EOS CHASMA AS A POTENTIAL SITE FOR THE MER-A LANDING

R.O. Kuzmin1, R. Greeley2, D.M. Nelson3, J.D. Farmer4, H.P. Klein5, 1Vernadsky Institute, Russian Academy of Sciences, Kosygin St. 19, Moscow, 117975, GSP-1 Russia (rok@geokhi.ru), 2Arizona State University, Dept. of Geology, Box 871404, Tempe, AZ 85287-1404, 3SETI Institute, 2035 Landings Dr., Mountain View, CA 94043

Introduction: The key science goals for the Mars 2003 Rover mission include the study of the climate and water history of Mars at sites favorable for life. The regions for the MER-A landing site are confined to the latitudes of 5°N-15°S [1]. We focus on Eos Chasma, a region characterized by long-term hydrologic processes related to underground water release resulting from Hesperian magmatic and tectonic activities. Surface sediments include fluvial, paleo-lacustrine, and possible hydrothermally-derived materials. In addition, the sediments could contain a chemical and mineralogical signature reflecting a hydrologic and climate history in which the conditions could have been favorable for pre-biotic and biotic processes.

Location: The proposed region for MER-A is in northeastern Eos Chasma (12°-15°S; 40°-42°W) on the smooth plain of a fluvial channel (~120 km in length and from 60 to 30 km in width). This channel joins chaotic terrain to the west with Aureum Chaos to east. Two landing ellipses are placed on the channel floor (Figure 1) at: 13.4°S, 41.4°W, and 13.95°S, 41.7°W.

Geologic background: Geologic mapping from Viking images [2,3,4,5] suggests that the ancient plateau surface was resurfaced throughout the Hesperian period from releases of huge volumes of subsurface water from the eastern part of Valles Merineris (Capri Chasma and Eos Chaos). The water mass could have resulted from melting of ground ice [4,6]. It is possible that the liquid phase of CO$_2$ and its gas hydrate (which could be part of the permafrost volatiles [7,8,9]) might be part of the powerful and catastrophic processes of the highland plateau resurfacing.

Resulting geomorphic features from flooding include fragments of eroded channels, chaos terrain, and terraces etched into the eroded plateau surfaces around Eos Chasma and its walls. A temporal paleo-lake formed within the large collapsed depression of the chaotic terrain and its later drainage resulted in formation of erosional channels and fluvial sedimentation. Multiple erosional levels are evident as distinct terraces along the Chasma walls and plateau surfaces. These features formed by successive drainage from the main system of Valles Marineris, Ganges and Capri Chasmata, which passed through Eos Chasma and eventually northward to form the Xanthe Terra outflow channels. Orientations of eroded ridges and grooves on the terraces indicate that local direction of the water flow changed with time.

As a result of outflow events, sediments on Eos Chasma floor could consist of fluvial and paleolake deposits, including ancient crustal fragments, and possible hydrothermal products related to volcano/magmatic processes within Valles Marineris. [2]. Therefore, the past conditions of the area could be favorable for preserving evidence of possible pre-biotic or biotic processes within the sediments of Eos Chasma.

Depending on the final position of the lander within the landing ellipse, the walls Eos Chasma could be viewed by the PanCam at a feature a few hundred pixels high.

Conformity To Engineering Constraints: The proposed landing site at Eos Chasma fulfills the engineering requirements for the MER-A mission. The site is well within the latitude limitation and landing ellipses with long axes of 56 km and azimuths of 66° can be accommodated. The areas of the ellipses are relatively flat and free from known topographical hazards. MOC images show that the floor of Eos Chasma is significantly smoother than the Viking-1 and MPF landing sites (Figure 1). The elevation of the ellipses is approximately ~3.5 km below the MOLA defined elevation reference [10].

Analysis of MOLA profiles across the Eos Chasma channel [11] shows that at the surface resolution of the data (footprint ~300 m) the channel’s surface is relatively smoother than the surface in the regions of the Viking and MPF landing sites. The topographic surface variations (across the area of the ellipses) range from 20-70 m over 10-30 km.

TES thermal inertia values of the surface at the proposed site range from 7 to 12 x10$^{-4}$ cal/cm$^2$ K$^{-1}$ s$^{0.5}$ of cgs units (equivalent to 293-502 J/m$^2$ s$^{0.5}$K) derived from 3-km pixel resolution data [12]. Effective particles sizes corresponding to the values of thermal inertia [13] indicate values which are interpreted as medium and coarse sand (particles ranging from 350-1000 µm). The relatively high thermal inertia values suggest small amounts of dust on the surface layer and supports evidence for a sufficiently high load bearing soil essential for the rover transportation. The rock abundance of the landing site region is 10-20%, based on Viking IRTM data [14]; this is similar to values found at the Viking and MPF sites [15]. The albedo values measured within the landing site ellipse are between 0.13-0.20, which is lower than the average value of Mars (0.24). This also implies low dust cover on the surface. The lack of dust could reduce the eventual covering of fine material on the rover’s solar panels during its active mission and extend the lifetime of the rover operations.
By reviewing the correlation between thermal inertia and radar properties [16], we determined that the site is sufficiently radar reflective for the descent radar altimetry to perform effectively. The values of the proposed site ranges from 0.05-0.08 and 0.05-0.06 at 13.6 cm 3.5 cm wavelength respectively (at scattering low exponent n=1.5). This information was obtained from global mapping of radar reflectivity (absolute depolarized reflectivity) of the Martian surface [17] which was created from Arecibo/Goldstone observations at 12.6 and 3.5 cm wavelengths. These values are sufficiently consistent with the engineering constraints for the surface radar reflectivity (>0.05).

Conclusion. Analysis of the proposed landing site in Eos Chasma channel reveals a elevation with a good load bearing and smooth surface, a moderate rock abundance, and a very rich and long-term history of fluvial processes resulting from multiple ground-water release and paleo-lake drainage.


Figure 1. Photomap of proposed landing sites in Eos Chasma. MOC image subframes are used to compare the surfaces of the candidate landing sites (A, B) with Viking-1 (C) and MPF (D). Available MOC images across this Chasma are identified.