AQUEOUS ALTERATION AND EVIDENCE OF HABITABILITY IN NILI FOSSAE

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Mineralogic data derived from OMEGA visible-infrared spectroscopy [1] on Mars Express and the forthcoming CRISM instrument on MRO are highlighted by hydrated mineral (sulfates, phyllosilicates) and Fe-bearing mafic minerals. These observations have important implications for assessing the habitability of potential landing sites. OMEGA has detected hundreds of outcrops of hydrated minerals for which detailed analyses have begun. This abstract presents one possibility in Nili Fossae and is complemented by companion abstracts describing others in Mawrth Valles [2] and Candor Chasma [3].

The Nili Fossae region, northeast of Syrtis Major, offers excellent opportunities to investigate habitability on early Mars. Analysis of OMEGA data reveals a rich collection of outcrops enriched in hydrated phyllosilicate minerals occuring in Noachian-aged crust [1,4,5,6]. The phyllosilicates are Fe-Mg smectite clays and imply long-duration exposure to water under warm, but not necessarily hydrothermal conditions, and a slightly acidic to slightly basic aqueous environment. Such environments are considerably more conducive to the origin, evolution, and maintenance of life than the oxidizing, arid and acidic environments documented by the Opportunity Rover in Meridiani [7,8]. Furthermore, smectite minerals exhibit properties that make them effective for the collection and preservation of organic matter. The superb exposures of phyllosilicate-rich outcrops in the Nili Fossae region are a premier site on Mars to meet the goals of the MSL mission.

Phyllosilicate-bearing rocks are exposed in many locations along the length of Nili Fossae. One example is shown in Figure 1. Areas that show signatures of phyllosilicate absorption consistent with Fe or Mg-rich smectite (e.g. nontronite) [4] are shown in blue in Figure 1. In the southern part of the region this increased presence of phyllosilcate is associated with ejecta from a 60 km diameter crater whose rim is 40 km east of this spot [5]. Along the western scarp of Nili Fossae are concentrations of phyllosilicate associated with a textured surface exhibiting crude layering and bright knobs. Superposition and analysis of geologic relationships in the Nili Fossae region show that most if not all of the alteration likely occurred during the Noachian [5,6]. This alteration occurred near the surface due to weathering in the presence of water or in the shallow subsurface due to low-grade hydrothermal alteration.

The floor of Nili Fossae is composed of lavas from the Syrtis Major complex and exhibit typical mineralogic signatures of basalt (low and high Ca pyroxene). Syrtis Major is an important volcanic province on Mars [9] and a type region for crustal composition as determined by remotely sensed methods [10,11]. The green areas shown in Figure 1 indicate a high concentration of low-Ca pyroxene (LCP). Mapping with OMEGA shows that LCP-dominated terrains are observed only in Noachian-aged rocks and may be a signature of early crustal formation [9]. Thus two major units important for understanding the early evolution of Mars and linking to global studies through remote sensing occur in close proximity.

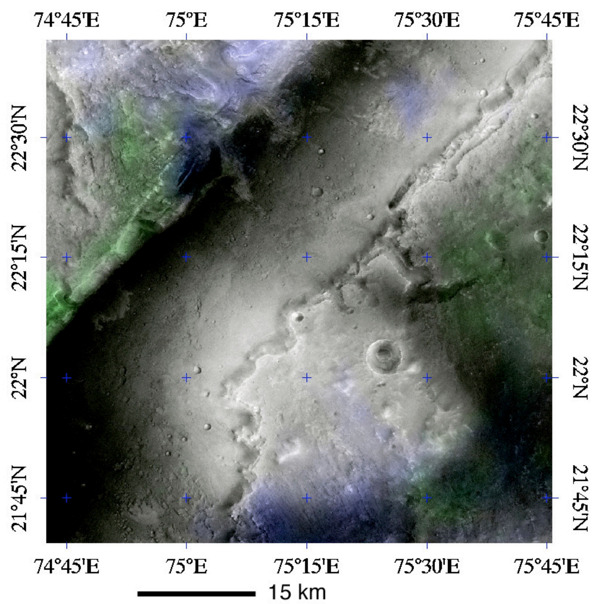

Figure 1. OMEGA mineral indicators draped on HRSC imaging. Green=low-Ca pyroxene, and blue = phyllosilicate.

Engineering Constraints: The site fulfills all engineering constraints for which data are currently available. This proposed landing site along the floor of Nili Fossae lies at an elevation of -600 m. The floor shows very low slopes (typically 100m/10 km or <1°), albedo <0.2, and thermal inertia >200.

Conclusions: Phyllosilicate-rich sites are important targets for the MSL objectives. They represent compelling environments to explore habitability in the context of early Mars. The Nili Fossae region hosts many such sites and the example target described here is just one of many possible. This site has the added science return of access to critical crust-forming units (ancient crust and lavas of Syrtis Major).

References: . [1] Bibring J.-P. et al., Science 307, 1576-1581, 2005 [2] Bibring J-P. et al., this volume. [3] Mangold N. et al., this volume. [4] F. Poulet et al., Nature 438, 623-627, 2005. [5] Mangold N. et al., LPSC XXXVII, #1971, 2006. [6] Mustard, J. F., et al., LPSCXXXVII #1683 [7] Squyres, S. W., et al., Science 306, 1698-1703, 2004. [8] Squyres, S. and A. Knoll, EPSL, 240, 1-10, 2005. [9] Hiesinger H. and J. W. Head, JGR, 109, E01004, 2004. [10] J. L. Bandfield et al., Science 287, 1626, 2000. [11] Mustard, J. F., et al., Science 307, 1594-1597, 2005.