primary sedimentary structures.

A case has been made that the Martian regolith may have significant amounts of $CaCO_3$ [8,9]. This carbonate may occur in several modes like calcrete layers, cement in the sand, and even as argillaceous limestone; any bedding may then be diagenetically enhanced [10]. Coring and trenching of the Martian regolith would be essential for an adequate investigation of processes leading to carbonate precipitation.

Orthogonal x-radiography and/or x-ray tomography via "catscan" methods of the drill core to visualize sedimentary structures and to correlate them with those seen in the trench walls, followed by textural analysis of drill core samples should provide data for interpreting the sedimentology of the sand body sampled.

REFERENCES : [1] Masursky (1987) Search for Mars Lander/Rover/Sample-Return sites - A status review : Oral presentation at the Mars Sample Return Science Workshop (Nov.18), Houston. [2] Pollack (1987) Climate, atmosphere, and volatile inventory evolution: Polar processes, climate records, volatile physical inventories : Oral presentation at the Mars Sample Return Science Workshop (Nov. 17), Houston. [3] Campbell (1976) Reservoir geometry of a fluvial sheet sandstone : Bull. AAPG, 60, 1009-1020. [4] McKee and Tibbitts (1964) Primary structures of a seif dune and associated deposits in Libya : JSP, 34, 5-17. [5] Hunter (1981] Stratification styles in eolian sandstones : some Pennsylvanian to Jurassic examples from the western interior U.S.A. : SEPM Sp. Pub., 31, 315-329. [6] Pettijohn et al. (1987) Sand and Sandstone, Springer-Verlag, 553p. [7] Reading (ed) (1986) Sedimentary Environments and Facies, Blackwell, 615p. [8] Warren (1987) Mars regolith versus SNC meteorites : Possible evidence for abundant crustal carbonates : Icarus, 70, 153-161. [9] Gooding (1987) Martian weathering products as tracers of climate change and atmosphere/hydrosphere evolution on Mars (abstract) : Mars Sample Return Science Workshop, LPI, Houston, 61-62. [10] Bathurst (1987) Diagenetically enhanced bedding in argillaceous platform limestones : stratified cementation and selective compaction : Sedimentology, 34, 749-778.