Aeolus – Direct Access to Martian Mid-Latitude Aqueous Environments

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Introduction: Missing from the current Mars mission set is an ability to perform in-situ investigation of the mid-latitude 'gullies' where the sub-surface aquifer appears to protrude from the surrounding terrain. It is in these volatile rich areas of recent aqueous activity that may offer the highest scientific value regarding the investigation of extinct or extant life. As a counterpoint to other proposed missions requiring complex drilling apparatus, a capability of accessing these sites directly with smaller, less complex technology may be attractive. To accomplish this, a high L/D entry system with target capability of <<10km would be required. Such a mature flight system currently exists in the Sandia Winged Energetic Reentry Vehicle (SWERVE) - which has flown four times (November 2011 the most recent) and, most important - for which a Martian atmosphere aerodynamic database has been developed. The 100 kg entry system would include two landed packages, which would be deployed supersonically at the target area in question. The science station canister would measure climate, local trace gases, as well as perform mineralogy using a short arm/sample retrieval system that would feed a mini-CheMin instrument (x-ray fluorescence/ diffraction). In addition, volatile compounds with potential organic origin could be collected/analyzed. Short scale roving system have also been studied which would provide <.5km mobility, and thus make up for targeting errors. At present, such a mission with the described attributes may be the only means of exploring these scientifically important - yet elusive - Martian features.

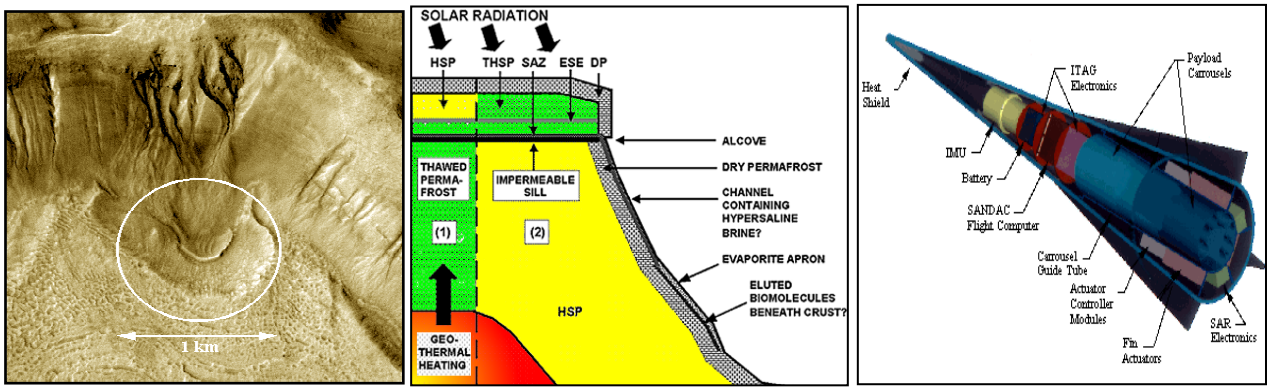

Figure 1. a) Typical site with debris apron inside an 8 km impact crater (40.5°S/142,22°W), b) possible hydrological model (Wynn-Williams, et al, 2001), c) Aeolus/SWERVE entry system modified for Mars mission application.

Precision Guidance Technology: After power up en route to Mars, the Aeolus vehicle would determine its inertial attitude from an onboard strapdown star tracker. The carrier spacecraft would deploy Aeolus, spin stabilized until it encounters the upper atmosphere. While spinning, surface imagery collected by the star tracker would be correlated against a stored database, generating a 1km or better position update for the navigation system.

In the upper atmosphere, the control surfaces would roll the vehicle to protect the star tracker from reentry conditions. A radar altimeter would be used to directly measure ground clearance. At lower altitudes, more precise position updates can be made by rotating the vehicle to image the surface again. This would enable the vehicle to precisely deploy the science canisters at the desired locations.

An alternate method of navigation, and one with general applicability, would be to deploy range transponders to land on Mars days ahead of the Aeolus vehicle. The transponders would be surveyed by existing orbiting spacecraft and the coordinates transmitted to the incoming Aeolus vehicle. Once in the atmosphere, the Aeolus vehicle would interrogate the transponders for range information and update the inertial navigator. Finally, future orbiting spacecraft could carry a range transponder to incrementally build a Mars navigation infrastructure of ground and orbiting assets that could be used by any vehicle or mission.

References:

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