LANDING SITE SELECTION FOR THE MARS 94 MISSION: A PRELIMINARY STUDY

F.M. Costard,* F.X. Chaffaut,** P H. Masson,*** D. Mège*** and J.P. Peulvast*

**Laboratoire de Géographie Physique, URA D0141, CNRS, 1 place Aristide-Briand, 92495 Meudon Cédex, France*

***Centre National d'Etudes Spatiales, 18, Av. Edouard Belin, 31055, Toulouse Cédex, France*

****Laboratoire de Géologie Dynamique Interne, URA 730, 91405 Orsay Cédex, France*

ABSTRACT

According to topographic and engineering constraints, a selection of potential landing sites for the Mars 94 mission is proposed. Three sites have been chosen in Acidalia, Utopia and Arcadia Planitiae. These plains exhibit various geological units such as volcanic rocks or eolian and fluvial sediments and contain subsurface ground-ice.

INTRODUCTION

The Soviet mission named Mars 94, which must be launched in October 1994, will include a balloon /1/ deployed from the descent module. Under the balloon, a gondola with most of the instruments will send very high resolution pictures of the surface, in-situ measurements ... During the night, the guiderope and a "snake" which contains a scientific payload are designed to constitute the interface with the ground /2/.

Within the context of the french-soviet cooperation, a French Landing Site Group was proposed in order to evaluate some potential landing site of the Mars 94 mission /3/.

ENGINEERING CONSTRAINTS

Engineering criteria will strongly influence the preselection of potential landing site. Also the engineering constraints from the balloon lead to have landing sites at north latitudes (higher than 40°N is better), and at elevations less than 0 km. According to the balloon deployment constraints, an altitude of -2 km for the first landing is proposed. In such a case, the old cratered upland and the northern lowland-southern cratered terrain scarp are excluded. According to atmospheric models, it is supposed a balloon movement of 1000-2000 km during a ten days mission. Three maps (figures 1, 2 and 3) were realized using data from the new USGS 1:15 m. topographic map /4/. According to topographic and engineering constraints, three landing sites were proposed /3,5/. They exhibit relatively small density of high relief accidents at kilometric scale. **All sites have been chosen for safety considerations (pressure constraints, low surface roughness ...).**

From this analysis, three regions were selected:

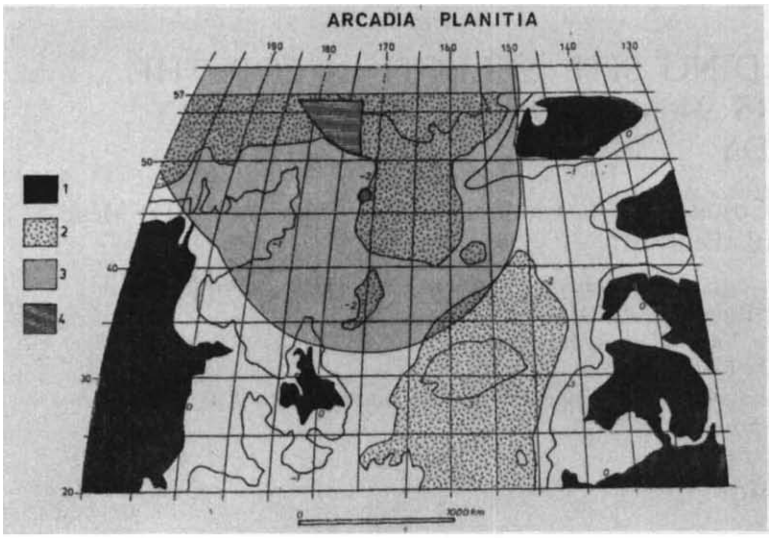
ARCADIA PLANITIA	**ACIDALIA PLANITIA**	**UTOPIA PLANITIA**
25-75°N	25-75°N	25-75°N
130-200°W	350-60°W	220-290°W

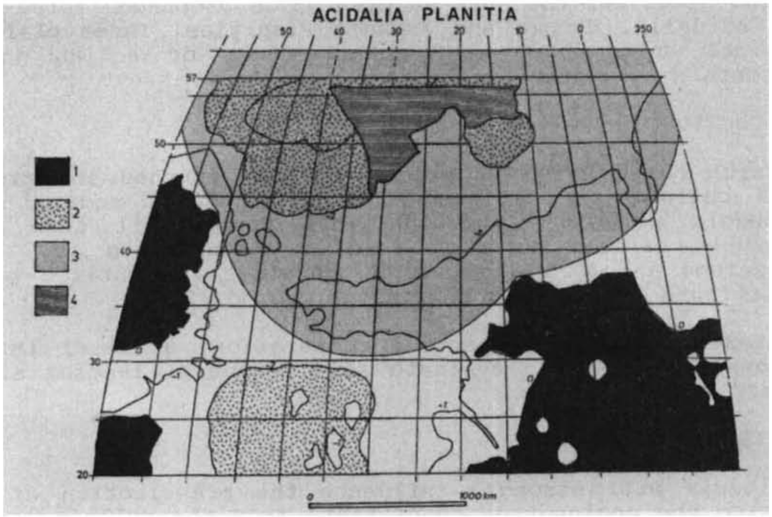
The potential landing site for the balloon are:

ARCADIA PLANITIA	**ACIDALIA PLANITIA**	**UTOPIA PLANITIA**
50-56°N	45-56°N	47-56°N and 38-43°N
173-183°W	12-40°W	248-260°W 254-258°W

ROUGHNESS CHARACTERISTICS

Outside VL1 and VL2 landing sites, the knowledge of terrains roughness is relatively poor. In order to secure the balloon motion during the guiderope movement on the surface, landing sites have to be chosen for there low regional slopes, low rock abundance and low trough density.





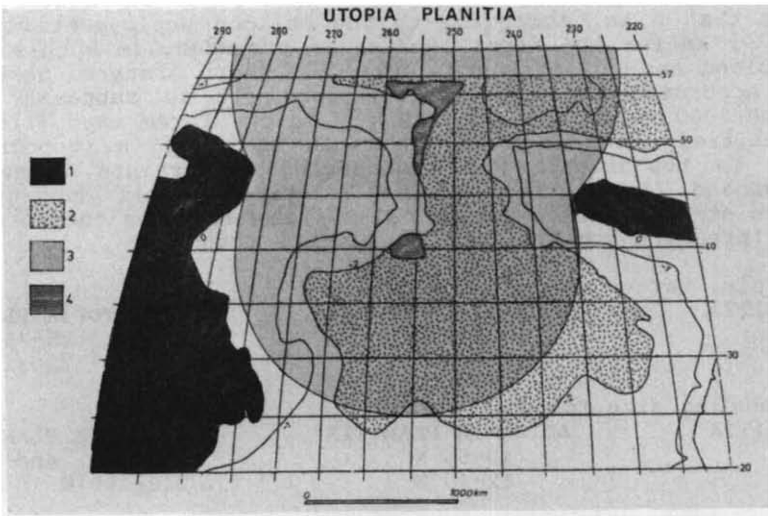


Fig: 1, 2 and 3: Landing site selection for the MARS 94 mission.
1: altitude > 0 km.
2: possible first landing site (altitude < -2 km).
3: area that can be reached by the balloon over a trajectory of 1000 km.
4: potential landing site according to a balloon movement of 1000 km.

According to thermal inertia measurements and by comparison with VL1 and VL2 landing views, Arcadia Planitia seems to be rather smooth and covered with fine materials such as aeolian deposits /6/. According to IRTM and radar measurements, the roughness of Acidalia and Utopia Planitiae is high as these areas are blocky. In some places (Hvk unit) rock abundance is similar to VL2 landing site. The crater density (for craters larger than 2 km) is higher than around VL2 Viking landing site. The presence of fresh impact craters suggests high rock abundance with fragments ejected from impact craters.

In order to quantify the landing site roughness and for a wind/relief interaction analysis, a relief model is proposed with a set of most common characteristical reliefs shapes such as elementary slope, impact crater, fracture, hill. All of these models have been listed and mapped for the most common geological units.

GEOLOGIC SETTING AND SCIENTIFIC OBJECTIVES

Utopia, Acidalia and Arcadia Planitiae (mostly Amazonian and Hesperian Systems) are less hilly, cratered and are younger than cratered upland (Noachian System) /7,8/. The three sites are localized in northern plains and include fresh impact craters. In northern plains most ejecta deposits around rampart craters exhibit a lobate or multilobate ejecta deposit, attributed to the melting of subsurface ground-ice during the crater excavation /9/. The origin of the northern plains is still controversial. One possibility is that they are underlain by fluvial sediments at the mouth of outflow channels /10/. Another hypothesis is that they are locally volcanic plains /11/. During the flight, a study of chemical components of the surface layer will give us more informations about the geology and the nature of northern plains.

Utopia and Acidalia Planitiae are both located at the mouth of outflow channels and exhibit various deposits such as eolian, fluvial or volcanic materials (figure 4). Small cratered mounds are usually found north of fractured terrain and are usually interpreted as volcanic domes /12/ or impact craters over an ice-rich ground /10/. In some areas, mantling materials of eolian origin occur. Many areas exhibit closely spaced hills averaging 2 km in diameter with in some place many curvilinear and polygonal patterns of grooves and troughs which may be produced by compaction, dessication or tectonism /13,14/. In Acidalia Planitia at 50°N, 26°W some lava flows extruded from fractures overlap flood plain materials. In these northern plains, a great number of features such as little pits, curvilinear ridges, flow lobes, pseudocraters, remain poorly understood. Higher resolution pictures will give more details about the nature and the evolution of these features.

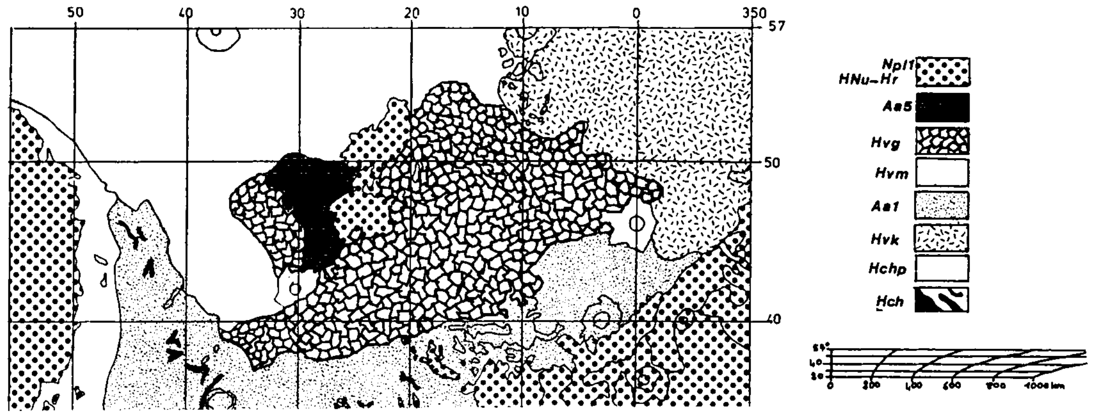


Fig 4: Geological map of Acidalia Planitia (redrawm from /7/).
At 50°N, 26°W, close to cratered upland remnants (Npl1), some lava flows (Aa5) seem to have erupted from fractures and overlap flood plain materials (Hvm) and fractured terrains (Hvg). At latitude higher than 40°N , the high density of rampart craters suggest an ice-rich alluvial deposit close to the surface.

Arcadia Planitia seems to be rather smooth with no major topographic irregularities. Late stage igneous activity with mostly Amazonian lava flows is related to Tharsis volcanism (Olympus Mons). Many large areas seem to be covered by eolian materials. Some high resolution Viking pictures show lobate flow fronts, small volcanoes and lava tubes. Landing in this site would provide accessibility to various volcanic units and lava flows.

In these northern plains, several authors have suggested the presence of large amounts of ground-ice. The search for volatiles below the martian surface is one of the main objectives of the Mars 94 mission. The selection of high latitude sites would give an opportunity to study the martian ground-ice. Acidalia and Utopia Planitiae concentrate most of the fluidized ejecta craters observable on Mars. The high densities of fluidized ejecta craters imply the occurence of a subsurface volatile-rich layer. This layer is contained in the sediments which were deposited in the reentrants of Acidalia Planitia and Utopia Planitia at the mouth of Chryse and Elysium outflow channels. In these two regions, the analysis of very high resolution Viking pictures (12 m/pixel) indicates a concentration of thousand of small depressions at kilometric scale /15/. The occurence of such temporary lakes supports the presence of volatile-rich fluvial sediments which contain major amounts of frozen water /16/. Actually, at latitudes higher than 40°N, the soil never reaches the melt point during the year and is therefore in equilibrium with the atmosphere. In such a case water is always stable as ice /17/. Utopia and Acidalia Planitiae should be good places to optmize the chance to identify near surface ground-ice. During the flight, measurements might give some data about major ground-ice discontinuities, volatile content, periglacial structures such as massive icy beds ...

CONCLUSION

The Mars 94 mission is supposed to prepare next rover sample return and human missions. In such a context, Utopia Planitia at 50°N and 26°W seems to be a good potential landing site for a rover mission by the presence of various units (lava flows, sedimentary materials, fresh crater ejecta, cratered upland remnant). The occurence of a near surface ground-ice with thermokarst depressions in Utopia Planitia and Acidalia Planitia might be possible environments for a past-biological activity and seems to be good landing site for a future Mars human exploration.

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