INTERAGENCY REPORT: ASTROGEOLOGY 60

GEOLOGIC MAPS AND TERRAIN ANALYSIS DATA FOR VIKING MARS '75 LANDING SITES CONSIDERED IN FEBRUARY AND APRIL 1973

By

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With geologic maps and terrain analysis data by:
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CONTENTS

INTRODUCTION

In October and November 1972, the Geological Survey prepared maps and terrain analysis information for nine prospective landing sites for the Viking Mars 1975 project. Information on these sites is contained in Interagency Report 59 (Masursky and Strobell, 1975).

At the Landing Site Working Group and Science Steering Group meetings held in Orlando, Florida early in December of that year the Working Group agreed to develop backup sites for the A Mission at 30° N latitude, and to consider a possible landing site in the north polar region where the presence of water (ice and vapor) and cold trapping of organic material might improve the chance for the biology experiment and the gas chromatograph mass spectrometer experiment to recognize evidence for life, either past or present, on Mars. Accordingly, the Science Steering Group members were polled regarding their agreement on a north polar landing site, and the Geological Survey was instructed to prepare maps in support of these two objectives. The cartographic and geologic mapping was done for the Viking Project Office under NASA Contract L-55232; Harold Masursky was project chief.

In mid-December, four possible polar sites were designated (site 12, Ortygia; site 13, Uchronia; site 14, Cedron; site 15, Scandia) and Survey geologists were assigned to complete maps of these sites plus the 1:5 million scale maps needed as background data for them; the 1:5 million map sheets prepared were: MC 1, North Polar Region; MC 3, Arcadia; MC 5, Ismenius Lacus. Late in December, two possible sites for the backup A Mission were chosen (Site 2, Lunae Palus; site 11, Tritonis Lacus) and geologists were assigned to map these sites. Geologic maps for these sites were prepared by J. M. Boyce, M. H. Carr, G. W. Colton, C. A. Hodges, Terry Kreidler, Harold Masursky, E. C. Morris, K. S. Murray, D. H. Scott, L. A. Soderblom, A. S. Walker, and D. E. Wilhelms of the Geological Survey. Photomosaics, using rectified and scaled photos processed by the Jet Propulsion Laboratory's Image Processing Laboratory, were prepared by the Geological Survey's Cartographic Unit under the direction of R. M. Batson. The photomosaics were used as base maps for the geologic maps. The maps were drafted under the direction of R. D. Carroll, and final preparation was done under the direction of J. W. VanDivier of the Geological Survey's Map Illustration Unit. Additional terrain analysis data was prepared by H. J. Moore of the Geological Survey.

The geologic maps and the additional terrain analysis data were completed in late January 1973, and presented by Harold Masursky to the Landing Site Working Group at their meeting held at Langley Research Center on February 8, 1973. After much discussion, a majority of the Working Group supported site 12, Ortygia, as the Prime B site with site 13, Uchronia, as its backup, provided the Science Steering Group decided in favor of a north polar landing. If an equatorial landing rather than a polar landing was finally agreed on, site 10, Aquae Apollinares, was designated the Prime B site, with site 9, Memnonia, as its backup. Site 11, Tritonis Lacus, was designated the backup site for the A Mission because the radar and picture information looked better at this site. The Working Group agreed, however, that more information was needed from Earth based radar and from further study of the meaning of low dielectric constant values before a decision could be reached on the final choice of Viking landing sites.

Additional work done by the biologists during February led to a realization that, since no life is supported on Earth in regions where the temperature is always lower than 20°F, the "north polar" sites 12, 13, 14, 15, where the temperature is always lower than 20°F were unlikely to yield any information concerning life on Mars. Accordingly, the Geological Survey was asked to prepare maps for two additional candidate landing sites at an intermediate latitude, low enough so that temperatures might be conducive to life support yet high enough so that a continuing source of water from the polar ice cap might be available. Site 16 (Cydonia) and 17 (Alba) at latitude 44° N were chosen from a group of seven possible sites because they fulfilled the dual constraints of temperature and availability of water. Harold Masursky, James Pettengill, N. J. Trask and D. H. Scott of the Geological Survey prepared maps of these two sites, plus an additional map at scale 1:5 million of the Mare Acidalium sheet, MC 4. These maps were presented by Masursky to the Working Group at their meeting held at Langley Research Center on April 2, 1973. The Cydonia site was certified at that meeting because both the ground based observations and those obtained from the Mariner 9 spacecraft indicated that the highest water content in the Mars atmosphere, during the season when Viking will land, occurs at this site.

The final choice of landing sites was made at the April meeting of the Working Group, and their choice of sites was accepted by NASA Headquarters. A press release, issued by NASA on May 15, 1975, announced Chryse (site 3) as the Prime A site and Cydonia (site 16) as the Prime B site. Tritonis Lacus (site 11) and Alba (site 17) were designated backup sites for the A and B Mission, respectively.

Early in 1974, the Landing Site Group became concerned that information obtained by the orbiting Viking spacecraft might prove the designated prime and backup sites unsuitable for spacecraft landing, or that operational difficulties with a spacecraft might require the choice of a site where safety was the prime consideration. It was therefore deemed necessary to choose another pair of "super safe" sites where radar, photographic and topographic information would optimize the chances for a safe landing. An additional detailed study was made in the fall of 1974 of the available radar information from the Arecibo, Haystack and Goldstone radio telescopes. Several additional C sites were tentatively chosen where the combined radar and elevation data indicated likely locations for a safe landing; these sites will be discussed in a future Interagency Report (IR 76, in preparation).

The geologic maps included in this report, together with the rectified and scaled photomosaics prepared as base maps for the geologic maps, were placed on open file by the Geological Survey on November 14, 1973. The maps were originally drawn on scales 1:5,000,000, 1:1,000,000 and 1:250,000; since the maps were reduced for this report, these scales no longer apply.

In the nine month period from August 1972 to April 1973 the Geological Survey prepared twelve quadrangle maps scale 1:5 million, seventeen site maps scale 1:1 million, and sixteen large scale maps scale 1:250,000 in support of the Viking Mars '75 landings.

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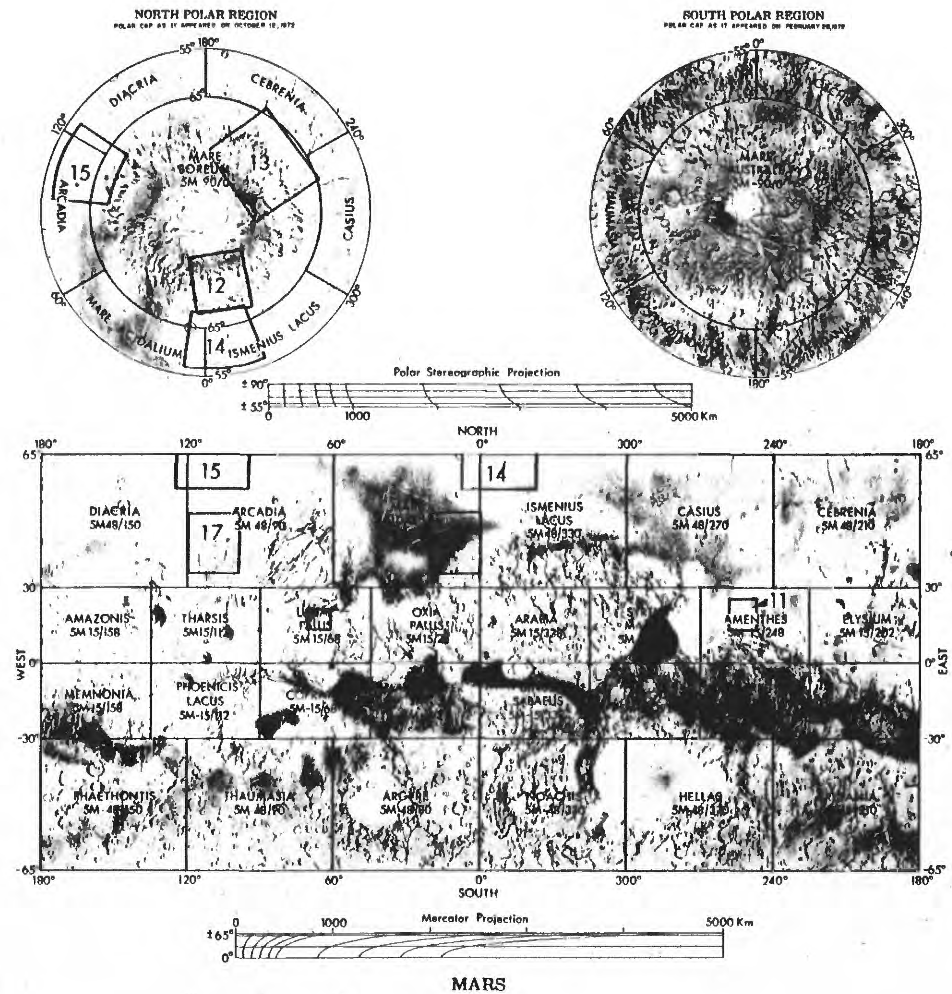


Figure 1. Index map of Viking '75 landing sites

Preliminary Geologic Map of the North Polar Quadrangle of Mars
Viking Mars 1975 Landing Site
Scale 1:5,000,000
by
L. A. Soderblom and Harold Masursky

The terrains of the North Polar Region of Mars are comprised principally of three major regional geologic units which, in turn, display some variations in character. The oldest of these units, termed mottled cratered plains (mcp), has numerous small craters (less than 20 km in diameter) and a highly mottled appearance inferred as resulting from light material trapped in the areas of coarser texture of the craters. This terrain unit shows a lower average albedo than does most of Mars and is the only regional unit on the planet which can be characterized by its albedo. At higher resolution (300 to 400 m) the same mottling charactaristic is observed in the smaller craters (2 to 5 km diameter). This unit is distinctly different from the cratered terrain of the equatorial region and southern hemisphere; it does not contain large ridges, hummocks or a dense population of craters 50 to 300 km in diameter. Unit mcp may be analogous to an early lunar mare.

Resting unconformably on unit mcp is a series of lightly cratered smooth plains units (sp). In the region 55° N to 70° N this unit appears as a loose debris mantle probably 100 m to 1 km thick. In this outer zone the contact with unit mcp is a gradational transition due to the gradual thinning of the smooth plains deposit. The boundaries often show serrated spiral patterns symmetrically disposed about the pole. This unit is inferred to be a mantle of loose debris that is being stripped from unit mcp by eolian erosion. In latitudes 70° N to 80° N unit sp occurs in three facies.

The first facies (unit sp) displays a smooth upper surface, which is gently updulating on a scale of about 100 km. In one area a number of conical constructs (vd) with summit craters have been observed. These features, inferred to be volcanic cones, are 50 to 100 km in diameter at their bases. The cones are very symmetrical and display no evidence of flow on their flanks or near their bases. Unit sp in this region is apparently uniformly thick. Only a few craters on the underlying mottled cratered plains (mcp) protrude through the cover.

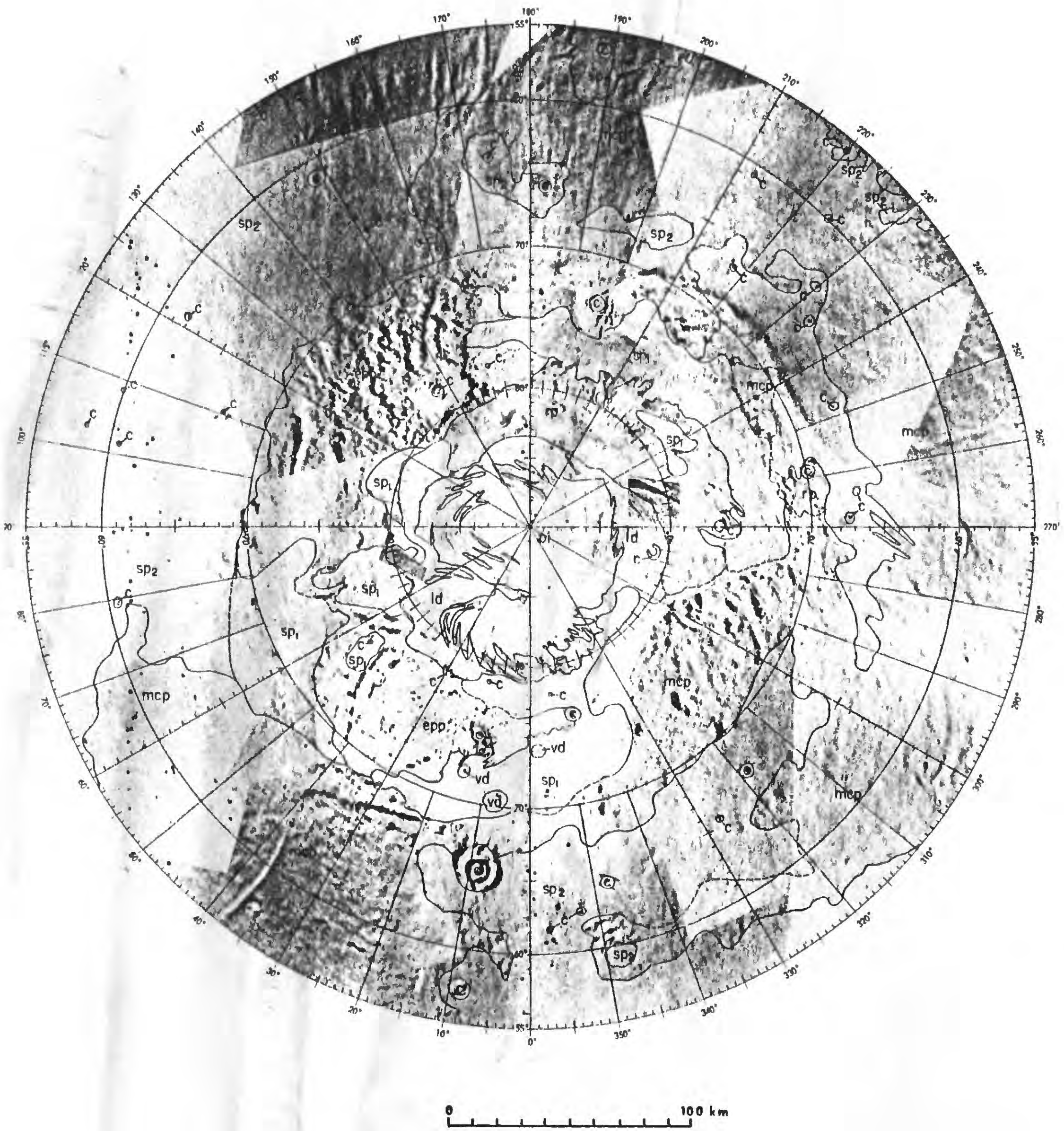
The second facies of the smooth plains in this region is erosional, termed etch-pitted plains (epp). This unit is quite similar to the pitted plains recognized in the south polar region at equivalent latitude. In these regions tha smooth plains have been intensely eroded into pits and hollows which in some cases coalesce and become so deep that the underlying mottled cratered plains unit (mcp) is exhumed. The erosional escarpments on the edges of the pits begin as a cliff at the top and grade into a concave outward slope at the base. The similarity in style of erosion and latitude of the etch pits in the northern and southern polar regions suggest that etch-pitting is a polar process related to the presence or action of volatiles.

The third facies of the northern smooth plains unit is also erosional and is located between longitudes 190° W to 280° W, and latitudes 75° N to 80° N. In this region the upper surface of the smooth plains unit is characterized by a coherent pattern of ripples (rp) ranging in wavelength from a few kilometers down to a few hundred meters, the limit of B-camera resolution. The zones of the etch-pitted plains (epp) and rippled plains (rp) display low albedo. This dark zone surrounds the pole in the 75° to 80° band and may represent the effects of torrential winds near the edge of the permanent ice cap.

Resting unconformably on top of the rippled plains (rp), smooth plains (sp), etch-pitted plains (epp), and mottled cratered plains (mcp), are a series of evenly layered deposits (ld). These have been eroded into a series of benches and slopes facing outward from the pole. Each bench consists of a number of individual beds. An essentially identical sedimentary complex was identified in the south polar region in the same latitude zone (80° N and S toward the poles). In both polar areas these layered deposits partially mantle etch pits and craters on underlying units. Therefore, an erosional unconformity exists between the underlying units and the laminated or layered terrains. The youngest of the polar units, the permanent ice (pi), rests on top of the layered deposits (ld). The ice (pi) is situated on the uppermost benches in the layered deposits (ld). The existence of substantial amounts of water and/or CO_2 ice within the layered deposits is inferred from the close association of the layered deposits with the permanent ice, and from their sinuous, rounded appearance which may have resulted from solar melting.

EXPLANATION

pi	Permanent polar cap; residual ice which survives northern summer after the rapid retreat of the annual CO_2 frost cover. Probably involves a substantial component of water-ice
ld	Layered or laminated deposits; a sedimentary complex which rests unconformably on older terrains and which erodes in a bench and slope topography facing outward from the pole. Each slope consists of a number of uniformly spaced beds. The beds are meters to tens of meters thick. Configuration and distribution are identified with south polar laminated deposits
vd	Volcanic deposits; conical constructs with summit craters; 50-100 km across at base
epp	Etch-pitted plains; smooth, flat surface, indented by irregular pits and a few small bowl-shaped craters. Edges of unit and walls of individual pits are concave in profile with a sharp upper edge. The unit is formed by erosion of smooth plains materials; possibly involving loss of volatiles
rp	Rippled plains; smooth plains with a rippled upper surface and some partially buried craters. Ripple wavelengths range from ~3 km down to 200-300 m (limit of resolution)
sp	Smooth plains; flat and relatively smooth, with sparsely distributed craters less than 50 km diameter. Also contain some faintly discernible rims of buried craters. Interpreted to be eolian deposits that lap upon and bury all older units
mcp	Mottled cratered plains; rough terrain with numerous small craters (less than 20 km in diameter). Characterized by dark patches and spots. Interpreted as an old terrain that was buried by smooth plains material and later exhumed
c	Crater material



PRELIMINARY GEOLOGIC MAP OF THE NORTH POLAR QUADRANGLE OF MARS
VIKING MARS 1975 LANDING SITE

Explanation

- pi — Polar ice
- ld — Layered deposits
- vd — Volcanic deposits
- rp — Rippled plains
- sp — Smooth plains
- epp — Etch pitted plains
- mcp — Mottled cratered plains
- c — Crater
- (solid and dashed line) — Contact

Preliminary Geologic Map of the Arcadia Quadrangle of Mars
Viking Mars 1975 Landing Site
Scale 1:5,000,000
By
Carroll Ann Hodges

A broad cratered dome, probably a large shield volcano (vs) is the most prominent feature in this quadrangle. Long graben and fractures are conspicuous around the flanks of the dome and continuous with a broad belt of narrowly-spaced linear fractures to the south. Structurally controlled crater chains also are prominent. At "B" frame resolution, lobate edges of lava flows and a dendritic drainage texture are recognizable on the flanks of the dome.

In the southeast part of the quadrangle, cratered terrain has several different morphological expressions and is strongly fractured in a northeast direction. The rugged and fractured unit (rft) appears more highly dissected than the adjacent plains and may be a remnant of an older topography. The patterned plains (pcp) are characterized by channels and collapse depressions, and very subdued craters; this unit may be an eroded extension of the adjacent fractured plain (fcp), which is smoother and less dissected. In the extreme southeast is a smooth plain (rgp) distinguished by several narrow, curvilinear ridges which resemble those of the lunar maria. The unit is neither fractured nor dissected, and may be relatively young volcanic materials. At the juncture of these contiguous units with the smooth plains (sp) an escarpment is commonly present, along which these "highlands" materials are apparently disintegrating. At the southeast margin of the map area disintegration is sufficiently extensive for the remnants to be termed chaotic terrain (cht).

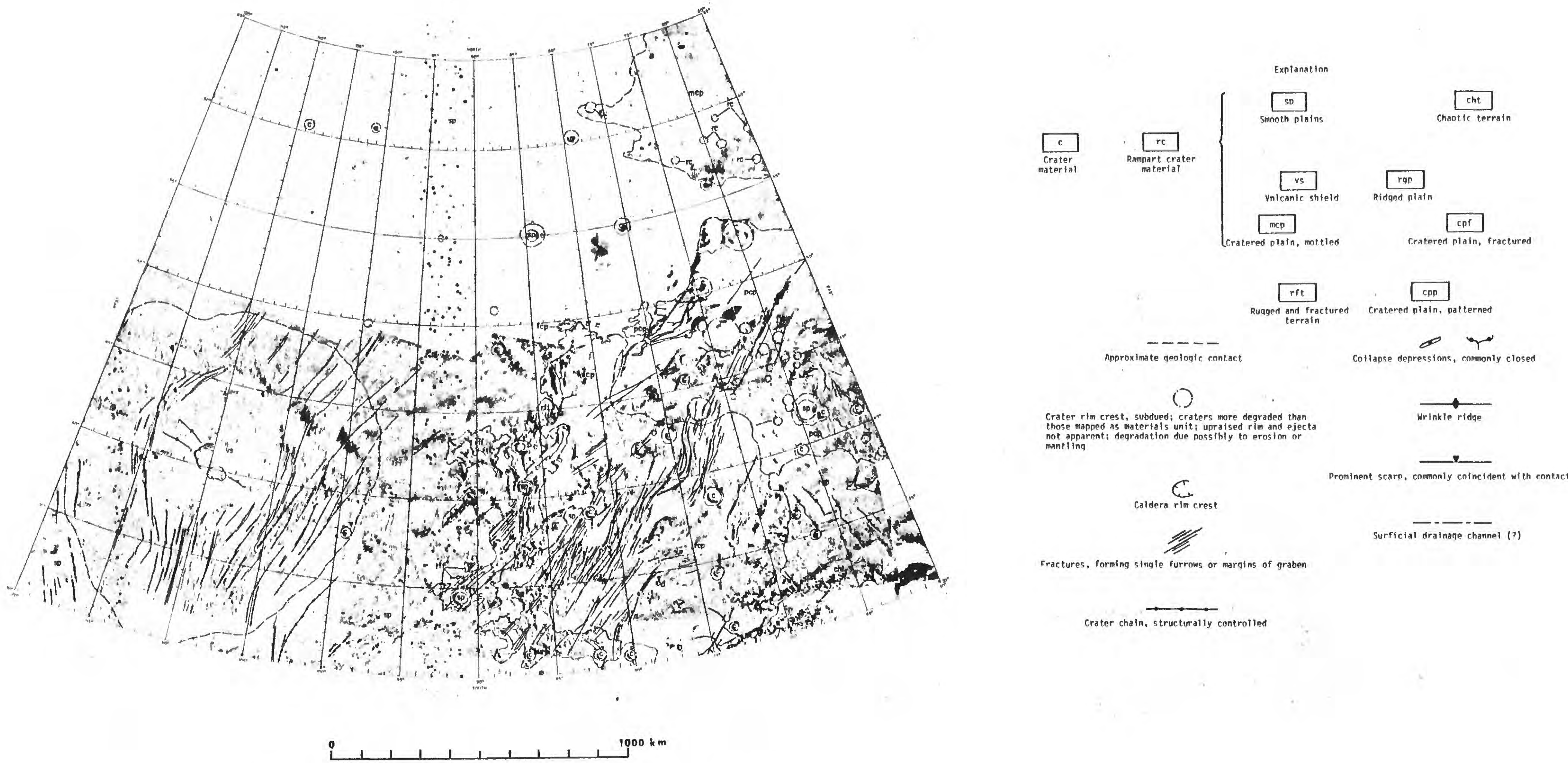
Mottled cratered plains (mcp) occur in the northeast part of the quadrangle. These are distinguished by a relatively low albedo and a peculiar crater morphology. Nearly all superposed craters (rc) are relatively small (~10-20 km) and surrounded by a symmetrical "rampart" of ejecta with higher albedo than the plains. "Wind plumes" contribute to the mottled appearance of the plains, indicating that wind is probably a dominant erosive agent in this area.

The smooth plains unit on the west and north appears to have a gradational contact with the mottled plains. Rampart craters are faintly visible near the contact, suggesting that the lighter plains materials may be mantling the darker unit except where the latter has been stripped of smooth plains. Throughout the smooth plains some faintly visible craters appear to be filled and mantled with eolian debris. At "B" frame resolution, lobate escarpments, presumably lava flow fronts, occur within the smooth plains unit adjacent to the volcanic shield. "A" frame resolution, however, does not allow distinction of these units from those farther to the north where eolian material may be the principal component.

The nominal landing site at 63° N, 110°, is on the smooth plains unit. Fresh craters are rare; subdued craters, apparently filled and mantled with eolian deposits, are sparesely scattered in a single "B" frame. If the smooth plains at the landing site area are predominantly wind transported material, as seems likely, samples may represent a broad spectrum of Mars material, of which a major component may be volcanic.

EXPLANATION

c	Crater material; relatively sharp rim crests and conspicuous rim deposits (ejecta); craters less than ~20 km not mapped
rc	"Rampart" crater material; distinctive raised "rampart" or "platform" (probably ejecta) around small craters; these craters are characteristic of unit mcp
sp	Smooth plains; mainly in relatively low areas, covering most of the north half of the map; apparent smoothness possibly due to grain size and texture of material; deposited by eolian or alluvial processes; surface detail possibly obscured in places; lobate "flow fronts" visible in some B frames adjacent to volcanic shield
cht	Chaotic terrain; complex of essentially equidimensional plateau remnants, concentrated at margin of plateau where disintegration is apparently in progress
vs	Volcanic shield; summit caldera, and numerous fractures and graben arcing around flanks of structure; north-south trending fractures extending in wide belt to south; embayed by smooth plains; prominent long, linear crater chains on flanks of shield; fine-textured dendritic pattern (shown in B frames) developed on flank lava flows, but is not a fully integrated drainage system, as indicated by numerous "blind" depressions and "intermittent" channels
rgp	Ridged plain; relatively smooth surface marked by narrow, curvilinear ridges, which strongly resemble ridges of lunar maria; probably volcanic material
cpf	Cratered plains, fractured; plain or plateau with numerous linear and curvilinear fractures and narrow graben dissecting fairly smooth, sparsely cratered surface
mcp	Mottled cratered plains; characterized by "rampart" craters and relatively low but "splotchy" albedo
cpp	Cratered plains, patterned; "etched" by a channel network (dendritic and reticulate) imparting a "scabland" topography; craters mainly subdued, either by erosion or mantling
rft	Rugged and fractured terrain; angular, knobby remnants of plateau, scored by numerous linear fractures and graben; disintegration along escarpments with "outliers" in adjacent "smooth plain"; horizontal layering and stripping indicated in B frame; numerous collapse depressions; large craters mostly subdued, with flat, featureless floors



PRELIMINARY GEOLOGIC MAP OF THE ARCADIA QUADRANGLE OF MARS
VIKING MARS 1975 LANDING SITE

Preliminary Geologic Map of the Mare Acidalium Quadrangle of Mars
Viking Mars 1975 Landing Site
Scale 1:5,000,000

By
N. J. Trask

The Mare Acidalium quadrangle (MC-4) is within the northern low-landing province of Mars. Most of the area is covered by mottled cratered plains (unit mcp) a deposit unique to the north polar region of the planet (Carr and others, 1973). A small portion of heavily cratered terrain occurs in the southeast corner of the quadrangle and an area of fractured, cratered plains occurs in the southwest corner. Several areas of smooth plains are present on both the east and west margins.

Evidence of wind activity is abundant in the widespread mottled cratered plains. Rampart craters and mantled craters are common. Long wind plumes on the lee side of craters are abundant in the southern sections of this unit. In the more northerly portions, fine to broad streaks of probable eolian origin extend across craters and through intercrater areas. Partially filled rampart craters are abundant in the northern portion indicating successive periods of mantling and erosion (Soderblom and others, 1973).

On a fine scale, the mottled cratered plains have a variety of scarps, cracks, knobs and irregular markings. Many of these are parallel to the fine streaks indicating a probable eolian origin. Some sinuous scarps suggest lava flow fronts. The surficial material on the unit is probably a mixture of primary volcanic and eolian debris.

REFERENCES

Carr, M. H., Masursky, Harold and Saunders, R. S., 1973, A generalized geologic map of Mars: Jour. Geophys. Res., v. 78, no. 20, p. 4031-4036.

Soderblom, L. A. Kreidler, T. J., and Masursky, Harold, 1973, Latitudinal distribution of a debris mantle on the Martian surface: Jour. Geophys. Res., p. 4117-4122.

EXPLANATION

sp — Smooth plains; flat and featureless except for superposed craters. Albedo relatively high; a few dark patches. Probably thick accumulations of wind blown deposits

mcp — Mottled cratered plains; characterized by "rampart" craters and relatively low but "splotchy" albedo. Several B frames indicate broken bedrock with projecting knobs and abundant streaks in dominant wind direction. Splotchiness increases to north. Interpretation: broken plains sculptured by wind and partly mantled by wind blown deposits.

pcp — Cratered plains, patterned; cratered plains "etched" by channel network (dendritic and reticulate) which imparts "scabland" topography; craters mainly subdued, either by erosion or mantling

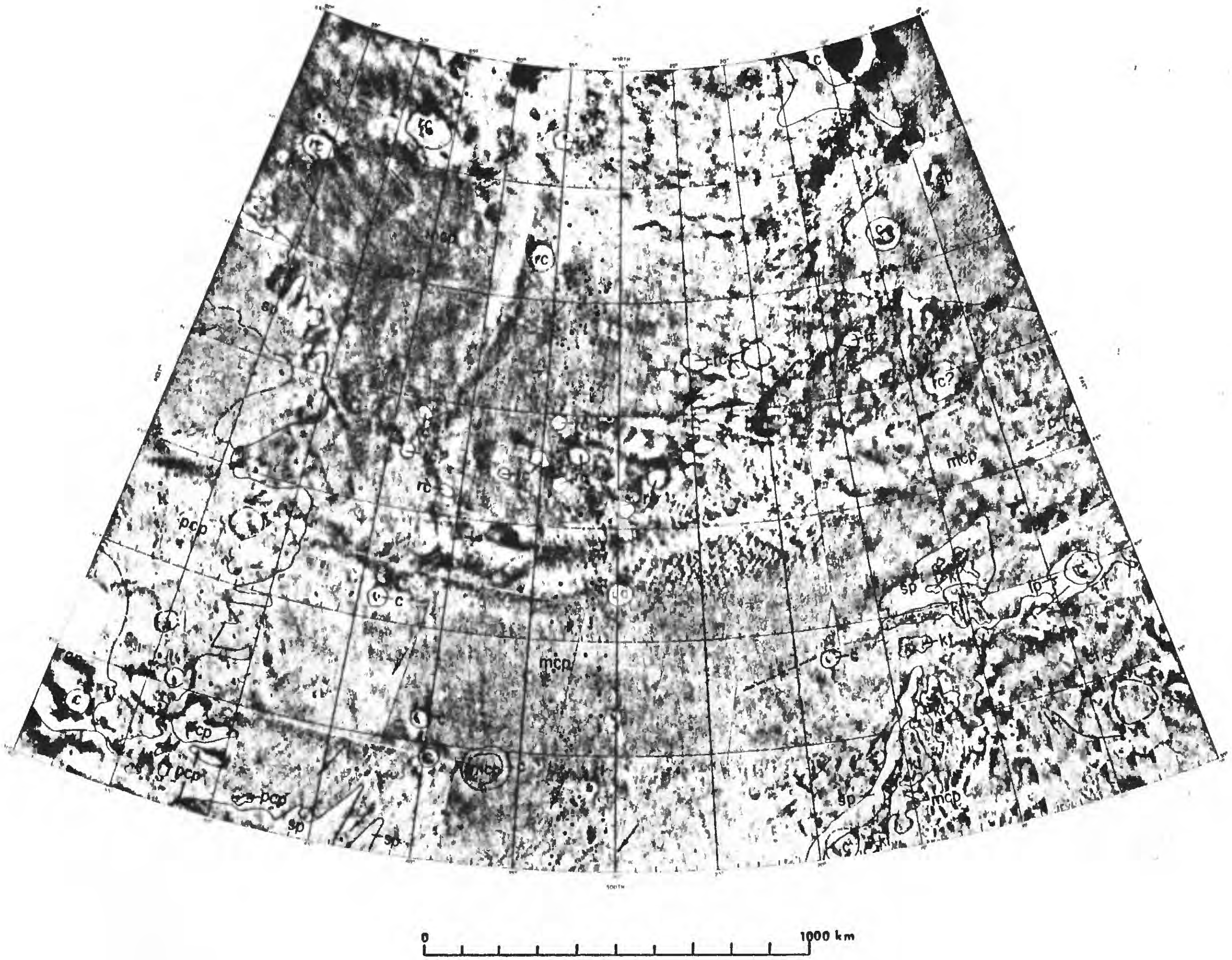
rgp — Ridged plain; relatively smooth surface marked by narrow, curvilinear ridges, strongly resembling ridges of lunar maria; probably volcanic material

ct — Cratered terrain; undulating plains with flat floored, severely degraded, moderately space craters that are seldom over 50 to 60 km in diameter. North trending subdued ridges and east-facing scarps are common

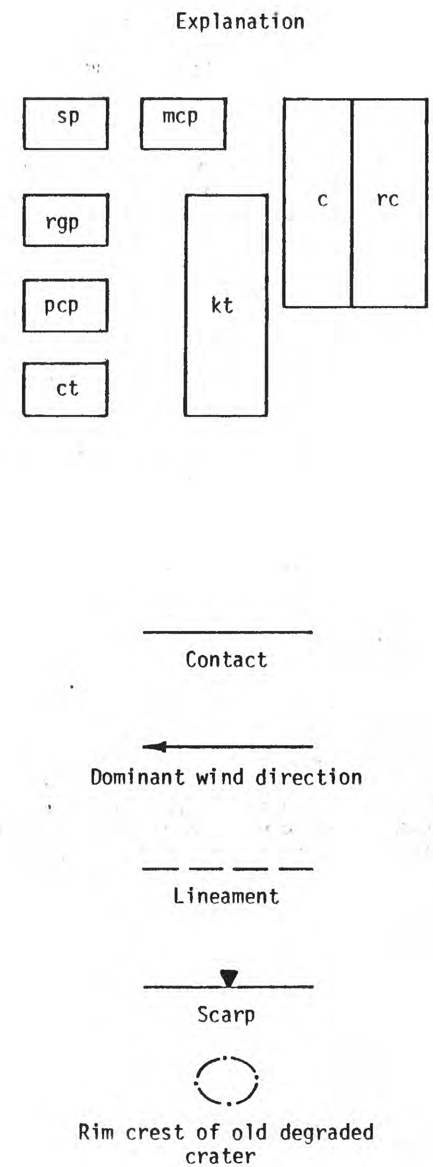
kt — Knobby terrain; circular to slightly elongate, closely spaced hills. 2 to 5 km across. Structurally dislocated and eroded cratered terrain

c — Crater material; relatively sharp rim crests and conspicuous rim deposits (ejecta); craters less than ~20 km not mapped

rc — "Rampart" crater material; distinctive raised "rampart" or "platform" (probably ejecta) around small craters; these craters are characteristic of unit mcp



PRELIMINARY GEOLOGIC MAP OF THE MARE ACIDALIUM QUADRANGLE OF MARS
VIKING MARS 1975 LANDING SITE



Preliminary Geologic Map of the Ismenius Lacus Quadrangle of Mars
Viking Mars 1975 Landing Site
Scale 1:5,000,000
By
E. C. Morris and J. M. Boyce

The southern half of this quadrangle is composed of cratered terrain (ct) that is deeply embayed on its northern boundary by an erosional escarpment and by channels that extend south almost to 30° N latitude. North of the erosional escarpment is a plain (ud) with numerous knobs, hummocks and flat top mesas; these are interpreted to be erosional remnants of the cratered terrain to the south. Extending northward, the distribution of knobs and mesas on the plain becomes less and the plain appears smooth (sp) with little relief except for a few craters with diameters less than 50 km. One notable exception is a large crater near the center of the quadrangle that is approximately 200 km across with a distinct hummocky rim deposit. The area of numerous knobs and mesas is interpreted to be a transition zone between the cratered terrain (ct) to the south and smooth plains (sp) to the north and is mapped as cratered terrain--smooth plains undifferentiated (ud). It is an area of active erosion where the cratered terrain is breaking up and being eroded back along escarpments.

In the northeast part of the quadrangle an area of mottled appearing terrain (mcp) contains numerous small craters. The mottling appears to be due to abrupt local albedo variations which seem to be unrelated to the numerous small craters. In high resolution pictures some of the mottled cratered plains appear rough and hummocky.

The smooth plains material that covers the northern part of the quadrangle is interpreted to be a young eolian deposit that laps upon and buries the older cratered terrain to the south. This relationship is best seen in the western part of the quadrangle at about 40° N latitude and 356° W longitude where the prominent erosional escarpment diminishes westward. To the north the smooth plains material also appears to lap upon and bury the mottled cratered plains.

EXPLANATION

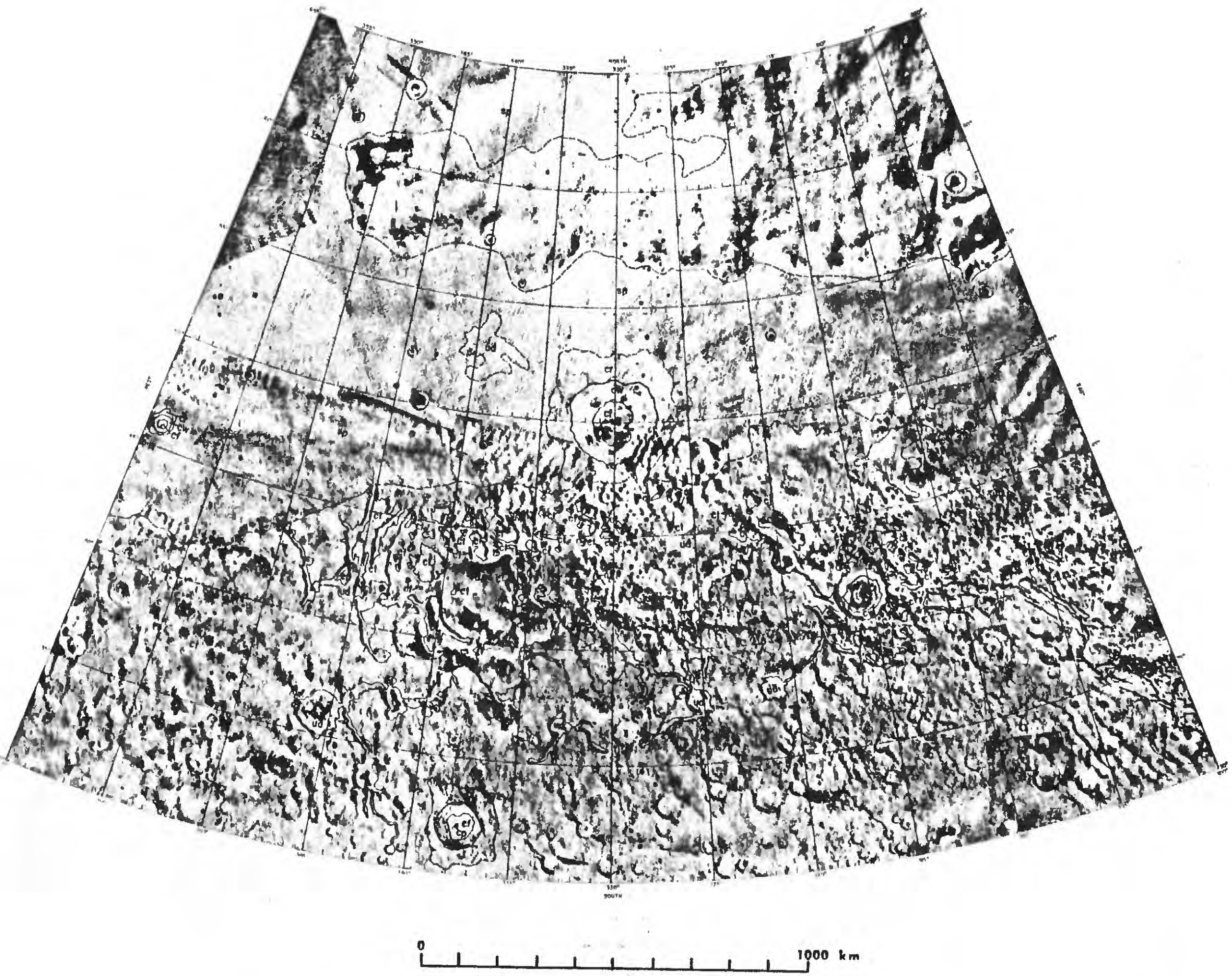
Crater materials
- cp - central peak
- cf - crater floor
- cw - crater wall
- cr - crater rim

sp Smooth plains; flat and relatively smooth with sparsely distributed craters with diameters less than 50 km. Also contain some faintly discernible rims of buried craters. Interpreted to be eolian deposits that lap upon and bury all older units

mcp Mottled cratered plains; rough terrain with numerous small craters, (less than 20 km in diameter) hills and knobs. Characterized by dark patches and spots. Interpreted as an old terrain of unknown origin that is being buried by, or exhumed from under a cover of smooth plains material

ud Smooth plains undifferentiated - cratered terrain. This is a transition zone between cratered terrain on the south and smooth plains on the north. It consists of channel deposits that extend southward into the cratered terrain unit; north of the escarpment that marks the edge of the crater terrain, it consists of smooth plains material with numerous knobs, hummocks and flat topped mesas which appear to be erosional remnants of cratered terrain projecting above the plain

ct Cratered terrain; undulating plains with flat floored, severely degraded, moderately spaced craters that are seldom over 50 to 60 km in diameter. North-trending subdued ridges and east-facing scarps are common



PRELIMINARY GEOLOGIC MAP OF THE ISMENIUS LACUS QUADRANGLE OF MARS
VIKING MARS 1975 LANDING SITE
Scale 1:5,000,000

Explanation

cp — Central peak

cf — Crater floor

cw — Crater wall

cr — Crater rim

sp — Smooth plains

ct — Cratered terrain

mcp — Mottled cratered plains

ud — Smooth plain - cratered terrain undifferentiated

Contact
Dashed where buried or extrapolated

Scarp

Crater rim

Graben

Preliminary Geologic Map of the Lunae Palus Region of Mars
Candidate Viking Mars 1975 Landing Site 2
Scale 1:1,000,000
By
Alta S. Walker

The candidate landing site, at 19° N 67° W, is in the north part of a sparsely cratered plateau unit (cp), conspicuous because of its relatively low crater density, low albedo, and broad extent. A prominent escarpment separates the plateau from smooth plains (sp_1) to the west, but retreat of the escarpment along fractures has left outliers of the plateau in the plains. Narrow curvilinear ridges, resembling those of lunar maria, mark the plateau surface, suggesting that the unit consists of volcanic flows.

The smooth plains (sp_1) appear essentially featureless at A frame resolution, but a single B frame west of the map area exhibits a lineated, grooved topography, suggestive of intensely fractured and possibly wind-scoured bedrock.

The most conspicuous feature of the area is the broad channel (ch) which transects the plateau; topographic data and channel morphology suggest fluid flow from west to east, toward Mare Acidalium. Terraces occur at different elevations along the channel and may be erosional and/or depositional.

Parts of the plateau, plains, and terraces appear to be disintegrating along fractures, and in extreme stages of degradation, chaotic terrain (cht) is formed.

Within the landing ellipse the plateau surface appears smooth, except for a few widely spaced, subdued, linear ridges and scattered small craters. Regolith materials sampled would probably include volcanic deposits; the region appears essentially free of light-colored eolian debris.

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ch Channel deposits; generally smooth surface with dark streaks indicating direction of flow. Eolian activity is evident on some of the B-frames

t Terrace; at varying elevations along the channel

cht Chaotic terrain; rectilinear slabs and blocks at the head of the channels and in unit cp north of the channel

cm Crater material; including rim, floor, central peak and ejecta blanket

cp Cratered plateau; topographically smooth, dark area with a few small, sharp craters. Ridges resembling lunar mare ridges can be mapped from the B-frames

sp_2 Smooth plains 2; overlies sp, west of the map area and in the northwest corner of the area. It is a featureless light colored plain with few craters

sp_1 Smooth plains 1; separated from sp_2 by chaotic terrain west of the map area. It appears featureless on A-frames, and has the same crater frequency as sp_2. A B-frame of the area, however, shows an extremely rough, jointed surface, possibly bed rock

Explanation

[ch] Channel deposits

[t] Channel terraces

[cht] Chaotic terrain

[cm] Crater material

[cp] Cratered plateau

[sp_2] Smooth plains

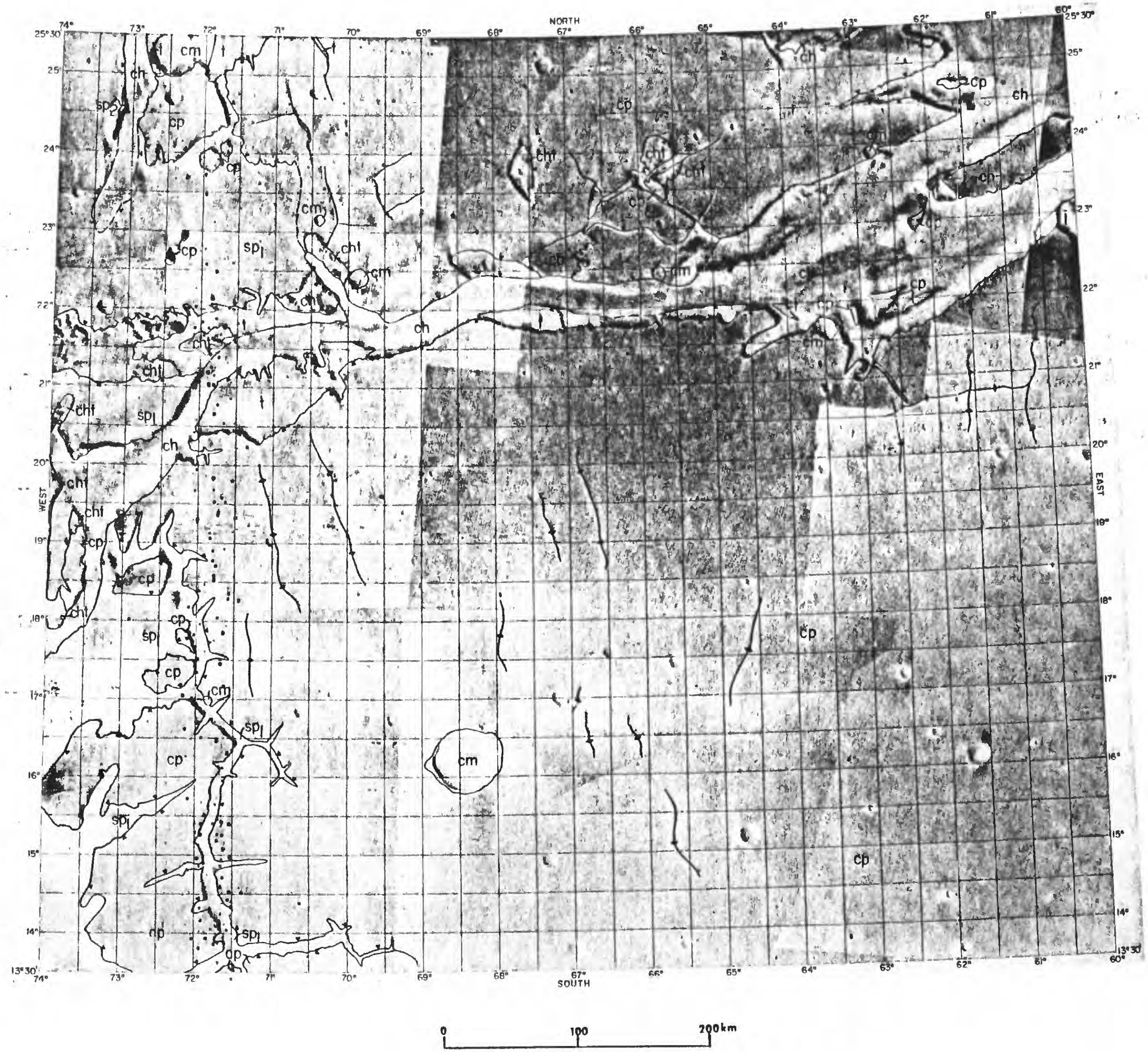
[sp_1] Smooth plains

Contact
Dashed where approximate

Ridge

Fracture

Scarp



PRELIMINARY GEOLOGIC MAP OF THE LUNAE PALUS REGION OF MARS
CANDIDATE VIKING MARS 1975 LANDING SITE 2

PRELIMINARY GEOLOGIC MAP OF PART OF THE LUNAE PALUS REGION OF MARS
CANDIDATE VIKING MARS 1975 LANDING SITE 2
Scale 1:250,000
By
Alta S. Walker

EXPLANATION

cm Crater material; including rim, floor, central peak and ejecta blanket

cp Cratered plateau; topographically smooth, dark area with a few small, sharp craters. Ridges resembling lunar mare ridges can be mapped from the B-frames

sp_1 Smooth plain 1; featureless on A-frames, but shows an extremely rough, jointed surface, possibly bedrock in B-frame

Explanation

cm
Crater material

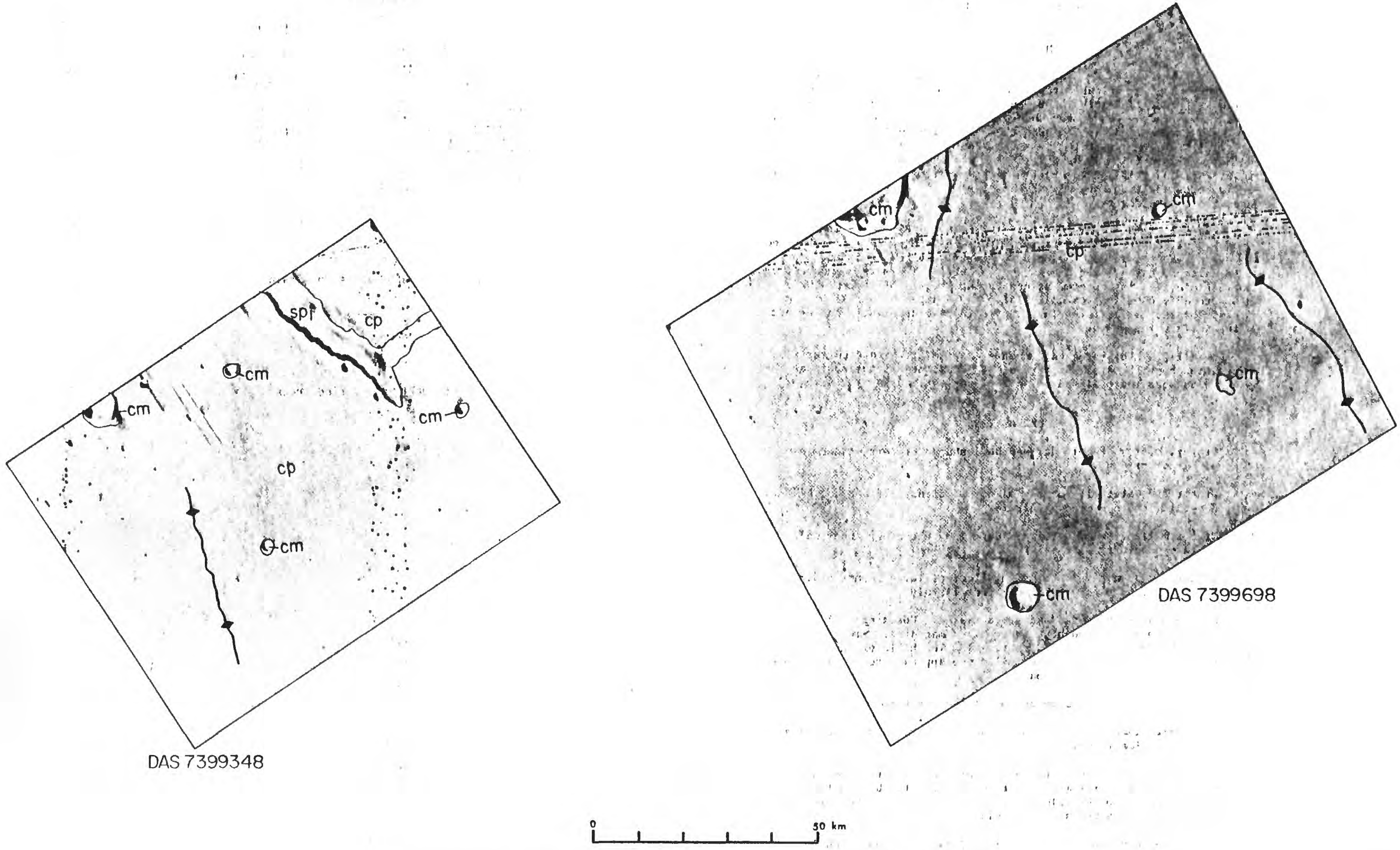
cp
Cratered plateau

sp_2
Smooth plain

sp_1
Smooth plain

Contact
Dashed where approximate

Ridge



PRELIMINARY GEOLOGIC MAP OF PART OF THE LUNAE PALUS REGION OF MARS
CANDIDATE VIKING MARS 1975 LANDING SITE 2

Preliminary Geologic Map of the Tritonis Lacus Region of Mars
Candidate Viking Mars 1975 Landing Site 11
Scale 1:1,000,000
By
M. H. Carr

The site is in an area of smooth plains situated several kilometers west of the Elysium volcanic region and just to the east of the Libya basin. The area is fairly monotonous with different kinds of plains-forming materials exposed over much of it. In the south it is a plains-forming unit more densely cratered than the plains units elsewhere in the site. The craters on the unit are generally small and bowl shaped and have crisp outlines. Several larger craters appear to predate the cratered plains unit and are partly buried by it. These cratered plains are interpreted as volcanic lava plains, perhaps covered with a thin veneer of eolian debris.

The smooth plains unit north of the cratered plains is a much smoother unit and is only sparsely cratered. Faint striae, interpreted as eolian features, cross the unit from northwest to southeast. To the north unit dsp has a lower albedo and the striae are more common. The smooth plains are interpreted as consisting largely of eolian debris which probably overlies volcanic plains. The depth of burial of the volcanic plains is sufficiently large as to have no significant effect on the surface topography.

Low hills, interpreted as remnants of primitive cratered terrain, occur throughout the area but increase in frequency to the south as the boundary between the plains and the cratered terrain is approached.

EXPLANATION

c Crater; mostly sharply defined bowl shaped craters, presumably of impact origin

cr Crater rim material; forms rims of relatively old subdued crater. Generally rough hummocky terrain

cw Crater wall material. Talus material on the steep inner walls of large craters

cf Crater floor material; forms the floor of large impact craters. Interpreted as highly shocked impact terrain

sp Smooth plains material, undifferentiated. Forms sparsely cratered plains throughout most of the map area. Smooth plain is broken by widely spaced craters and low hills of the unit kt. B-frame detail indicates low hills are approximately 1 km across and are spaced 10-20 km apart

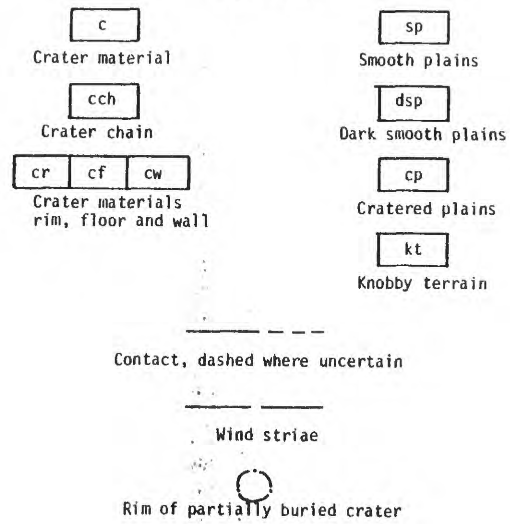
dsp Dark smooth plains. Same as sp but lower albedo

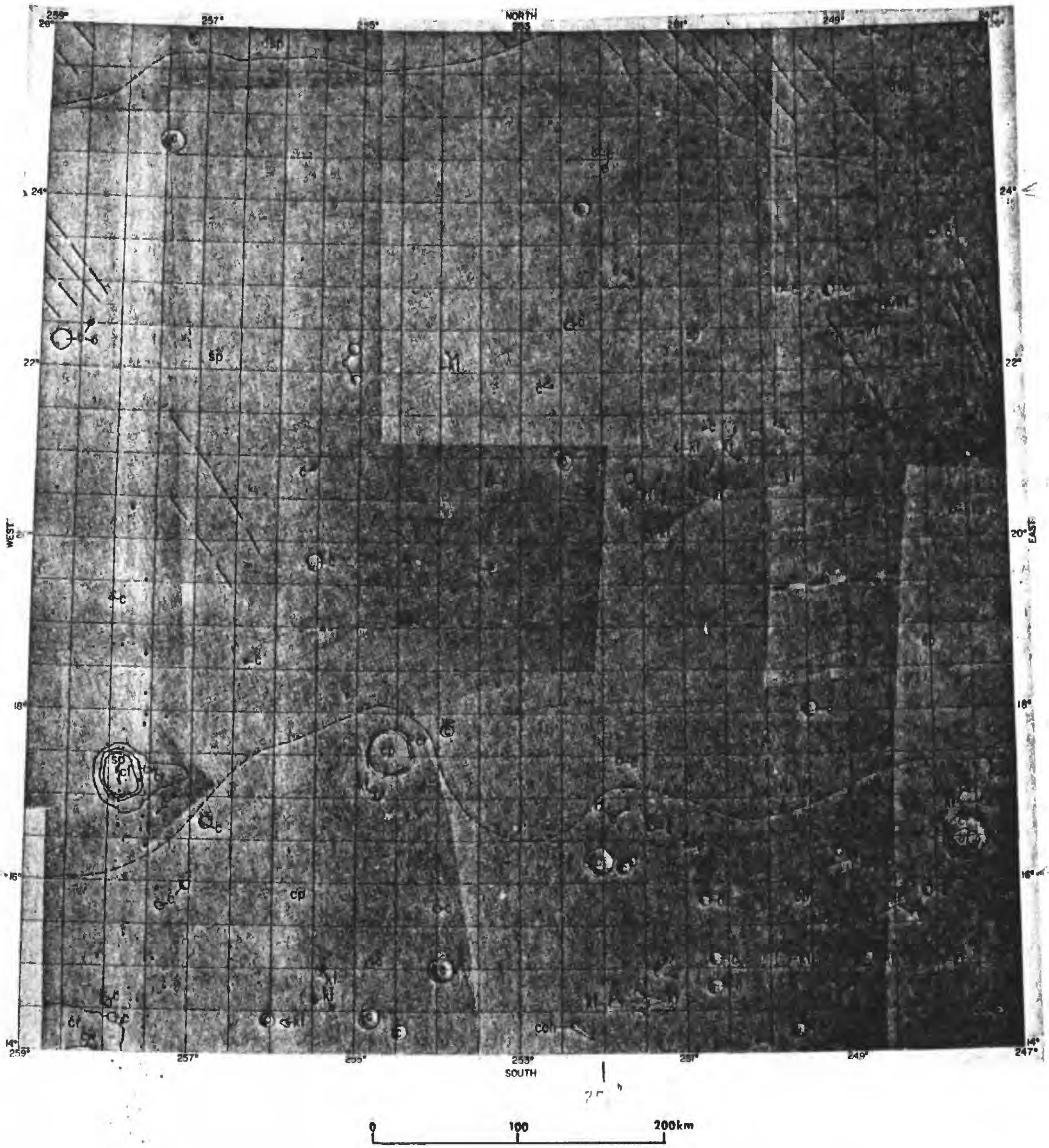
Both units interpreted as eolian debris. Probably cover volcanic plains similar to unit cp

cp Cratered plains; smooth plain but more densely cratered than unit sp and contains more outcrops of unit kt. Unit extends to the west into the volcanic region of Elysium. The unit is interpreted as a volcanic lava plain

kt Knobby terrain; forms isolated low hills and mesas which increase in frequency to the south. South of the map area the unit kt appears to have formed by the break-up of the primitive cratered terrain. The small patches of kt in the map area are accordingly interpreted as remnants of cratered terrain

Explanation





PRELIMINARY GEOLOGIC MAP OF THE TRITONIS LACUS REGION OF MARS
CANDIDATE VIKING MARS 1975 LANDING SITE 11

PRELIMINARY GEOLOGIC MAP OF PART OF THE TRITONIS LACUS REGION OF MARS
CANDIDATE VIKING MARS 1975 LANDING SITE 11
Scale 1:250,000
By
M. H. Carr

EXPLANATION

c Crater; mostly sharply defined bowl shaped craters, presumably of impact origin

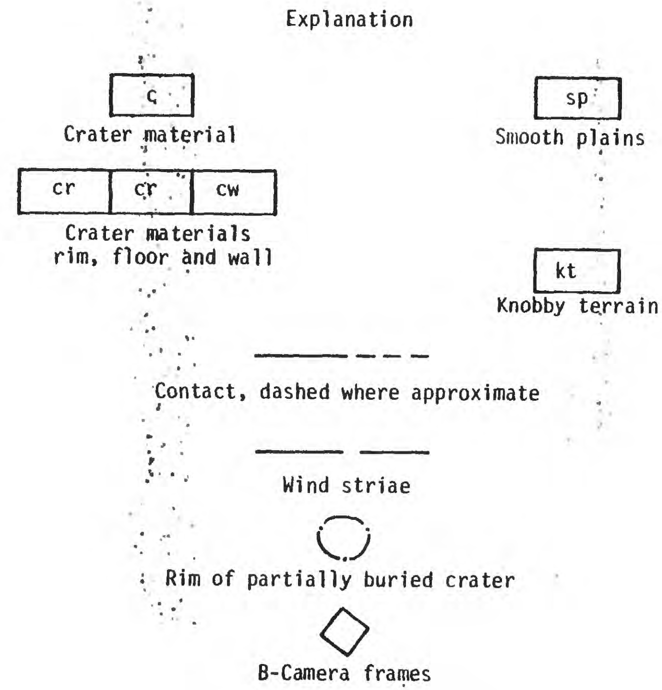
cr Crater rim material; forms rims of relatively old subdued crater. Generally rough hummocky terrain

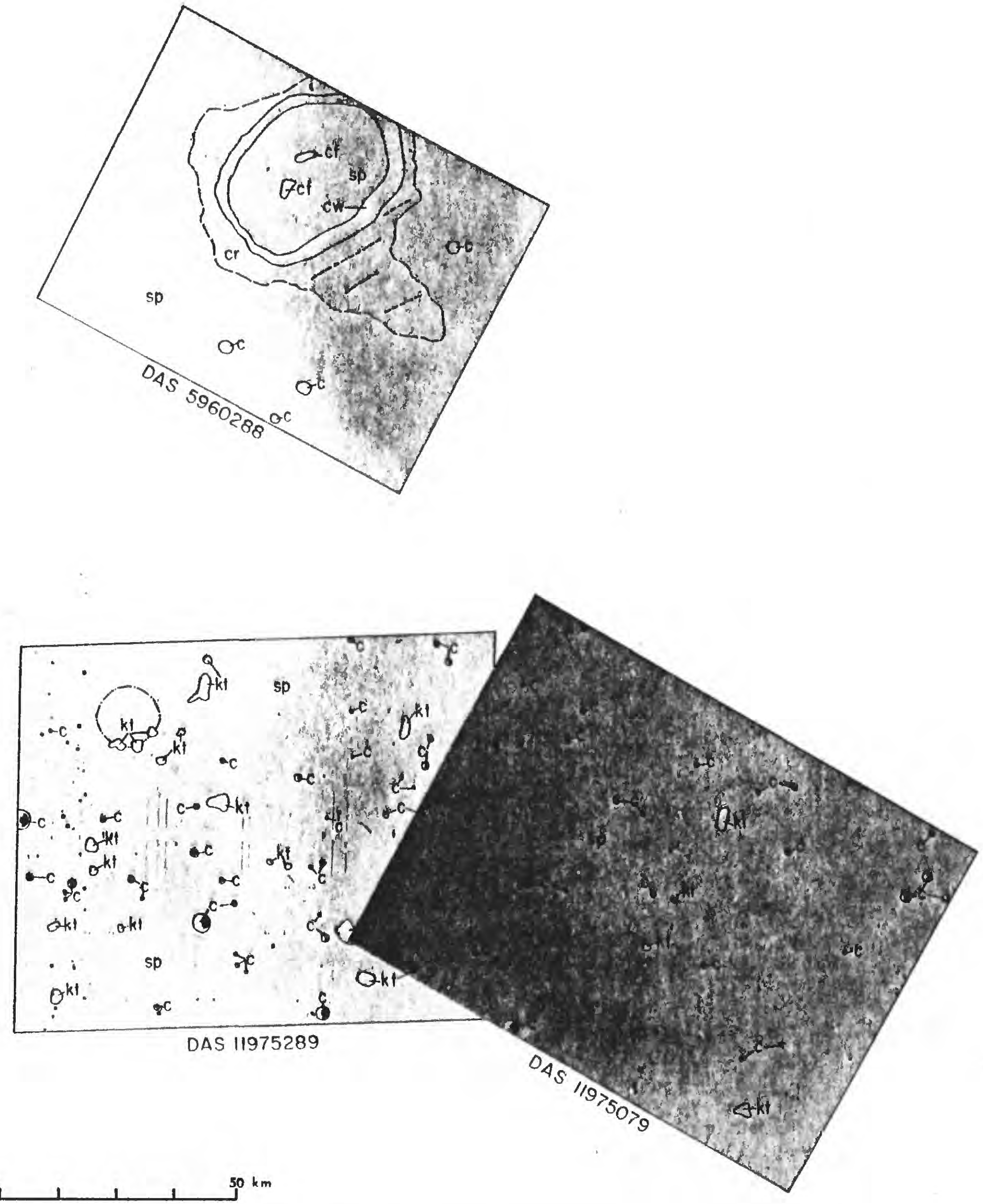
cw Crater wall material. Talus material on the steep inner walls of large craters

cf Crater floor material; forms the floor of large impact craters. Interpreted as highly shocked impact terrain

sp Smooth plains material, undifferentiated. Forms sparsely cratered plains throughout most of the map area. Smooth plain is broken by widely spaced craters and low hills of the unit kt. Interpreted as eolian debris. Probably covers volcanic plains

kt Knobby terrain; forms isolated low hills 1 km across and mesas spaced 10-20 km apart. South of the map area the unit kt appears to have formed by the break-up of the primitive cratered terrain. The small patches of kt in the map area are accordingly interpreted as remnants of cratered terrain





PRELIMINARY GEOLOGIC MAP OF PART OF THE TRITONIS LACUS REGION OF MARS
CANDIDATE VIKING MARS 1975 LANDING SITE 11

Preliminary Geologic Map of the Ortygia Region of Mars
Candidate Viking Mars 1975 Landing Site 12
Scale 1:1,000,000
By
Terry Kreidler and Harold Masursky

This region lies well within the area covered by the winter frost cap. The northernmost portion of the map area contains an edge of the permanent ice cap, and in the south central portion, near 69° N latitude, 346° longitude, there is a domed crater with vestiges of frost on its flank.

There are two main geologic units, smooth plains (sp) and mottled cratered plains (mcp). The dominant unit is the smooth plains. This unit appears to be a mantle, probably of eolian origin, characterized by a relatively featureless surface with few craters. The mottled cratered plains, on the other hand, exhibit a much rougher topography with a larger population of craters (see North Polar 1:5,000,000 map). The mottled cratered plains unit appears to be an exhumed, older terrain at one time blanketed by the smooth plains unit. Evidence of this can be seen in B-frame 12870683, in which a crater appears to be on a pedestal and has a filled interior. The mottling is an albedo effect, a result of crater ejecta blankets and topographic lows acting as traps and preventing the erosion of the lighter colored smooth plains unit.

There are two dome-shaped structures with summit craters located in the west central part of the map area (an additional one appears on the 1:250,000 map). Their shape has led to their tentative identification as volcanic domes (vd). However, lack of B-camera coverage disallows any firmer statement as to their origin. In the extreme northern portion lies the edge of the residual polar ice cap (pi/ld). On the other maps, the unit also contains laminated deposits; on this map the two are undivided because the ice still covers the laminated deposits. The units labelled (c) are craters of impact origin.

EXPLANATION

pi/ld Polar ice/laminated deposits undivided; characterized by escarpments separating flat areas in a "deck of cards" fashion. Interpreted to be residual polar ice covering laminated deposits

sp Smooth plains; flat with few craters and some rims of buried craters. Interpreted to be eolian deposits

mcp Mottled cratered plains; rough terrain characterized by craters, hills and knobs. Interpreted as older cratered, hilly, or knobby terrain which was at one time mantled by the sp unit, and has now been exhumed by erosion

vd Volcanic domes; dome-shape structures with summit craters. Interpreted as volcanic in origin; their apparent resistance to erosion may be due to a composition of lava as opposed to pyroclastics

c Crater materials of impact origin

Explanation

[pi/ld] Polar ice/laminated deposits undivided

[sp] Smooth plains

[mcp] Mottled craters plains

[vd] Volcanic cone

[c] Crater

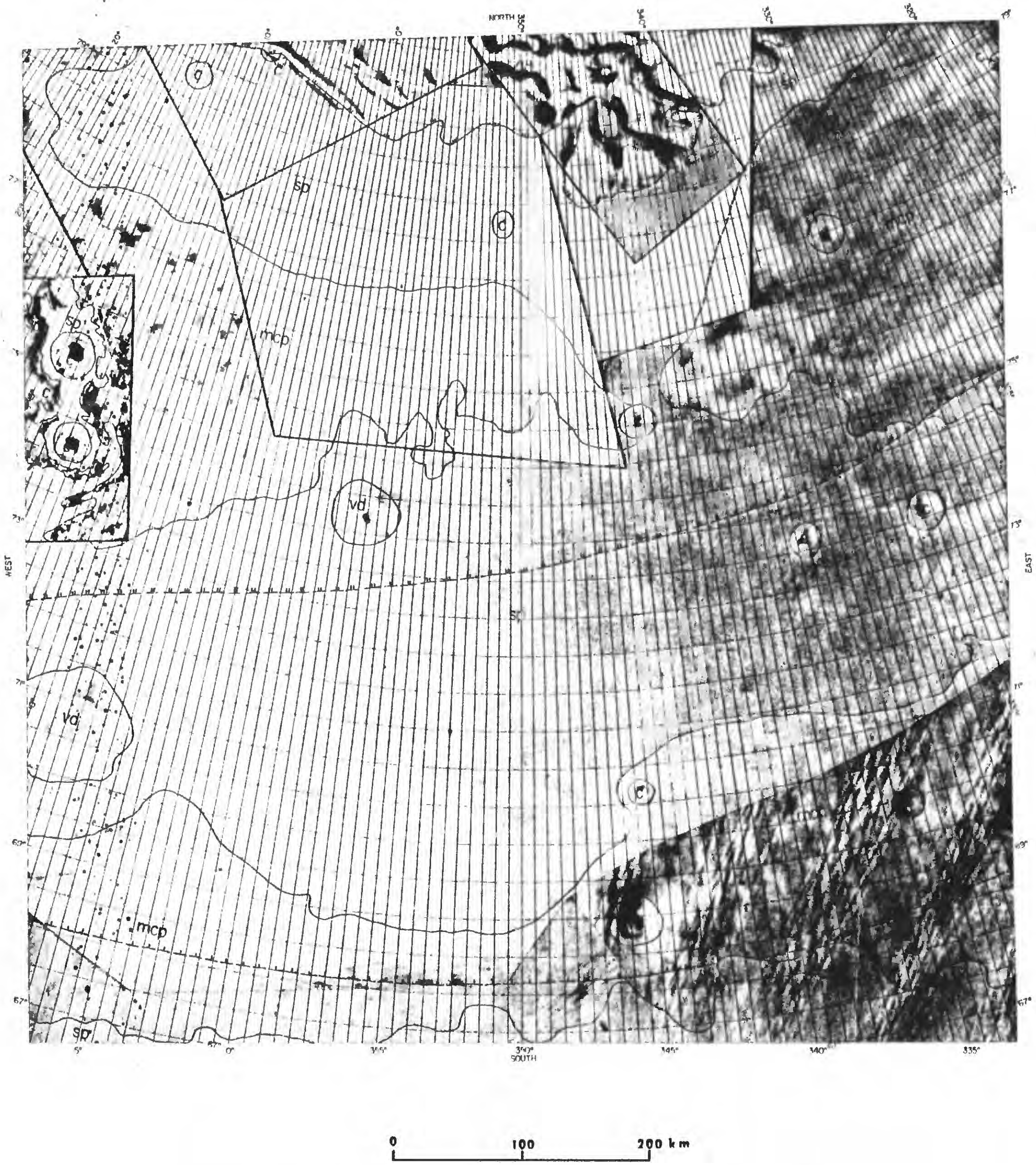
Contact, dashed where approximate

Ice boundary mid June 1972. (Ls=47°) Hatchures point toward ice

Ice boundary early August, 1972 (Ls=67°)

Ice boundary mid October, 1972 (Ls=97°)
Ls = Areographic longitude

B-Camera frames



PRELIMINARY GEOLOGIC MAP OF THE ORTYGIA REGION OF MARS
CANDIDATE VIKING MARS 1975 LANDING SITE 12

PRELIMINARY GEOLOGIC MAP OF PART OF THE ORTYGIA REGION OF MARS
CANDIDATE VIKING MARS 1975 LANDING SITE 12
Scale 1:250,000
By
Terry Kreidler and Harold Masursky

EXPLANATION

pi/ld Polar ice/laminated deposits undivided; characterized by escarpments separating flat areas in a "deck of cards" fashion. Interpreted to be residual polar ice covering the laminated deposits

sp Smooth plains; flat with few craters and some rims of buried craters. Interpreted to be eolian deposits

mcp Mottled cratered plains; rough terrain characterized by craters, hills and knobs. Interpreted as older cratered, hilly, or knobby terrain which was at one time mantled by the sp unit, and has now been exhumed by erosion

vd Volcanic domes; dome-shape structures with summit craters. Interpreted as volcanic in origin; their apparent resistance to erosion may be due to a composition of lava as opposed to pyroclastics

c Crater materials of impact origin

Explanation

pi/ld
Polar ice/laminated deposits undivided

sp
Smooth plains

mcp
Mottled craters plains

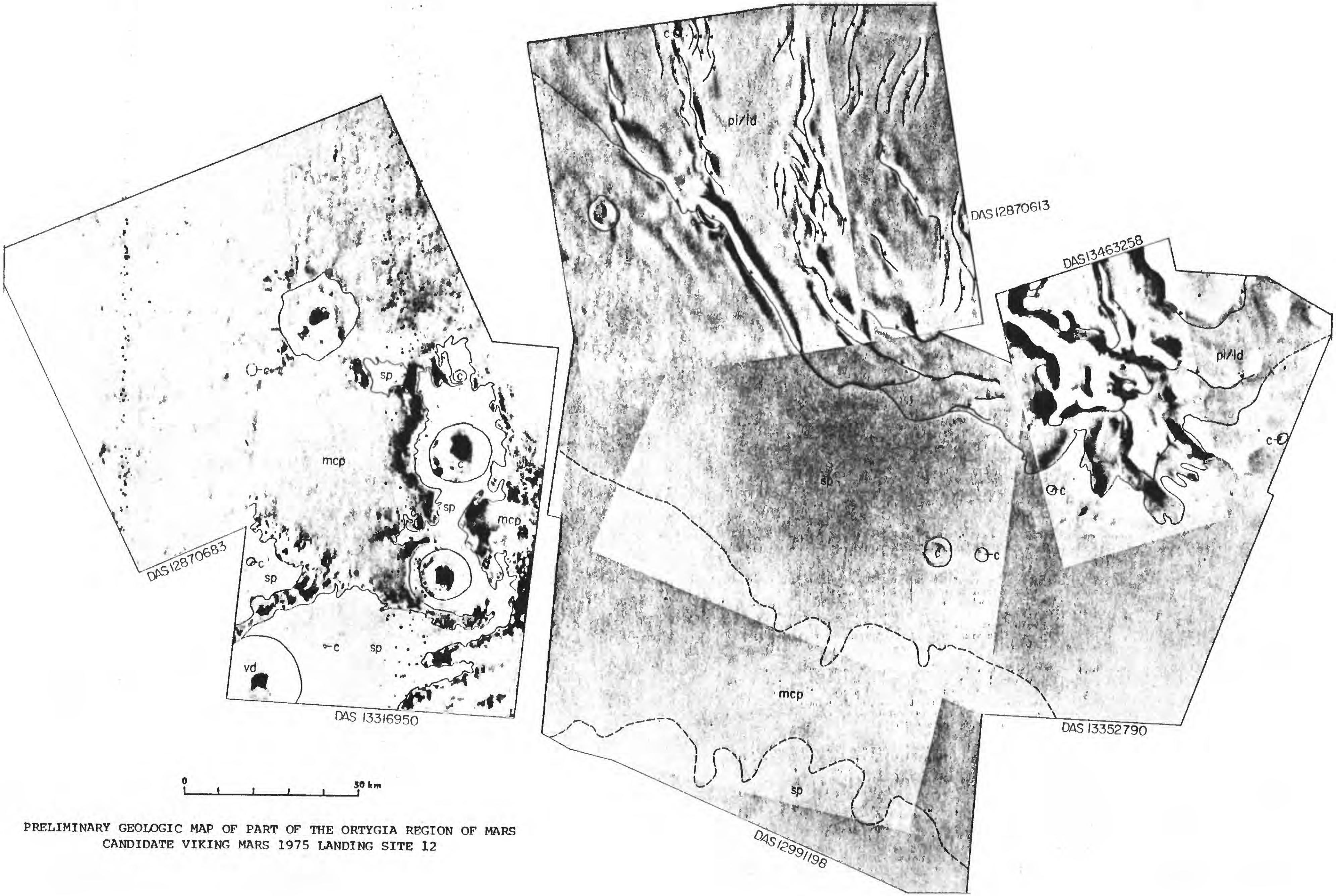
vd
Volcanic cone

c
Crater

Contact, dashed where approximate

Scarp
Barb points down slope

B-Camera frames



PRELIMINARY GEOLOGIC MAP OF PART OF THE ORTYGIA REGION OF MARS
CANDIDATE VIKING MARS 1975 LANDING SITE 12

Preliminary Geologic Map of the Uchronia Region of Mars
Candidate Viking Mars 1975 Landing Site 13
Scale 1:1,000,000
By
D. H. Scott

The area of interest lies in the north polar region of Mars and is centered near 73.5° N latitude and 221.5° longitude. Most of the region was covered by ice until mid-June 1972 but by mid-October the ice boundary has retreated to the northern part of the map area.

A description of the map units is included below. Only two of the units, smooth plains (sp) and smooth plains, rolling (spr) are considered to be sufficiently safe for a landing site.

The landing ellipse (3-sigma) should be positioned within these units; the narrow corridor of plains material in the central part of the map probably affords the best location. In the absence of B-camera photography and because the A-camera photographs of this region are of relatively low resolution, the surface hazards of landing cannot be adquately evaluated.

Geologically the site would provide analysis of Martian materials that would probably consist of wind blown dust and sand, possibly cemented or partly indurated by permafrost. At this high latitude the source of the eolian material may be from the laminated deposits (ld), etch-pitted plains (ep), or the rippled and cratered unit (rc) farther to the north. Volcanic flows may constitute some of the plains units but no evidence of such deposits or their sources are visible on available photography.

EXPLANATION

sp Smooth plains; flat level surfaces at A-camera and B-camera (where available) resolution. Crater density, low; albedo moderate. Unit believed to consist of young, relatively thick eolian material burying subjacent mottled cratered hilly plains (unit hc)

spr Smooth plains; rolling; resembles smooth plains unit (sp) but has broadly undulating surface. Probably represents thinner blanket of eolian material than unit sp, and/or subjacent topography is more irregular

ld Laminated deposits; bright smooth material having stepped, flat surfaces with thin (30 m) light and dark banding visible in scarp-like faces

hc Hilly and cratered plains; low relief hilly, ridged and mottled, generally level terrain with abundant fresh appearing to highly subdued craters as much as 40 km diameter. Mottling appears as large differences in albedo that is usually, but not always, associated with local variations in crater densities. Believed to be oldest unit in area, possibly analogous to cratered plains or moderately cratered terrain of equatorial region

rc Rippled and cratered terrain; moderately cratered uplands having rippled or regularly ridged surface at B-camera resolution. Ridges trend east-west and northwest-southeast; distance between crests is 2-5 km. Albedo high to low, but less patchy than unit hc. Old surface, possibly same as mottled crater plains unit but more modified by eolian deposition and erosion

ep Etch-pitted plains; surface generally smooth, flat, indented by irregular pits and rare small bowl-shaped craters. Edges of unit and walls of individual pits are concave in profile with a sharp upper edge. The unit may originate by strong wind erosion of other plains materials

c Crater material, undivided; includes rim, wall and floor materials. Craters formed by impact

crr Crater rim material, radial facies; forms outer faintly lineated rim around some craters. Indicates craters are relatively less eroded than others of comparable size and thus younger

Explanation

sp — Smooth plains
spr — Smooth plains, rolling
ld — Laminated deposits
hc — Mottled cratered plains, hilly
rc — Rippled and cratered terrain
ep — Etch-pitted plains
c — Crater rim material, undivided
crr — Crater rim, radial facies

Contact
Hatchured where coincident with ice boundary

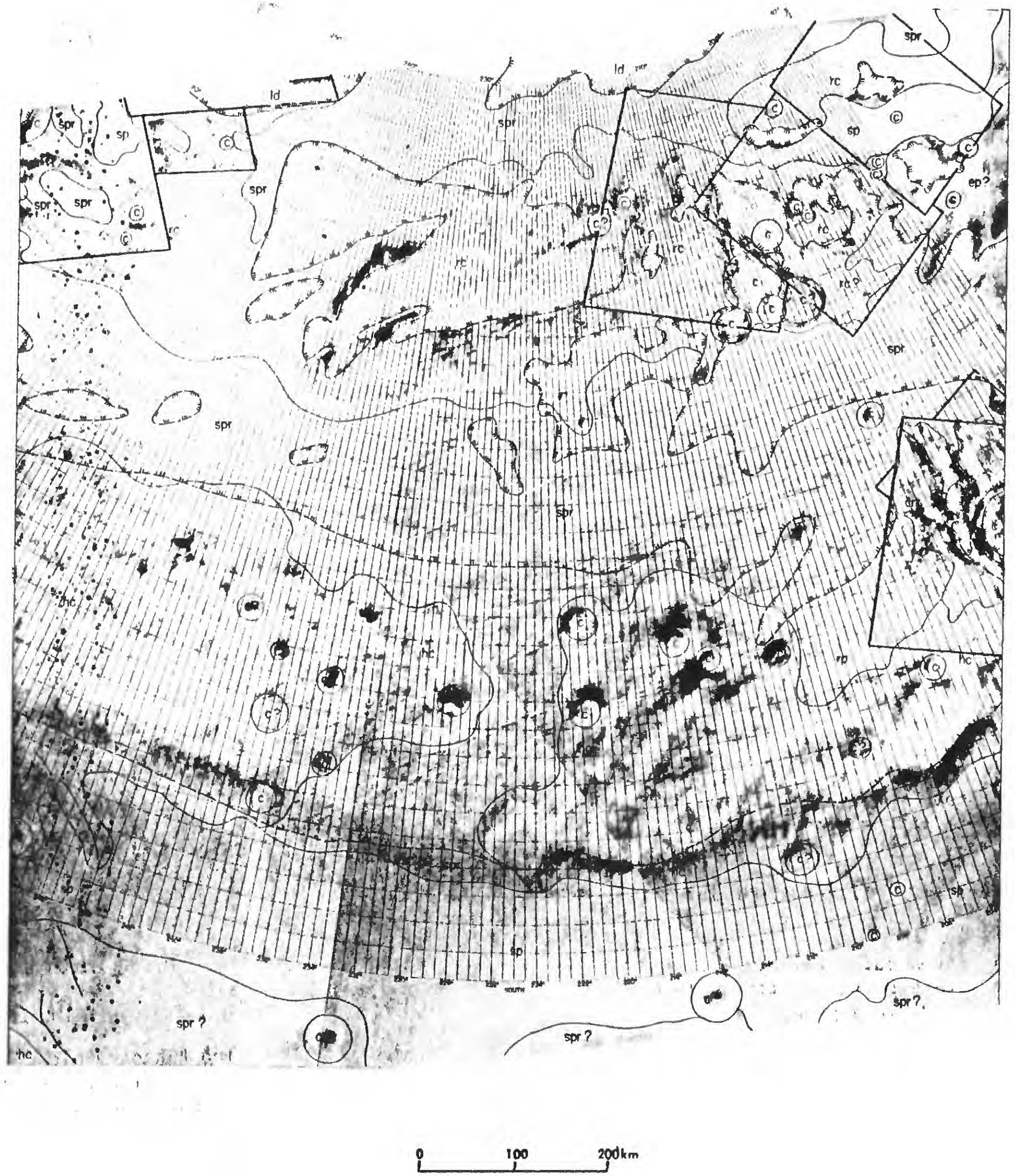
Ridge

Trough

Ice boundary mid June 1972. (Ls=44°)
Hatchures point toward ice.
Ls,# Areographic longitude of sun.

Ice boundary early August, 1972 (Ls=67°)

Ice boundary mid October, 1972 (Ls=96°)



PRELIMINARY GEOLOGIC MAP OF THE UCHRONIA REGION OF MARS
CANDIDATE VIKING MARS 1975 LANDING SITE 13

PRELIMINARY GEOLOGIC MAP OF PART OF THE UCHRONIA REGION OF MARS
CANDIDATE VIKING MARS 1975 LANDING SITE 13

Scale 1:250,000

By

D. H. Scott

EXPLANATION

sp Smooth plains; flat level surfaces at A-camera and B-camera (where available) resolution. Crater density, low; albedo moderate. Unit believed to consist of young, relatively thick eolian material burying subjacent mottled cratered hilly plains (unit hc)

spr Smooth plains; rolling; resembles smooth plains unit (sp) but has broadly undulating surface. Probably represents thinner blanket of eolian material than unit sp, and/or subjacent topography is more irregular

ld Laminated deposits; bright smooth material having stepped, flat surfaces with thin (30 m) light and dark banding visible in scarp-like faces

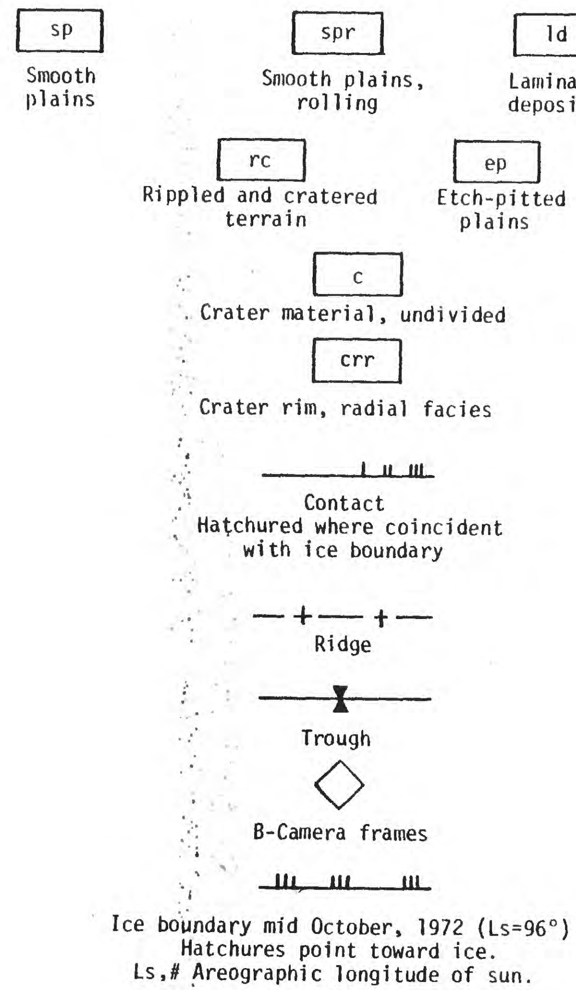
rc Rippled and cratered terrain; moderately cratered uplands having rippled or regularly ridged surface at B-camera resolution. Ridges trend east-west and northwest-southeast; distance between crests is 2-5 km. Albedo high to low, but less patchy than unit hc. Old surface, possibly same as mottled crater plains unit but more modified by eolian deposition and erosion

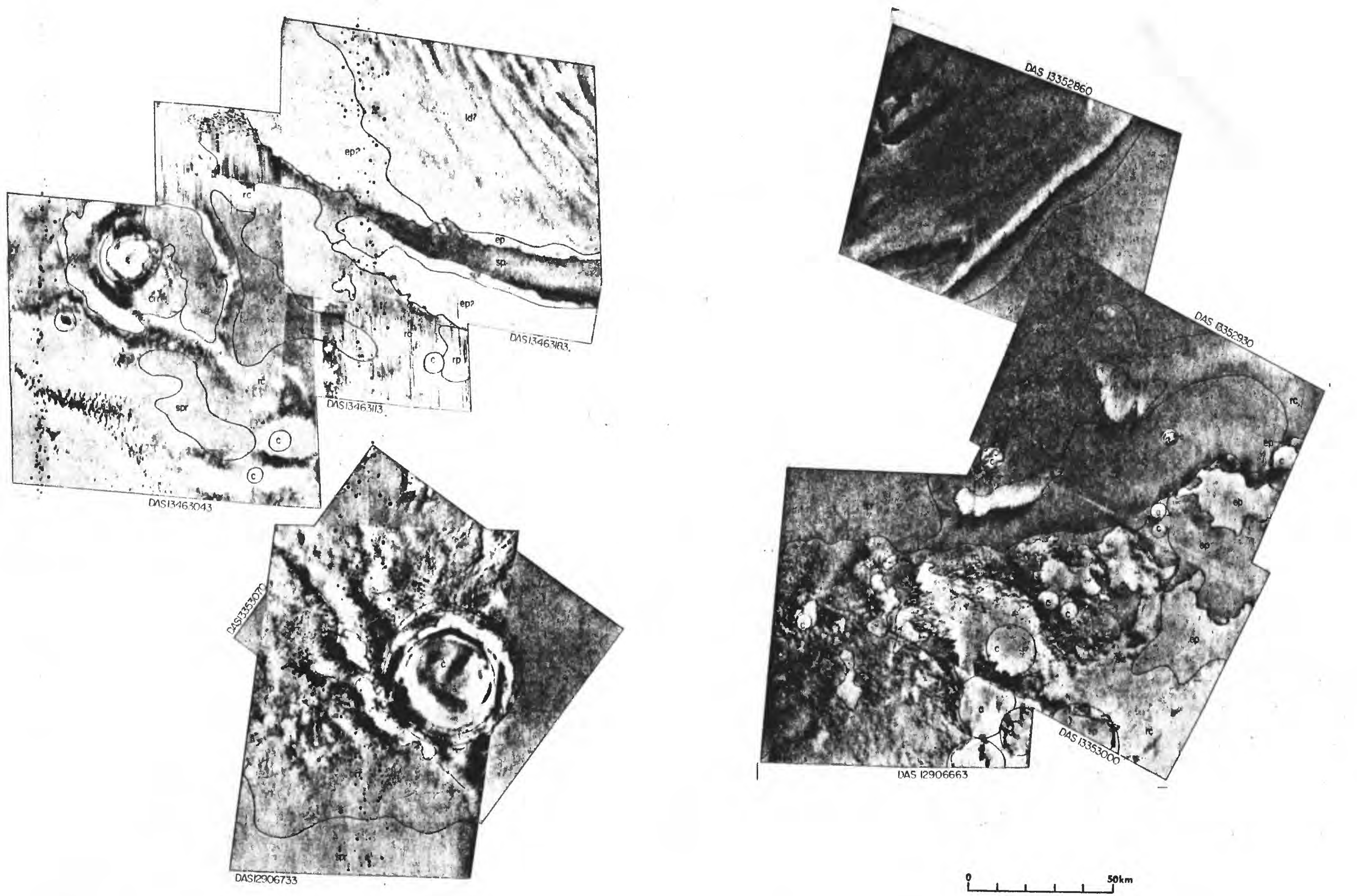
ep Etch-pitted plains; surface generally smooth, flat, indented by irregular pits and rare small bowl-shaped craters. Edges of unit and walls of individual pits are concave in profile with a sharp upper edge. The unit may originate by strong wind erosion of other plains materials

c Crater material, undivided; includes rim, wall and floor materials. Craters formed by impact

crr Crater rim material, radial facies; forms outer faintly lineated rim around some craters. Indicates craters are relatively less eroded than others of comparable size and thus younger

Explanation





PRELIMINARY GEOLOGIC MAP OF PART OF THE UCHRONIA REGION OF MARS
CANDIDATE VIKING MARS 1975 LANDING SITE 13

Preliminary Geologic Map of the Cedron Region of Mars
Candidate Viking Mars Landing Site 14
Scale 1:1,000,000
By
K. S. Murray and G. W. Colton

Site 14 is located in the large bright area, Ortygia; the proposed landing site is at 63° N latitude and 355° W longitude. During periods of maximum extent of the north polar ice cap all of the mapped area is within the polar hood. When most of the pictures composing the mosaic were taken, the ice cap had retreated, leaving vestiges of the former ice cover around the rims of two large craters and on the east flank of a large dome.

Geologically the area is dominated by smooth plains (unit sp) in the central part and by mottled cratered plains (unit mcp) in the northern and southern parts.

Although the smooth plains are topographically much more subdued than the surrounding mottled cratered plains, they are significantly rougher than the smooth plains unit mapped nearer the equator. If B-frame DAS 12362876 is typical of all of the area so mapped, unit sp is so thin that the rims of many subjacent craters are partly exposed. The unit is probably of eolian origin, but features that can be identified as definitely eolian in origin are not visible. However, a vaguely defined streaking (trending nearly E-W) is probably caused by wind action. If the streaking is parallel to the direction of wind movement, a polar circumferential pattern is indicated; however at the resolution of the available pictures, the wind direction cannot be determined.

The mottled cratered plains are characterized by their tonal mottling (abrupt local albedo variations) and relatively rough texture. The latter is caused by the presence of numerous craters in various stages of exhumation, and by irregularly distributed hills and knobs. In much of the southeastern part of the map, unit mcp is relatively more subdued in relief, and less prominently mottled. It appears to be heavily mantled by material that is indistinguishable from the younger smooth plains material. A limited area of unusually rough terrain in the southeastern part of the map has been recognized and mapped as mottled cratered plains, hilly (mcph). It appears to be essentially devoid of surficial mantling material.

Several cone-like structures with summit craters are present in the northern part of the mapped area. Because of their shape they are tentatively interpreted to be of volcanic origin and are mapped as unit vc. The apparent alinement of the three cones nearest the northwest corner is also suggestive of an internal or volcanic origin. It is difficult to determine the true shape of the large structure near the northeast corner of the map because of the frost patch on its east flank. Although it appears to be a steep (volcanic) cone with a summit crater, it may be a very gentle relatively low-rimmed crater of impact origin.

NOTES: Three factors to be considered are the inadequate B-frame resolution at this latitude, the paucity of B-frames near the landing point, and the relatively rough nature of the smooth plains material in the one B-frame available.

The landing ellipse would be better centered within the smooth plains unit if the landing point were shifted 1/2° to 1° south-southwest along the approach azimuth.

EXPLANATION

sp Smooth plains; flat, relatively smooth plains with faintly discernible rims of buried craters. Interpreted to be wind-blown deposits from uncertain, but probably numerous source areas. Probably thinner than in many equatorial areas

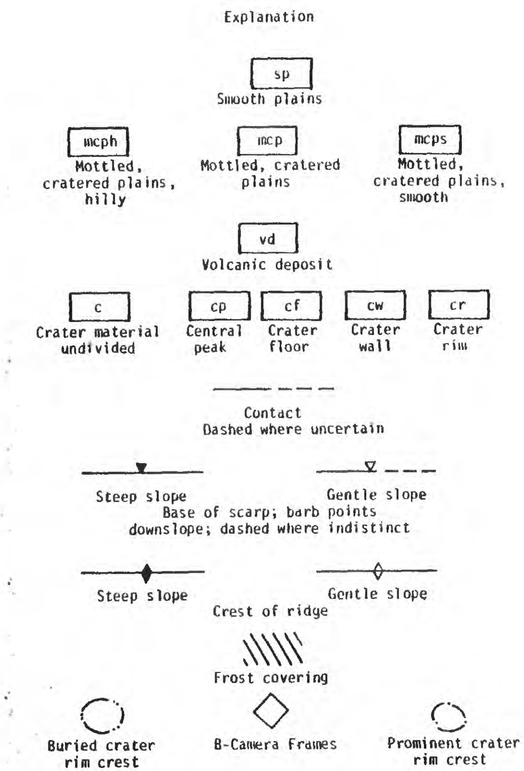
mcp Mottled cratered plains; rough terrain characterized by patchy albedo and numerous craters, hills and knobs. Relief varies considerably but is everywhere greater than unit sp. Locally resembles knobby terrain recognized and mapped elsewhere. Interpreted as older terrain of uncertain origin which is being buried by or exhumed from a cover of unconsolidated eolian debris. Albedo variations may reflect differences in composition and/or particle size

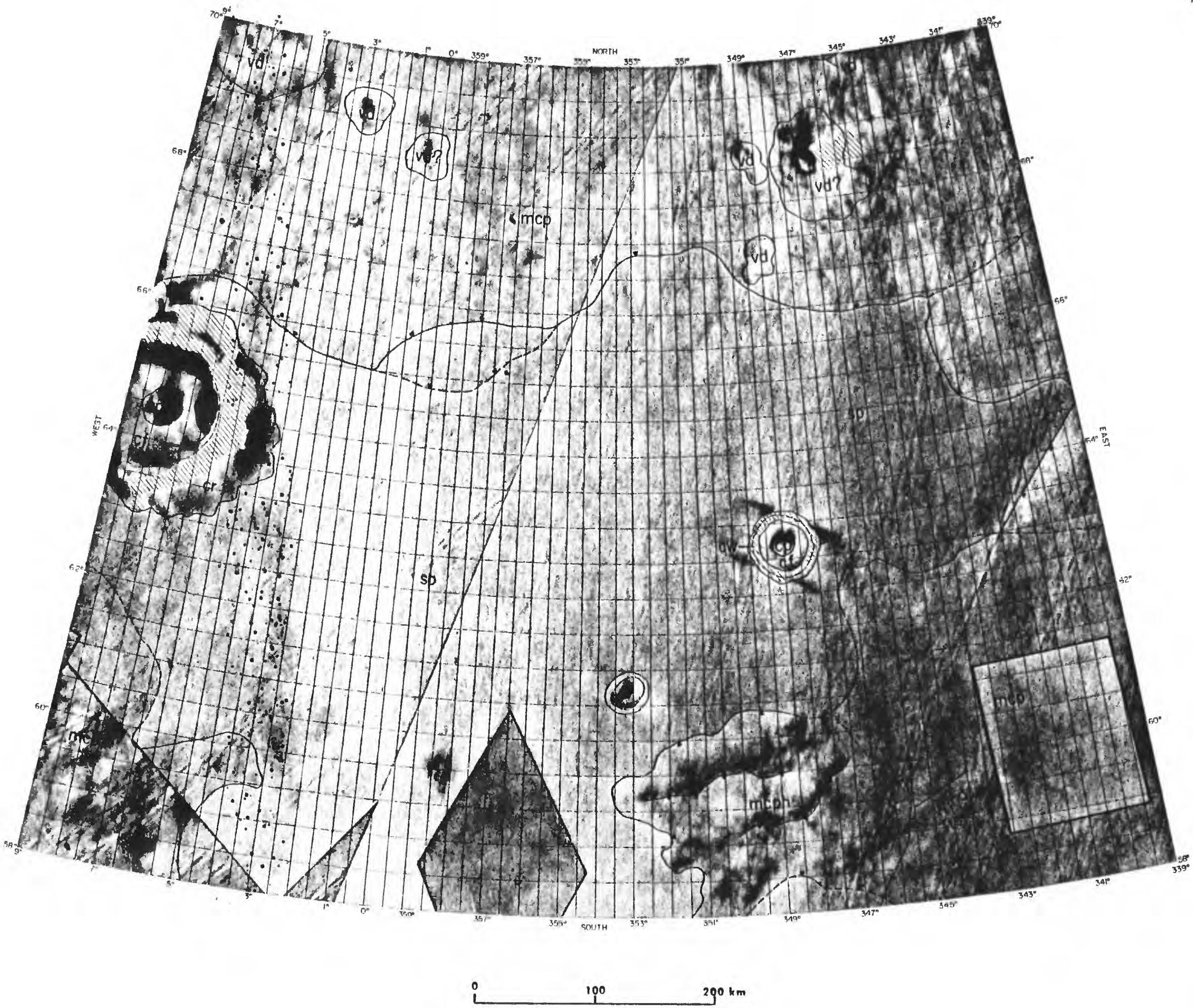
mcph Mottled cratered plains, hilly; grossly similar to mcp, but with appreciably greater relief. Similar in origin to mcp but much less deeply buried

mcps Mottled cratered plains, smooth; similar to mcp, but relief much lower. Recognized only in area of one B-frame. Similar in origin to mcp but is either more deeply buried, or it possessed less relief before burial

vd Volcanic deposit; shallow, circular to irregular cones with summit craters. Also includes one gentle irregular dome without visible craters. Outer edges defined by gentle escarpment. Queried where origin is least certain. Probably of volcanic origin. Resistance to erosion suggests they are composed largely of lava rather than pyroclastic debris. Outer escarpment apparently caused by eolian erosion

c Crater materials; undivided
cp Materials of central peak
cf Materials of central floor
cw Materials of crater wall
cr Materials of crater rim





PRELIMINARY GEOLOGIC MAP OF THE CEDRON REGION OF MARS
CANDIDATE VIKING MARS 1975 LANDING SITE 14

PRELIMINARY GEOLOGIC MAP OF PART OF THE CEDRON REGION OF MARS
CANDIDATE VIKING MARS 1975 LANDING SITE 14
Scale 1:250,000
By
K. S. Murray and G. W. Colton

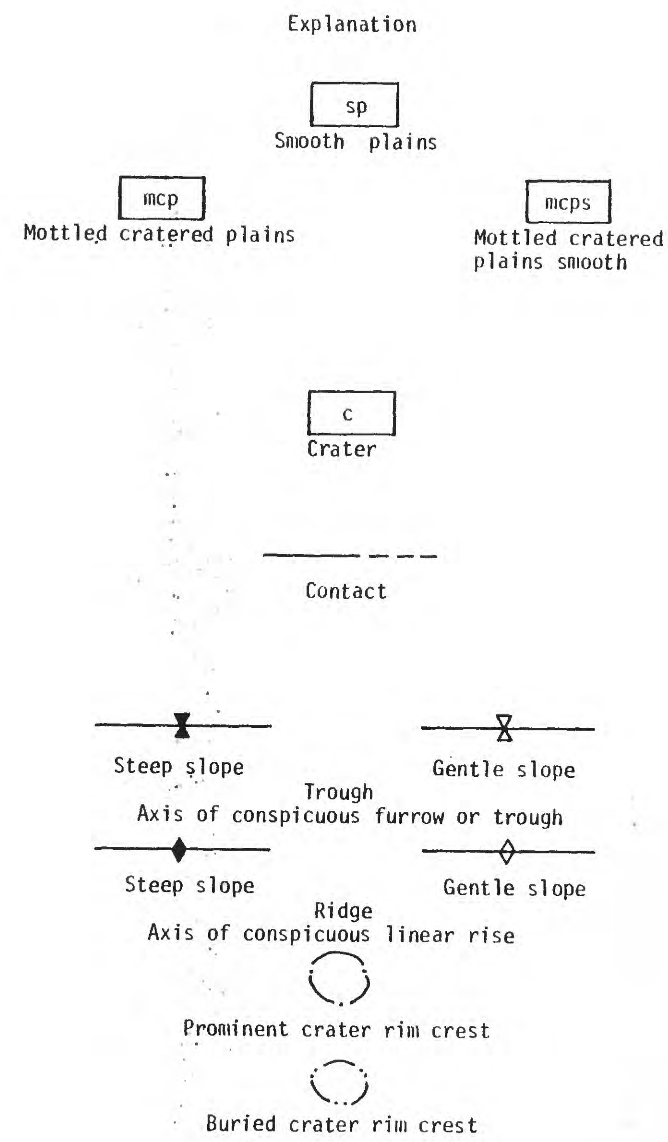
EXPLANATION

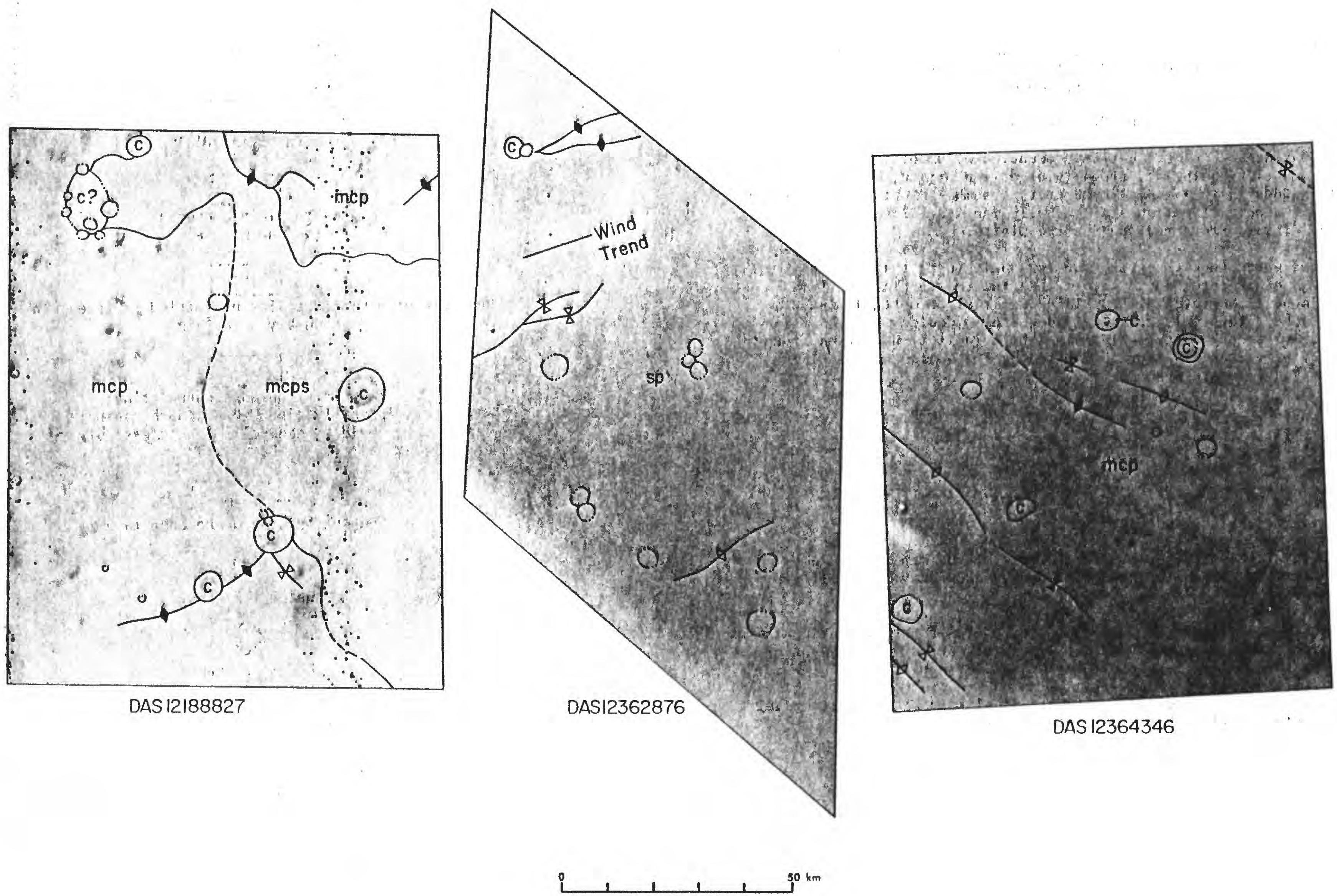
sp Smooth plains; flat, relatively smooth plains with faintly discernible rims of buried craters. Interpreted to be wind-blown deposits from uncertain, but probably numerous source areas. Probably thinner than in many equatorial areas

mcp Mottled cratered plains; rough terrain characterized by patchy albedo and numerous craters, hills and knobs. Relief varies considerably but is everywhere greater than unit sp. Locally resembles knobby terrain recognized and mapped elsewhere. Interpreted as older terrain of uncertain origin which is being buried by or exhumed from a cover of unconsolidated eolian debris. Albedo variations may reflect differences in composition and/or particle size

mcps Mottled cratered plains, smooth; similar to mcp, but relief much lower. Recognized only in area of one B-frame. Similar in origin to mcp but is either more deeply buried, or it possessed less relief before burial

c Crater materials; undivided





PRELIMINARY GEOLOGIC MAP OF PART OF THE CEDRON REGION OF MARS
CANDIDATE VIKING MARS 1975 LANDING SITE 14

Preliminary Geologic Map of the Scandia Region of Mars
Candidate Viking Mars 1975 Landing Site 15
Scale 1:1,000,000
By
D. E. Wilhelms

The map area is almost entirely occupied by smooth plains material. This is a mantling material, probably of eolian origin, which subdues several craters in the area. The craters resemble donuts because their interiors and outer rim flanks are heavily mantled. Several fresh appearing craters are superposed on the plains.

At the northern edge of the map is a unit (epp) that has more craters and other topographic detail than the smooth plains. This unit could be either etch-pitted plains material or mottled plains material; photographic imagery is inadequate to decide which unit is portrayed. A smooth, apparently raised hill (unit t) next to a fresh crater may be either old terrain mantled by the eolian smooth plains material or a volcanic cone.

EXPLANATION

c Crater materials, undivided

sp Smooth plains materials; underlie most of the map area. Interpreted to be a mantle of eolian debris. Boundary with unit epp is uncertain

epp Etch-pitted plains (or mottled crater plains); normal distinguishing characteristics of unit epp are poorly developed in this area or are not certainly detectible in the available pictures

t Terrain of unknown origin; may be conical base of volcanic crater. Possibly is older than smooth plains materials

Explanation

[c]
Crater material

[sp]
Smooth plains material
(eolian mantle)

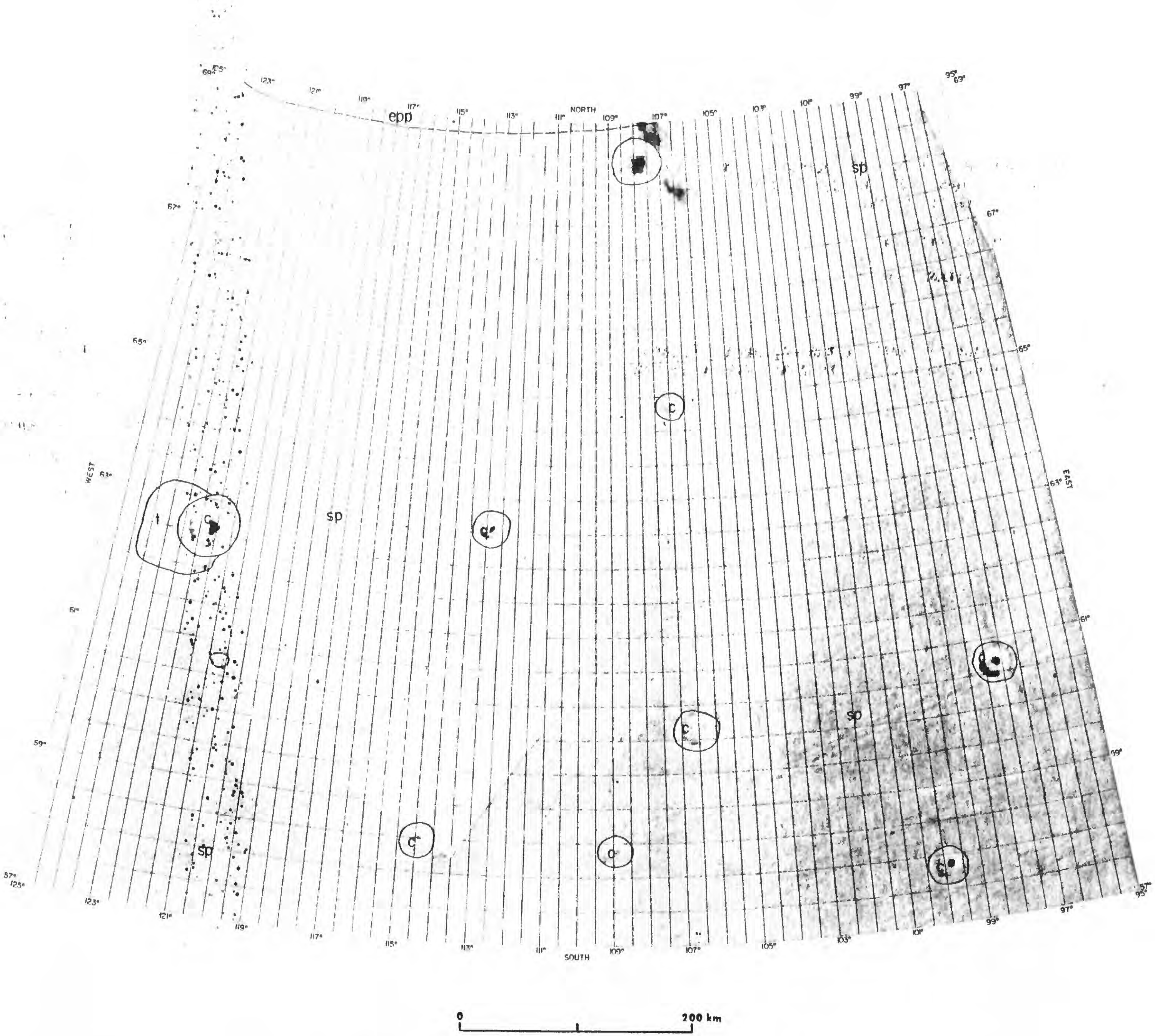
[epp]
Possible etch pitted plains or mottled cratered plains
(boundary uncertain)

[t]
Terrain of unknown correlation; possibly older than smooth plains; could be conical volcanic base of crater

Contact, dashed where uncertain

Buried rim crest

B-Camera frames



PRELIMINARY GEOLOGIC MAP OF THE SCANDIA REGION OF MARS
CANDIDATE VIKING MARS 1975 LANDING SITE 15

PRELIMINARY GEOLOGIC MAP OF PART OF THE SCANDIA REGION OF MARS
CANDIDATE VIKING MARS 1975 LANDING SITE 15
Scale 1:250,000
By
D. E. Wilhelms

EXPLANATION

c Crater materials, undivided

sp Smooth plains materials; underlie most of the map area. Interpreted to be a mantle of eolian debris. Boundary with unit epp is uncertain

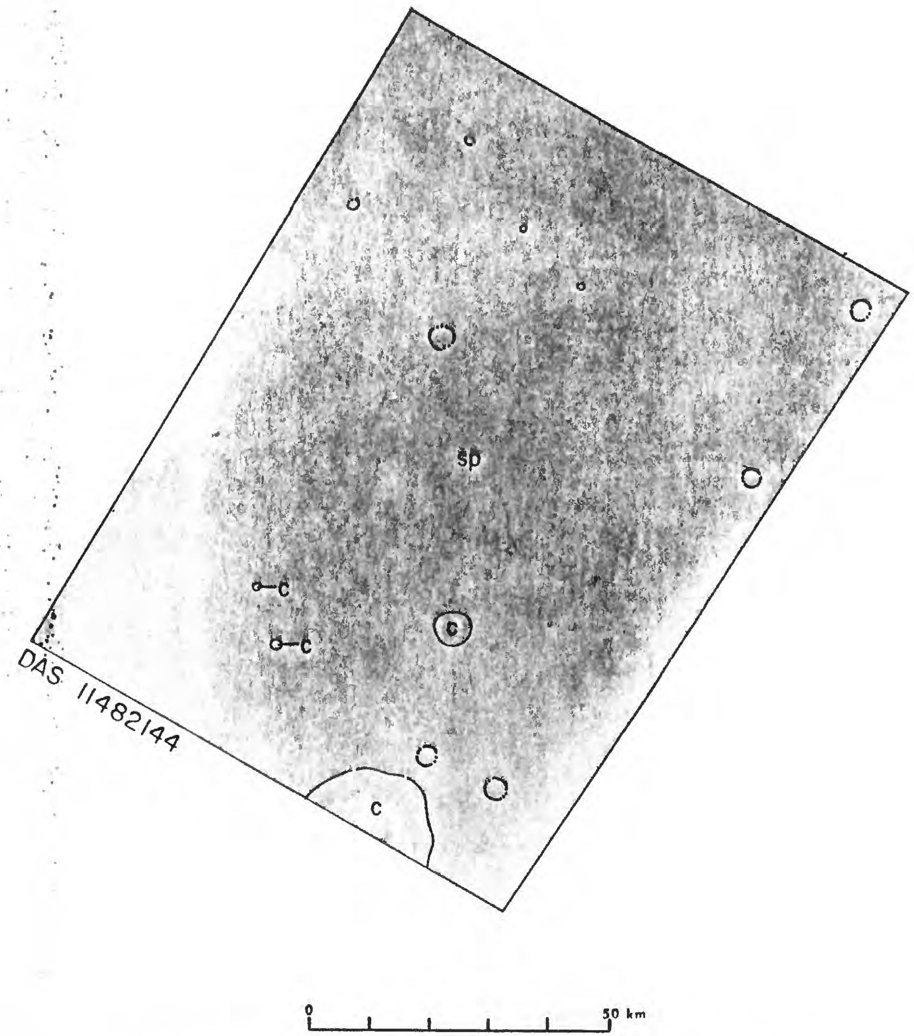
Explanation

[c]
Crater material

[sp]
Smooth plains material
(eolian mantle)

Contact, dashed where uncertain

Buried rim crest



¯MINARY GEOLOGIC MAP OF PART OF THE SCANDIA REGION OF MARS
CANDIDATE VIKING MARS 1975 LANDING SITE 15

Preliminary Geologic Map of the Cydonia Region of Mars
Candidate Viking Mars 1975 Landing Site 16
Scale 1:1,000,000
By
D. H. Scott

The Cydonia region of Mars is located along the eastern side of Mare Acidalium where plains units (p and rmp) of the lowlands abut against the higher plateau and hills (units cp and kt) forming the southeastern shelf. The area is geologically interesting, particularly in regards to stratigraphy, as it provides the possibility of sampling several different types of materials of diverse origin and provenance. The landing ellipse lies mostly within the plains unit p which is believed to consist of thin layers of eolian sand and loess transported from subpolar regions to the north and northeast. These eolian deposites may be intermixed with alluvial delta and plains materials derived from channels transecting the plateau to the south and east. Many channels originating within the upland areas show floor textures closely resembling those of terrestrial stream beds. Volcanic cones and lava flows (units vc and gt) are recognized on some high-resolution photographs and may be more extensive throughout the area than presently mapped. Thus, in summary, units consisting of eolian and pyroclastic material may all be present within the selected area.

It is recommended that the coordinates of the center of the 3-sigma landing ellipse be shifted from 44.3° latitude and 10° longitude to 42.8° latitude and 10.8° longitude with an azimuth of about 60°. This will insure that about 95% of the ellipse lies within the plains unit p, versus about 60% within this unit for the originally proposed location. The plains unit p is relatively smooth compared with adjacent units--rolling mottled plains (rmp) and knobby terrain (kt)--and presents fewer landing hazards. It is not as featureless, however, as some of the "smooth plains" (sp) mapped elsewhere on some of the previous candidate Viking landing sites, hence its designation simply as "plains" material.

EXPLANATION

c — Crater material, undivided; includes all material visibly associated with impact craters. Craters generally small (< 15 km) and/or old

cr — Crater rim material; includes raised rim and low relief (radial) facies extending outward from rimcrest

ccp — Crater central peak material; prominent hill and mound nearly central to crater floor

vc — Volcanic crater material; morphologic characteristics include: conical hills with summit craters, craters with breached walls, and small double ring craters. Queried where shape not well defined or origin uncertain

ci — Irregular crater material; craters having highly elongate outlines and raised rims. Origin uncertain, may be volcanic or formed by highly oblique impacts and/or simultaneous impacts

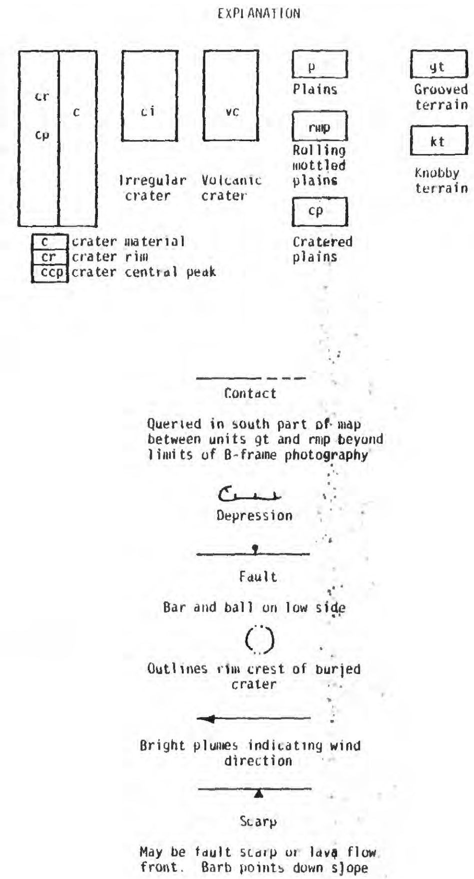
p — Plains material; appears smooth at 1:1,000,000 scale. Few superposed or buried craters

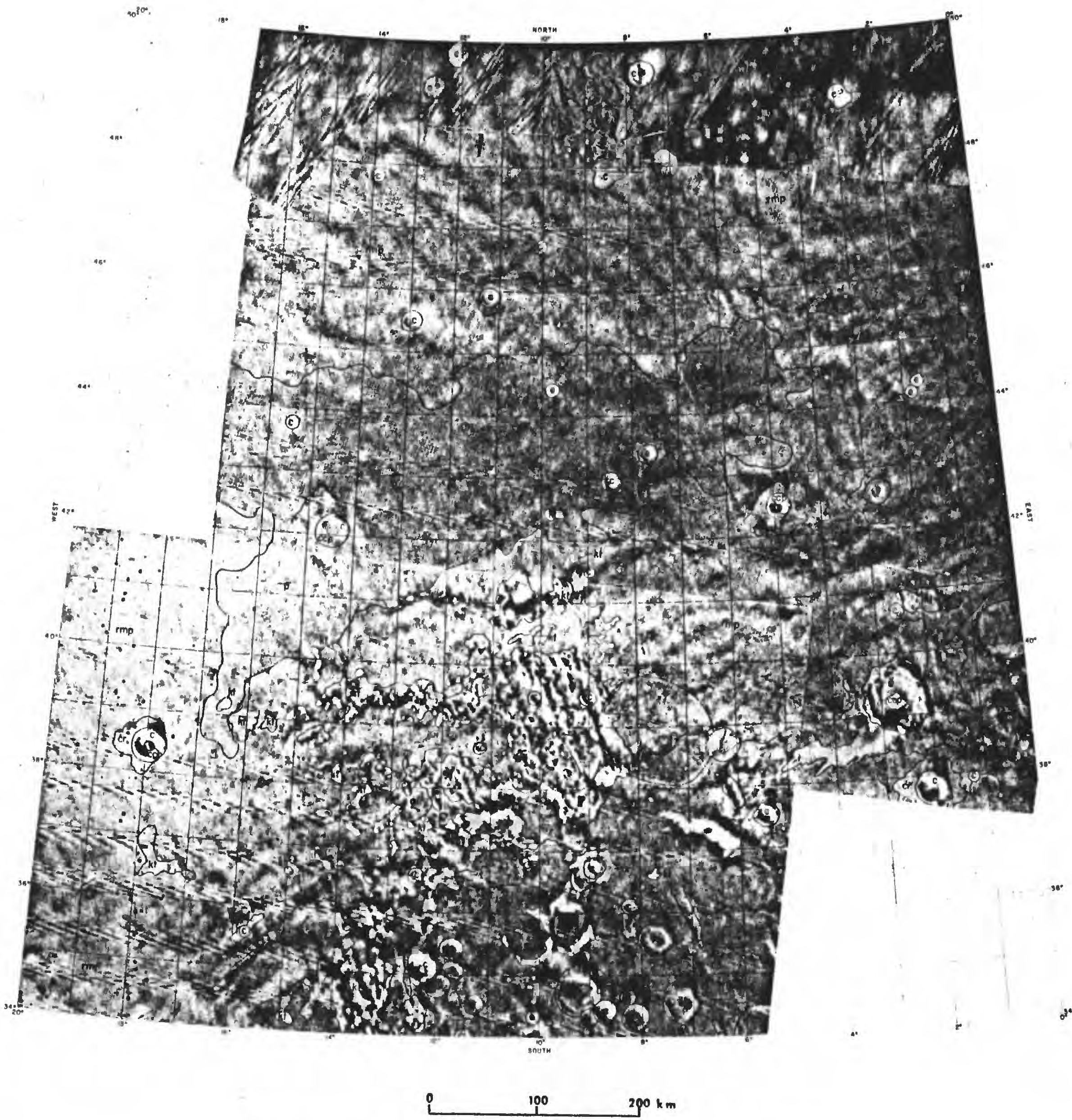
rmp — Rolling mottled plains material; undulating, albedo highly variable and spotty. Moderate density of superposed craters, increases to north; few buried crater rims visible

cp — Cratered plains material; highly cratered relatively flat surface forming plateau in southeast part of map. Craters show all stages of topographic freshness - from sharp rimmed bright young craters to those having highly subdued, nearly buried rim crests

gt — Grooved terrain material; curvilinear troughs and rilles separate patches of mottled terrain. Resembles floors of some lunar craters attributed to volcanic filling and subsequent uplift and arching. Many volcanic and queried volcanic constructs in vicinity

kt — Knobby terrain material; subround hills occurring singly and in clusters mostly in southern part of map between cratered plains unit (cp) and rolling mottled terrain (unit rmp). May represent intermediate stage of erosion - between cratered plains and rolling mottled plains





PRELIMINARY GEOLOGIC MAP OF THE CYDONIA REGION OF MARS
CANDIDATE VIKING MARS 1975 LANDING SITE 16

PRELIMINARY GEOLOGIC MAP OF PART OF THE CYDONIA REGION OF MARS
CANDIDATE VIKING MARS 1975 LANDING SITE 16
Scale 1:250,000
By
D. H. Scott

EXPLANATION

c — Crater material, undivided; includes all material visibly associated with impact craters. Craters generally small (< 15 km) and/or old

cr — Crater rim material; includes raised rim and low relief (radial) facies extending outward from rimcrest

crd — Crater rim material, discontinuous; extends outward from unit cr as discontinuous patches

ccp — Crater central peak material; prominent hill or mound nearly central to crater floor

vc — Volcanic crater material; morphologic characteristics include: conical hills with summit craters, craters with breached walls, and small double ring craters. Queried where shape not well defined or origin uncertain

ci — Irregular crater material; craters having highly elongate outlines and raised rims. Origin uncertain, may be volcanic or formed by highly oblique impacts and/or simultaneous impacts

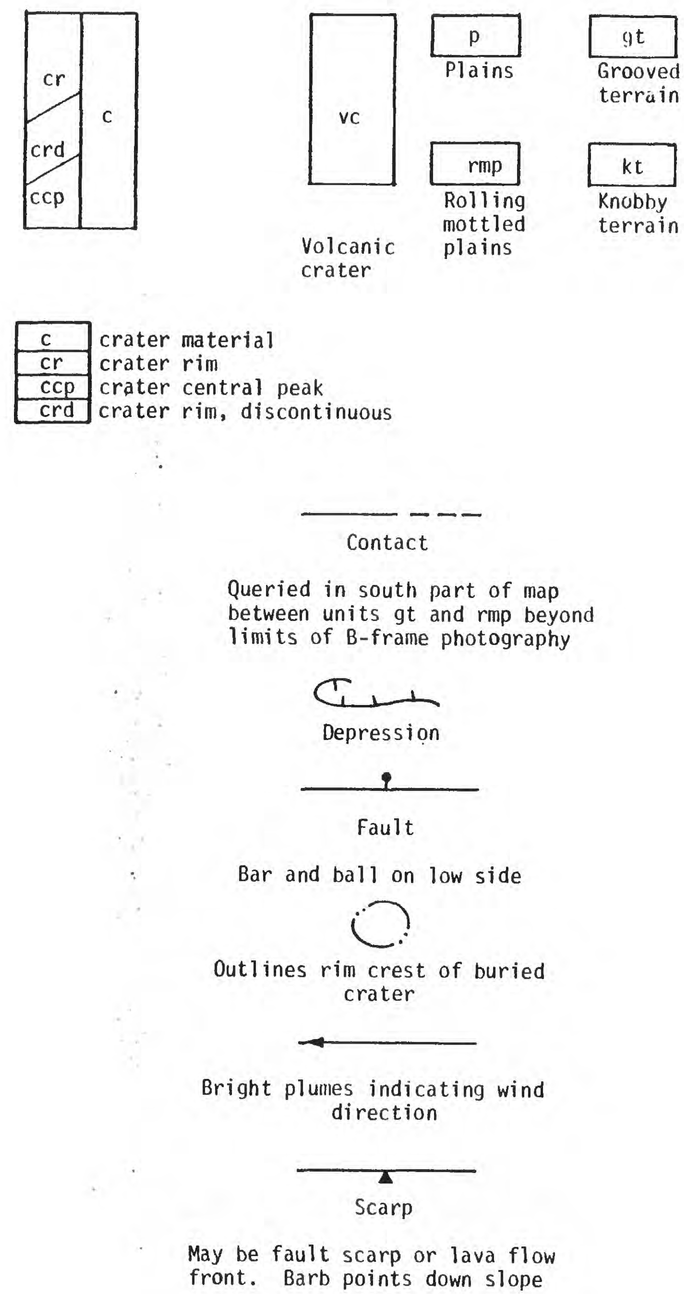
p — Plains material; appears hilly to hummocky at large scale (B-frame 9162659). Few superposed or buried craters

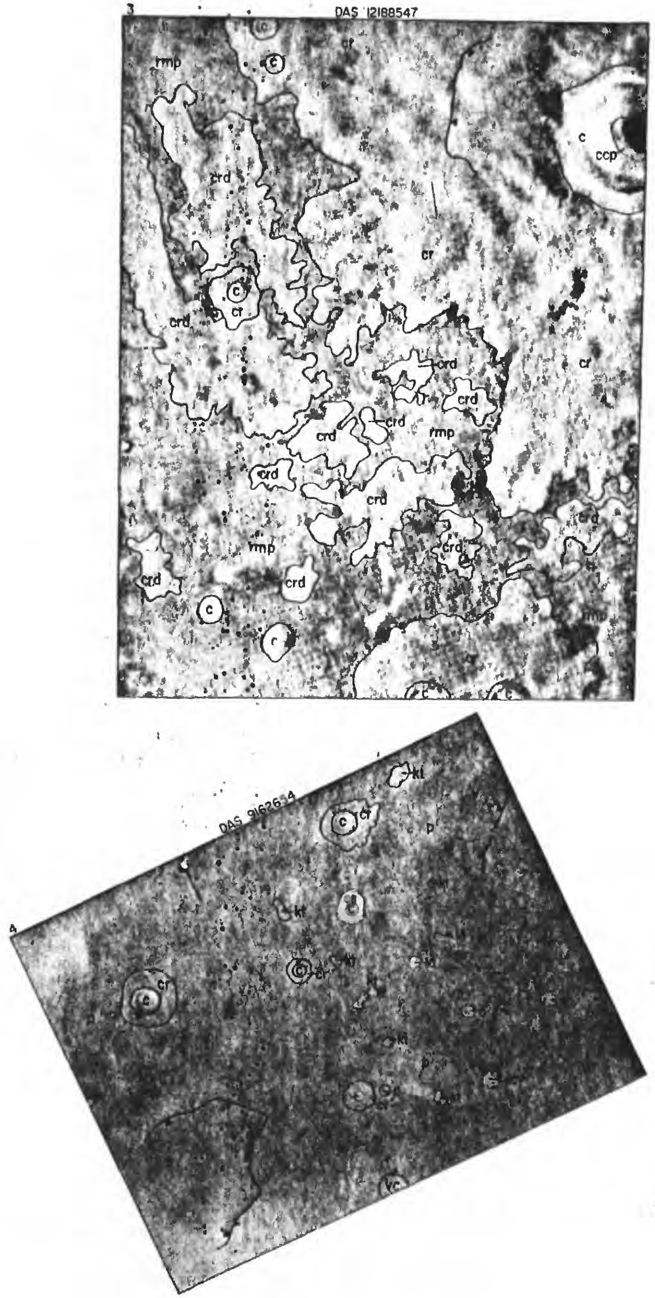
rmp — Rolling mottled plains material; undulating, albedo highly variable and spotty. Moderate density of superposed craters, increases to north; few buried crater rims visible

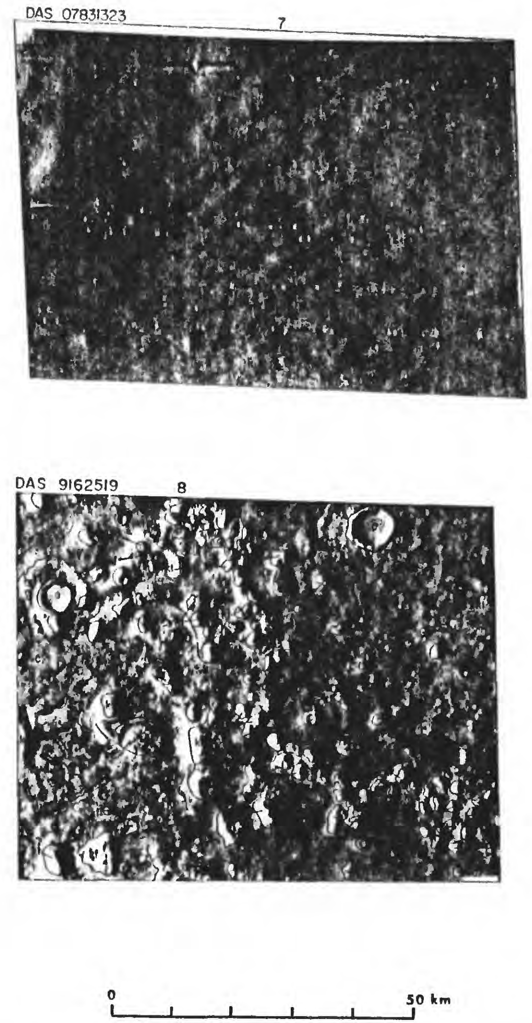
gt — Grooved terrain material; curvilinear troughs and rilles separate patches of mottled terrain. Resemble floors of some lunar craters attributed to volcanic filling and subsequent uplift and arching. Many volcanic and queried volcanic constructs in vicinity

kt — Knobby terrain material; subround hills occurring singly and in clusters mostly in southern part of map between cratered plains unit (cp) and rolling mottled terrain (unit rmp). May represent intermediate stage of erosion - between cratered plains and rolling mottled plains

EXPLANATION







PRELIMINARY GEOLOGIC MAP OF PART OF THE CYDONIA REGION OF MARS
CANDIDATE VIKING MARS 1975 LANDING SITE 16

Preliminary Geologic Map of the Alba Region of Mars
Candidate Viking Mars 1975 Landing Site 17
Scale 1:1,000,000
By
Harold Masursky and Terry Kreidler

Explanation

sp — Smooth plains

dwd — Dark wind deposits

lwd — Light wind deposits

Arrow shows wind direction

vf — Volcanic flow

vd — Volcanic deposit

fd — Fractured volcanic deposits

rd — Ridged volcanic deposits

vm — Volcanic material

c — Crater

cf — Crater floor

cr — Crater rim & wall undivided

cp — Central peak

ch — Crater chain

ce — Crater ejecta

Contact
Dashed where approximately located

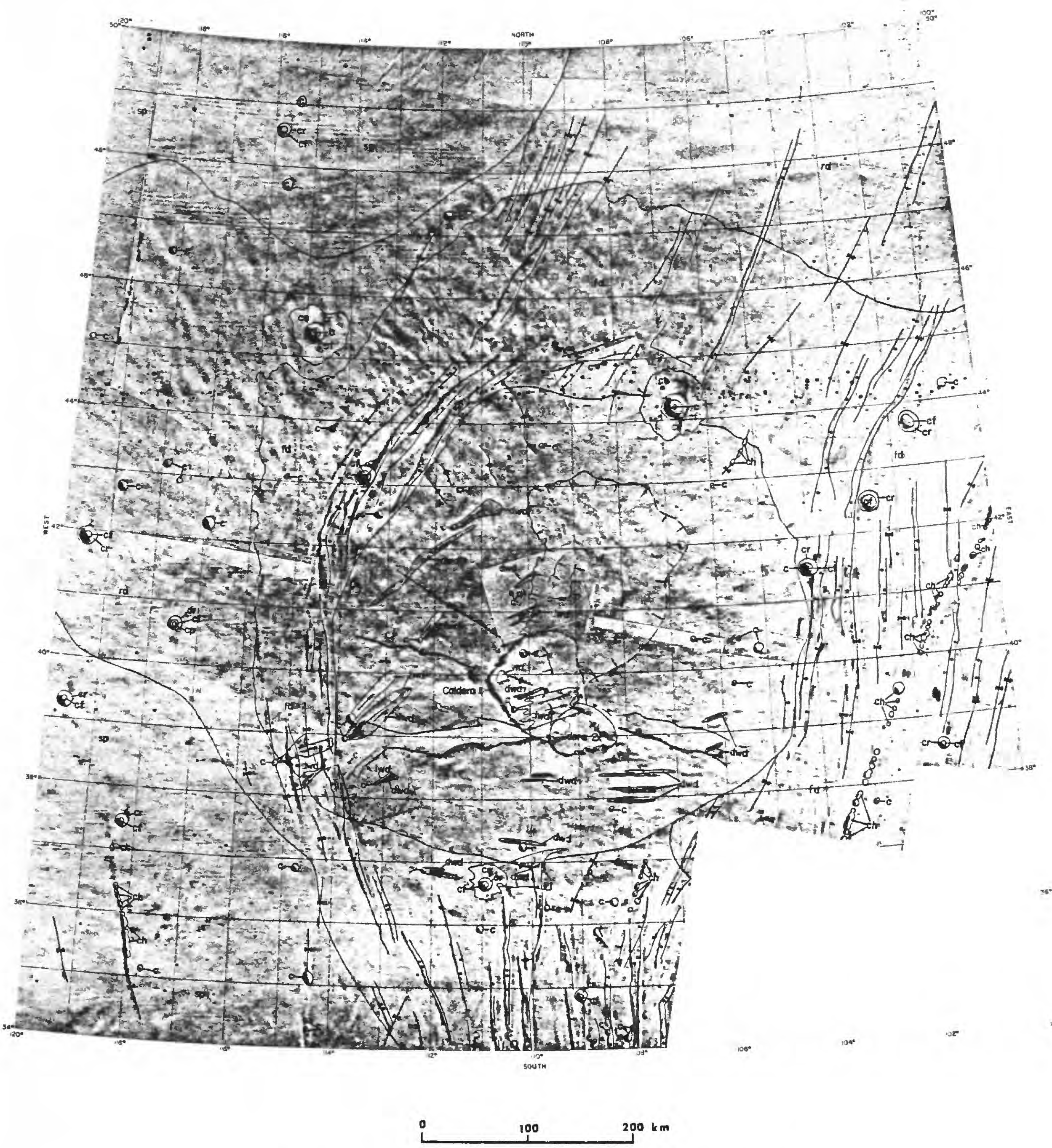
Trough

Ridge

Scarp
Barb ponts downslope

Fault
Ball on downslope

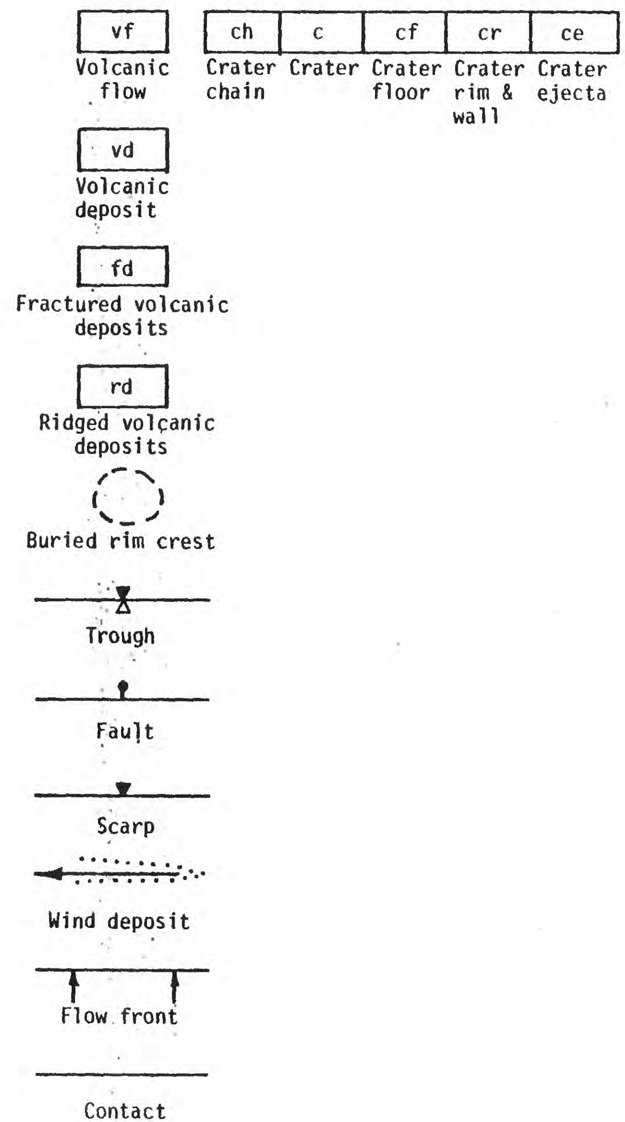
Flow front
Arrow shows flow direction

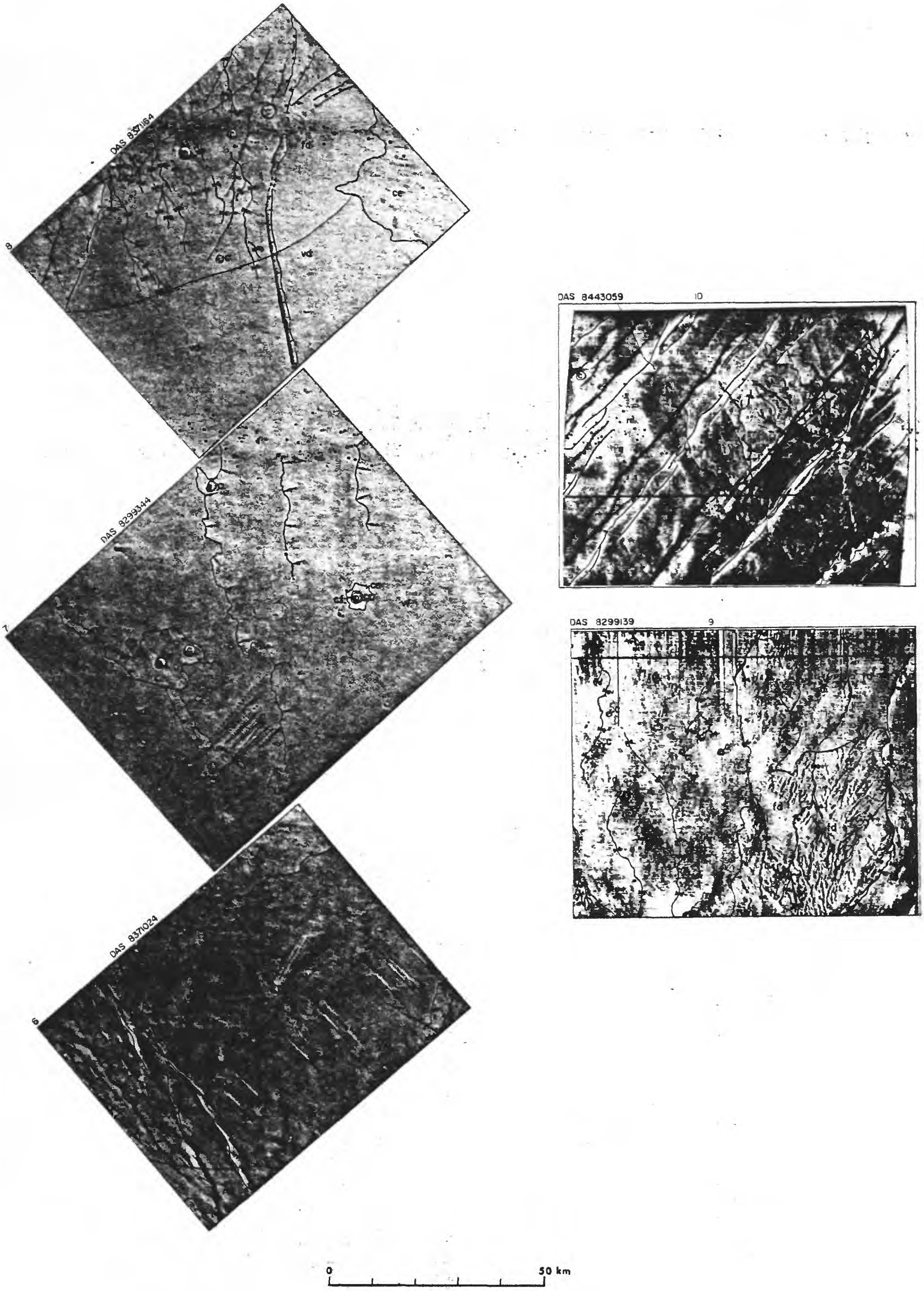


PRELIMINARY GEOLOGIC MAP OF THE ALBA REGION OF MARS
CANDIDATE VIKING MARS 1975 LANDING SITE 17

PRELIMINARY GEOLOGIC MAP OF PART OF THE ALBA REGION OF MARS
CANDIDATE VIKING MARS 1975 LANDING SITE 17
Scale 1:250,000
By
Harold Masursky and Terry Kreidler

Explanation





PRELIMINARY GEOLOGIC MAP OF PART OF THE ALBA REGION OF MARS
CANDIDATE VIKING MARS 1975 LANDING SITE 17

SOME COMMENTS ON VIKING LANDING SITES

By

H. J. Moore

Two problems concerning the proposed prime and backup landing sites are worthy of consideration: (1) the prime northern site (Chryse) and the two southern landing sites (Apollinares and Memnonia) have similar radar properties, and (2) the possibility of water in the equatorial region of Mars has not been sufficiently explored.

In regard to the first problem, it may be unwise to have a prime northern site, a prime southern site, and a backup southern site which have similar radar properties. According to Haystack radar, Chryse has an average relative dielectric constant near 2.2; Memnonia has an average relative dielectric constant near 2.3, and limited data for Apollinares indicates 1.7. Goldstone has no data for Chryse. They indicate low reflectivities consistent with relative dielectric constants of 1.8 for Memnonia and 2.4 for Apollinares (Downs, LSWG Mtg. 4-5 Dec. 1972).

Thus, if Mission A fails in Chryse because it penetrates too far, it seems probable that the same fate will befall Mission B at Memnonia and Apollinares.

The imminent dilemma could be avoided by the selection of an alternate backup site for Mission B. Perhaps the region 13° to 18° S and 351° to 357° W would be a good choice. According to Goldstone radar the region is reasonably smooth at the scale length of the spacecraft ($\theta_r = 3° - 4°$), the radar cross-section is reasonably large, and the elevation is low (Downs, LSWG Mtg. 4-5 Dec. 1972). Haystack radar also finds the area smooth at a scale length of a spacecraft (rms slopes of unit CTf $\approx 2.2° \pm 1.4°$), the relative dielectric constants are large (4.5 ± 1.6 excluding high values larger than about 10), and the elevations are within the acceptable limits (proposed in VDAT report M75-144-0).

The problem may not exist for Mission A if the backup site turns out to be near 252° W, 23.5° N or 256.5° W, 19.9° N where the Haystack radar relative dielectric constants are 3.3 and 3.2 and rms slopes are near 1.3° and 2.7° (see attached memo to A. T. Young dated 29 Dec. 1972).

In regard to the second problem, a north polar Viking Landing Site is being considered because of the possible presence of water there which might increase the probability for occurrence of life there and the possible geologic importance of the laminated terrains. The possibility of the presence of water in the equatorial region has not been fully explored by those recommending a north polar site. Evidence for water in the equatorial region of Mars is by no means conclusive. However, some indicated relative dielectric constants obtained by the Haystack Observatory are in excess of 20 and as large as 49. A list of high relative dielectric constants (>10) from the Haystack Observatory is attached. Some of these numbers are so large that, if they are correct, it could imply the presence of water in the Martian surface materials. Experimentally measured relative dielectric constants for soils with varying moisture contents are plotted as a function of frequency on the attached graph (Fig. 1) where it may be seen that dry soils have relative dielectric constants near 2.5. As the moisture content of the soils increases, so do the relative dielectric constants, and soils with 14 to 20 percent moisture have relative constants of 11 to 22. These values are much larger than common rocks such as granite and basalt. Water, at the top of the graph, is near 78 to 55.

Offsetting these statements, are the Goldstone radar data where reflectivities--if they are interpreted in terms of dielectric constants--rarely, if ever, indicate values larger than 10. Thus, results at this time are conflicting. Nevertheless, the matter should be further explored.

Geologic evidence relating to the large dielectric constants is not particularly conclusive. However, the region near longitude 15° to 350° W, where some high values occur, does have dendritic and sinuous channels (i.e., at 12° S, 4° W, 17° S, 7.5° W; 11° S, 358.5° W). This region is in cratered terrain characterized by relatively extensive flat intercrater areas at A-frame resolution.

Longitude (°W)	Latitude (°S)	Dielectric Constant	RMS Slope	Longitude (°W)	Latitude (°S)	Dielectric Constant	RMS Slope
352.54	14.16	13.65	4.68	321.52	21.76	11.74	5.73
14.43	14.17	13.32	5.73	325.48	21.91	17.14	4.68
349.44	14.31	14.89	4.68	83.41	19.58	23.26	2.86*
356.78	14.31	11.46	4.68	88.76	19.58	16.76	2.86*
352.95	16.82	10.66	3.31*	80.67	19.74	23.26	2.86*
1.01	16.82	23.61	4.05	86.03	19.75	23.37	3.31*
343.87	16.74	14.74	2.86*	87.23	19.75	11.37	2.86*
358.49	16.74	19.97	4.05	79.14	20.72	14.24	2.86*
359.24	16.74	10.57	3.31*	86.44	20.72	18.23	4.05
2.15	16.74	12.68	2.86*	91.18	20.72	10.07	3.31*
5.81	16.74	10.10	2.86*	49.31	20.86	10.83	5.73
9.46	16.74	13.29	4.05	77.24	20.88	14.98	2.86*
334.76	16.49	10.76	2.86*	274.76	17.89	13.96	5.73
335.48	16.49	13.18	3.31*	242.45	17.88	20.76	5.73
349.39	16.49	10.01	3.31*	289.91	16.33	14.87	5.73
0.36	16.49	19.60	3.31*	297.24	16.33	10.20	5.73
1.09	16.49	15.45	3.31*	308.21	16.32	11.82	5.73
4.01	16.49	10.71	2.86*	319.42	16.32	13.60	4.05
315.02	16.41	10.31	4.68	278.33	15.68	10.85	5.73
347.19	16.40	10.15	3.31*	169.98	15.25	12.87	5.73
355.24	16.40	15.79	4.05	200.78	15.15	11.46	5.73
320.15	16.32	15.77	4.05	290.94	13.84	14.28	5.73
320.35	15.86	13.67	5.73	247.70	13.85	10.39	4.68
332.21	13.88	16.73	3.31*	271.59	13.85	13.32	5.73
332.88	13.88	12.92	2.86*	221.18	13.87	13.10	5.73
341.06	13.86	11.56	2.86*	221.90	13.87	13.11	5.73
343.81	13.86	48.89	4.68	225.31	13.87	10.14	4.68
8.37	13.86	10.15	5.73	252.61	13.87	20.56	5.73
324.41	13.84	15.74	2.03*	272.37	13.88	12.54	5.73
331.24	13.84	23.61	4.05	223.04	18.16	14.70	5.73
348.30	13.84	12.41	2.86*	190.97	18.31	13.49	4.68
351.75	13.84	11.18	2.86*	200.69	18.32	17.10	5.73
339.36	15.56	20.77	5.73	235.32	18.33	10.61	5.73
4.19	15.57	14.45	3.31*	189.16	18.48	11.69	4.68
5.06	15.57	10.07	2.86*	218.38	18.49	14.84	5.73
12.49	15.57	12.67	4.05	169.67	19.62	17.58	5.73
0.80	20.68	30.50	4.68	223.03	22.87	11.39	5.73

TABLE 1. HIGH DIELECTRIC CONSTANT AND RMS SLOPE VALUES FROM HAYSTACK RADAR DATA.

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

Astrogeologic Studies
345 Middlefield Road
Menlo Park, California 94025

December 29, 1972

Mr. Thomas Young
Mail Stop 159
Langley Research Center
Langley, Virginia 23365

Dear Tom:

Re your memo of December 26, 1972 concerning backup "A" sites, 11a (20° N, 253° W) and 11b (20° N, 237° W).

This is, indeed, a first -- a Christmas present. An area has finally been picked which has larged averaged dielectric constants and small rms slopes which are 3.89 (ε) and 3.32° (rms slopes). This is in contrast with Chryse (ε = 2.18, rms = 5.91°), Apollinares (ε = 1.7, rms = 5.6°), and Memnonia (ε = 1.9, rms = 2.3°).

Between 11a and 11b, the Haystack numbers for 11a look best (ε = 3.26, rms = 2.02°). 11b numbers are very variable.

It should be kept in mind that large values of ε (> 3.5) might represent "rocky" areas that would give the Surface Sampler problems.

Long. (°W)	Lat. (°N)	Dielectric Conatant	RMS Slope
232.82	22.96	1.52	0.81°
235.01	19.85	5.57	4.03°
238.43	22.97	1.82	0.81°
240.38	19.85	3.63	4.03°
244.04	22.97	5.60	4.03°
245.75	19.86	-	8.06°
246.10	23.47	4.61	2.69°
251.11	19.86	4.46	4.03°
251.95	23.47	3.32	1.34°
256.48	19.86	3.20	2.69°
257.80	23.47	5.19	4.03°

"Best" values are 3.32 and 1.34° at 251.95° W, 23.47° N, and 3.20 and 2.69° at 256.48° W, 19.86° N.

Sincerely,

Henry J. Moore

P.S. Did you write your memo on the 25th of December? I hope not.

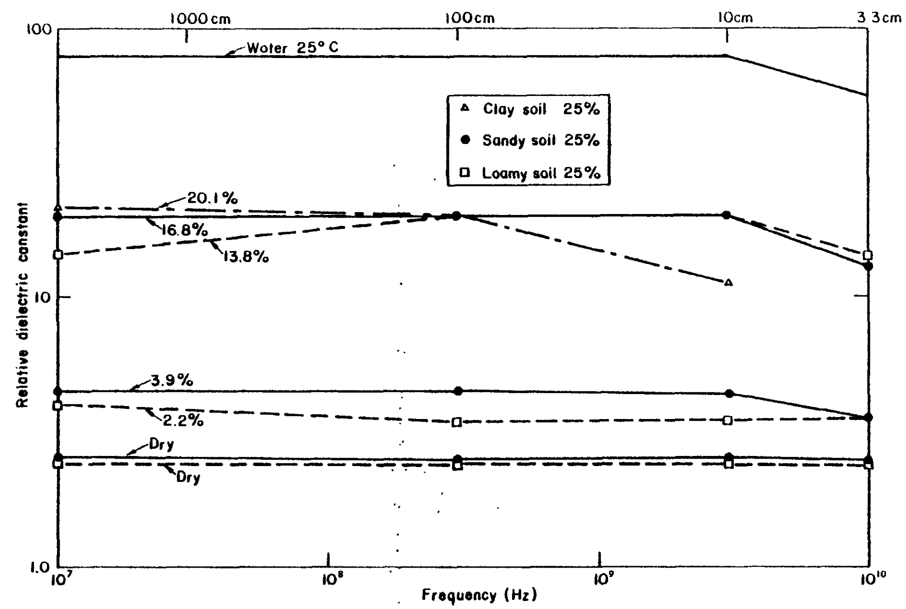


Figure 1. Relative Dielectric constant values for soils with varying moisture contents