PROPOSED LANDING SITE FOR MARS SCIENCE LABORATORY: SOUTHERN ARGYRE PLANITIA

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Introduction: Argyre is the best preserved of the large multi-ringed impact basins on Mars. Its form is comparable to the Orientale Basin of the moon when viewed at resolutions less than a kilometer per pixel, although at Viking Orbiter image resolutions it is evident that the basin has been severely degraded by erosional and depositional processes. Southern Argyre Planitia was the primary region where evidence of possible ancient alpine glacial erosion and basin deposition was described by [1]. Sharp-crested ridges, peaks, and wide alpine amphitheatres in the Charitum Montes (the dominant southern ring of Argyre) were described as possible alpine glacial landforms based on Viking Orbiter images; adjacent plains on the floor of Argyre have esker-like ridges and other possible glacial features. However, all these features, and especially the esker-like ridges, have been interpreted in numerous ways. Most of those alternate interpretations were made before the availability of MOC images, and so their bouldery nature was not then known, but now the abundant boulders are known to be consistent with either an esker-like formational scenario involving highly pressurized, sediment-rich flows emanating from the cratered highlands adjoining Argyre [2] (Figure 1).

MOC imagery also has shown details of erosional structures on the Charitum Montes, details of lobate debris aprons, and other regional features that are ideally consistent with glacial processes. The topographic relations and morphological characteristics of the smooth plains of Argyre Planitia are ideally consistent with lacustrine deposition as Kargel and Strom [1] and Kargel [2] described, but which Parker and colleagues have also discussed in a different hydrologic process regime [3]. The story in Argyre has only been partly read and interpreted by several groups. It will be fascinating eventually to explore the region and compare the record there with the records in the adjoining Thaumasia quadrangle [4] and elsewhere on the planet.

The fact that magnesian olivine is abundant and widespread in the Charitum Montes [6] indicates impact uplift of materials from the upper mantle and presumably also from a full section of the early Martian crust. The impact apparently occurred post-magnetosphere, and so would provide a valuable window into a span of time ranging from the pre-Noachian, through the impact cataclysm, and into the time of glaciation or whatever other processes have modified the basin. Although this record would be scrambled due to sedimentary transport and deposition in the sinuous ridges, smooth plains, and lobate debris aprons, if access to the massifs can be gained the record of a deep crustal and mantle transect would be more nearly intact.

Until we get there, we will not know with certainty what processes produced the distinctive Argyre landscapes. Regardless of the actual genetic nature of the landscapes, recent publications (e.g., 3, 5) indicate that the Argyre basin is a vast repository of sedimentary materials derived from the ring mountains and the adjoining cratered highlands. In some of these concepts, notably [3], Argyre was a way station of material transported from the south pole to as far as the northern plains. Certainly there was a vast drainage basin, and southern Argyre Planitia doubtless contains clastic material derived from a vast domain of the Martian cratered highlands and from the deep mantle uplifted in the Charitum Montes [6]. The sinuous ridges, smooth plains, and lobate debris aprons of southern Argyre Planitia each probably contain materials eroded from the Charitum Mountains and cratered highlands. The sinuous ridges—areas where they protrude above mantling smooth plains (Figure 1)-- in particular would be attractive targets for exploration.

In places, the smooth plains would provide a smooth ramp up to individual boulders (Figure 1), which may have been derived from tens to thousands of kilometers away across a deep crustal and mantle section. Much like a large impact crater's ejecta blanket, a diversity of lithologic types is expected. Unlike most places on a basin's ejecta, here large boulders are expected to be accessible, whereas in most parts of basin ejecta, the ejecta has been buried or eroded.

Within the engineering constraints imposed on the mission, we have identified numerous points of possible access to southern Argyre Planitia by the MSL rover. If -2 km is a hard lower limit on elevation, it imposes the most severe constraint on selection of targets within southern Argyre Planitia, since it rules out what otherwise would be the obvious place: the smooth plains proximal to bouldery sinuous ridges and lobate debris aprons; the upper elevation limit, slope constraints, and rock abundance tolerances further constrain the choice of possible landing sites, but this leaves many interesting areas for consideration. Rock abundance tolerances are the least well constrained by available data, since MOC imaging is incomplete and does not extend to the smaller boulder sizes that would be prohibitive. Considering all constraints, certain low sloping portions of fine sediment-mantled lobate debris aprons appear to be a good choice for landing. The general region of interest is contained within the region: Lat -54º to -59º, 309º to 324º lon, -1 to -3 km elevation (Figure 2). Higher elevation get into the massifs of the Charitum Montes and could be inaccessible to the MSL rover and certainly are inaccessible for landing; but these massifs would be very interesting if the rover could make an ascent during an extended mission.

A possible specific candidate site is located at lat -56.8º, 317.7º lon, -1500 m; the possible candidate site has 1-3º slopes on 3-5 km length scale within a 10 km landing error ellipse. This site occurs on lobate debris apron material adjoining steep mountain slopes on one side and a polygon-marked smooth plain containing bouldery esker-like ridges protruding through the smooth plain from below. In places the plain drapes over or onto the margins of the ridges; this situation would provide easy access to boulders for analysis by MSL. Small impact craters provide ejecta exposing deeper sections of the plain material (probably lake sediments) and underlying basin fill (probably glacial till).

Southern Argyre—from the plains and sinuous ridges looking toward the Charitum Montes; and from the Charitum Montes looking amidst the mountains and toward the plains) would provide among the most dramatic views on

Mars. The appeal of dramatic views for planetary explorers (scientists and the tax-paying lay public alike) should not be underestimated and should be valid considerations.

References.

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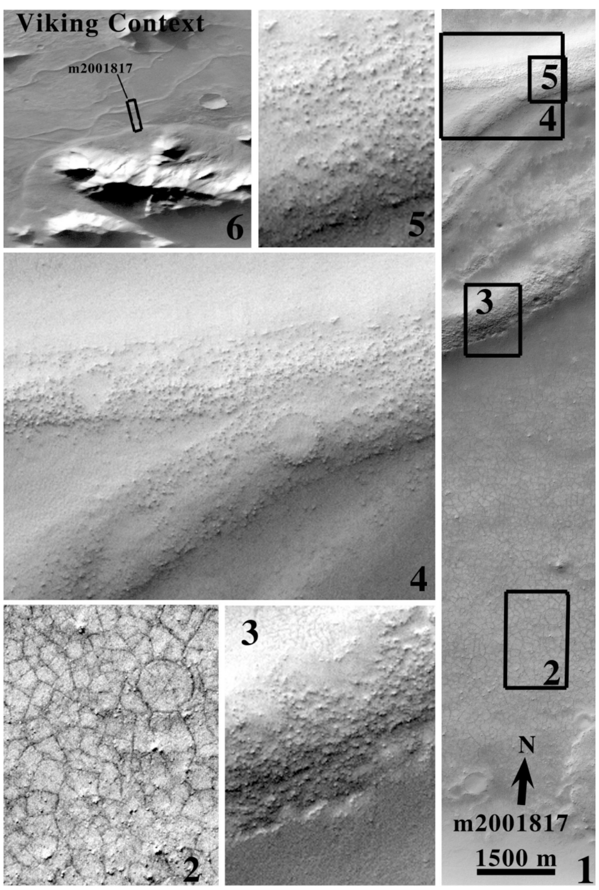
FIGURE 1, BELOW: Martian sinuous ridges (glacial eskers?) and polygon-cracked smooth plain (glaciolacustrine?). Other interpretations of these features are possible and have been proposed.



Polygon-cracked plains lap onto a bouldery, sinuous, braided ridge. The ridge is probably an esker or esker-like glacial deposit; the polygon plains may be periglacially modified glaciolacustrine plains.

FIGURE 2, BELOW: MOLA topography of three sections of southern Argure Planitia and the adjoining Charitum Montes (contiguous and overlapping, arranged from west to east). Landing site possibilities are generally on low-sloping portions of the lobate debris aprons (shown generally in green, representing the -1 to -2 km elevation zone), and particularly where these aprons are wide (low sloping) and proximal to the smooth plains (in blues) and sinuous ridges..