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FINAL TECHNICAL REPORT

PHOTOGEOLOGIC MAPPING OF MERIDIANI SINUS REGION FROM MARINER 6 AND 7 IMAGERY

Rene' A. DeHon

*Northwestern State University
Natchitoches, La. 71457

*Present address: University of Arkansas at Monticello
Monticello, Arkansas 71655

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Region from Mariner 6 and 7 Imagery

ABSTRACT

Photogeologic mapping of Mariner photographs characterizes major stratigraphic units of the Martian equatorial region. The low resolution photomosaic ship across Meridiani Sinus-Deucalionus Regio is divided into regional map units based on albedo and crater density. High resolution frames reveal map units defined by varying surface texture, crater densities, and degree of crater sharpness. Mariner photographs provide clear evidence of eolian action and channelization by fluid flow.

INTRODUCTION

This report contains the results of geologic mapping of Martian surface within the limits imposed by Mariner 6 and 7 imagery. The same techniques used in mapping the lunar surface are applied to the interpretation of Mariner photographs (Hackman, 1960; Carr, 1970; and Wilhelms and McCauley, 1971). For the purpose of this study, test areas were limited to the equatorial region of the planet. The primary objectives are:

1. To distinquish surface patterns of material distribution
2. To establish a local framework of time sequences in depositional history

3. To recognize processes operating on the surface. The study was performed using unrectified JPL/IPL versions of the imagery and a composited shaded map of the Meridiana Sinus region by Cross (1971).

Geologic mapping was carried out at three scales within the Meridiani Sinus region. Three high resolution frames (6N18, 6N20, and 6N22) were selected for their clarity of detail and near vertical nature. One frame of low resolution (6N21) was selected as an intermediate between mapping on high resolution photographs and regional mapping. The albedo map of Meridiani Sinus (Cross, 1971) was choosen as the best available regional base combining albedo variations of the far encounter phase with surface detail of the near encounter mission.

LARGE SCALE MAPPING

The results of mapping on high resolution photographs is shown in figures 1, 2, 3, and 4. In general, the surface is divisible into recognizable mapping units displaying a diversity of surface textures, albedo variations, and overlapping or transecting relationships. Due to resolutions lower than those available for lunar mapping, contacts are observed as gradational boundaries and age relationships are, in part, obscure.

Craters are grouped into four morphological classes based on degree of rim crest sharpness and apparent relative depth in the manner of Pohn and Offield (1970) for lunar craters. Superposition of crater materials indicates that the morphological classification is, in part, age related also. Subdivision of crater materials is also possible. The only significant difference from lunar craters was the occurrence of a more extensively developed interior apron at the base of the crater walls (fig. 3). This material is probably talus or colluvium worn from the crater walls by more active surface processes of degradation.

In general, regional units of plains and featureless plains-forming materials appear to be the youngest deposits occurring in topographic lows. The occurrence of sinuous ridges similar to lunar "wrinkle ridges" and low lobate scarps (fig. 2) in some plains material suggests emplacement by flow similar to lunar mare materials. Other plains may be either eolian or volcanic in origin. Lineate plateau material is bracketed in a stratigraphic sense by its superposition on c_1 craters and it is in turn overlain by c_3 crater materials. Relative ages of hummocky and subdued hummocky materials are less distinquishable and uncertain. Embayment by featureless plains and lineate plateau materials in figure 3 indicates that hummocky and subdued hummocky materials are older. The relationships on other photographs are ambiguous.

SMALL SCALE MAPPING

Small scale mapping of frame 6N21 is shown in figures 5 and 6. Mariner 6N22 is included in the central right hand portion of this frame.

A major feature of this map is the contact between textured plateau material and plains materials. The units are texturally distinct as well as differing in albedo. The albedo boundary corresponds to the Sabaeus Sinus--Deucalionis Regio boundary. However, crater frequency counts of the two units do not reveal any marked difference. The plains materials might be similar to the textured plateau material with a thin overlay of surfacing deposits which is sufficient to brighten the area and mantle low surface irregularities without greatly affecting larger surface irregularities. Also prominent in this region are faint sinuous channels which in overall appearance are similar to gullied terrain in arid regions.

REGIONAL MAPPING

Figures 7 and 8 are based on Cross's durface map (1971). Surface resolution varies greatly across the map area, hense, the amount of detail mapped varies accordingly. Sources for mapping information include individual low resolution frames and photomosaics of frames in the region (6N9-25, 7N1-9)

Regional map units at this scale are albedo; therefore, they are biased by the overall albedo pattern of the region. Such bias may show little more than transitional surface mantle materials rather than bedrock differences. Rugged material, dark cratered terrain, and light colored terrain have similar crater frequencies and may reflect the extent of deposition or nondeposition of eolian materials. Dark smooth terrain materials, however, exhibit low crater densities and are probably younger basin filling materials of volcanic origin.

The albedo pattern of dark material of Margaritifer Sinus -- Oxia Palus forms an incomplete half circle suggestive of a large filled basin. Radar elevations across Margaritifer Sinus and Deucalionis Regio exhibit a scarp that coincides with the light-dark boundary facing eastward toward light materials of Deucalionis Regio. East of the scarp the elevations rise to the point that the interior is as high as the rim. One possible interpretation of the pattern is that the area represents a large mare-like basin modified by later infilling and constructional deposition in the interior. To the southeast and east, the basin is filled to the point of obliteration.

Materials mapped as surficial materials occur as bright patches on crater rims, crater floors, and dune field-like deposits. These materials are probably eolian in origin , and seem to indicate a dominant wind from the north.

Of special significance are the broad sinuous areas mapped as valley and canyon materials. Photographic coverage of this area is several orders of magnitude too low to delineate precisely the distribution and gradient of these features. However, their presence reveals a significant addition to the possible surface processes operating on the planet. The Sinuous and branching patterns seen at this scale are suggestive of fluid water erosion.

CONCLUSIONS

Mariner 6 and 7 resolutions provide distinct limitations on mapping; however, this exercise does confirm that geologic mapping is possible. This brief study indicates that diverse processes are operating on the surface of mars.

In terms of planet history, the mapping reveals an older period of crater formation similar to the early history of the lunar surface. Unlike the moon, however, martian surface modifing processes have continued to operate. These processes include: volcanism, eolian processes, and possibly the action of permafrost and liquid water.

RETROSPECT

Mariner 9 photography has greatly improved resolution of surface features. Units defined on the high resolution

Mariner 6 and 7 images are generally transferable to later coverage. Regional patterns are not recognized in the later coverage and probably reflect the distribution of thin surface mantles. Physiographic maps of Mars do not show evidence of the supposed basinal character of the region mapped in figure 7. The valley and canyon units of the western portion of the regional map do coincide with the location of the eastern terminus of the canyon system and were the first indications of this prominent feature.

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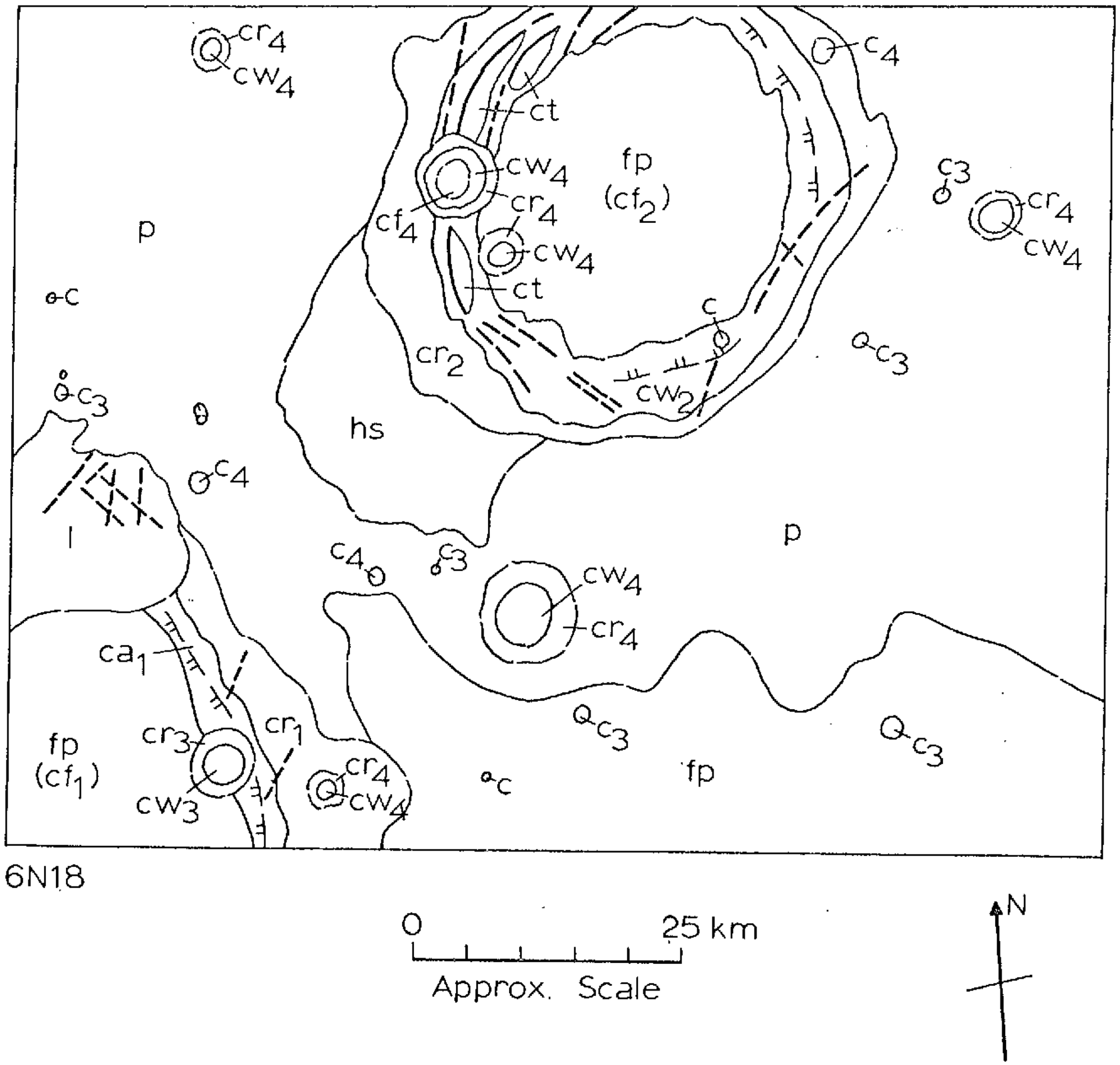
Wilhelms, D. E. and McCauley, J. F., 1971, Geologic Map of the near side of the moon: U. S. Geol. Survey Misc. Geol. Inv. Map I-703.

ILLUSTRATIONS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c3
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c4
l
c4
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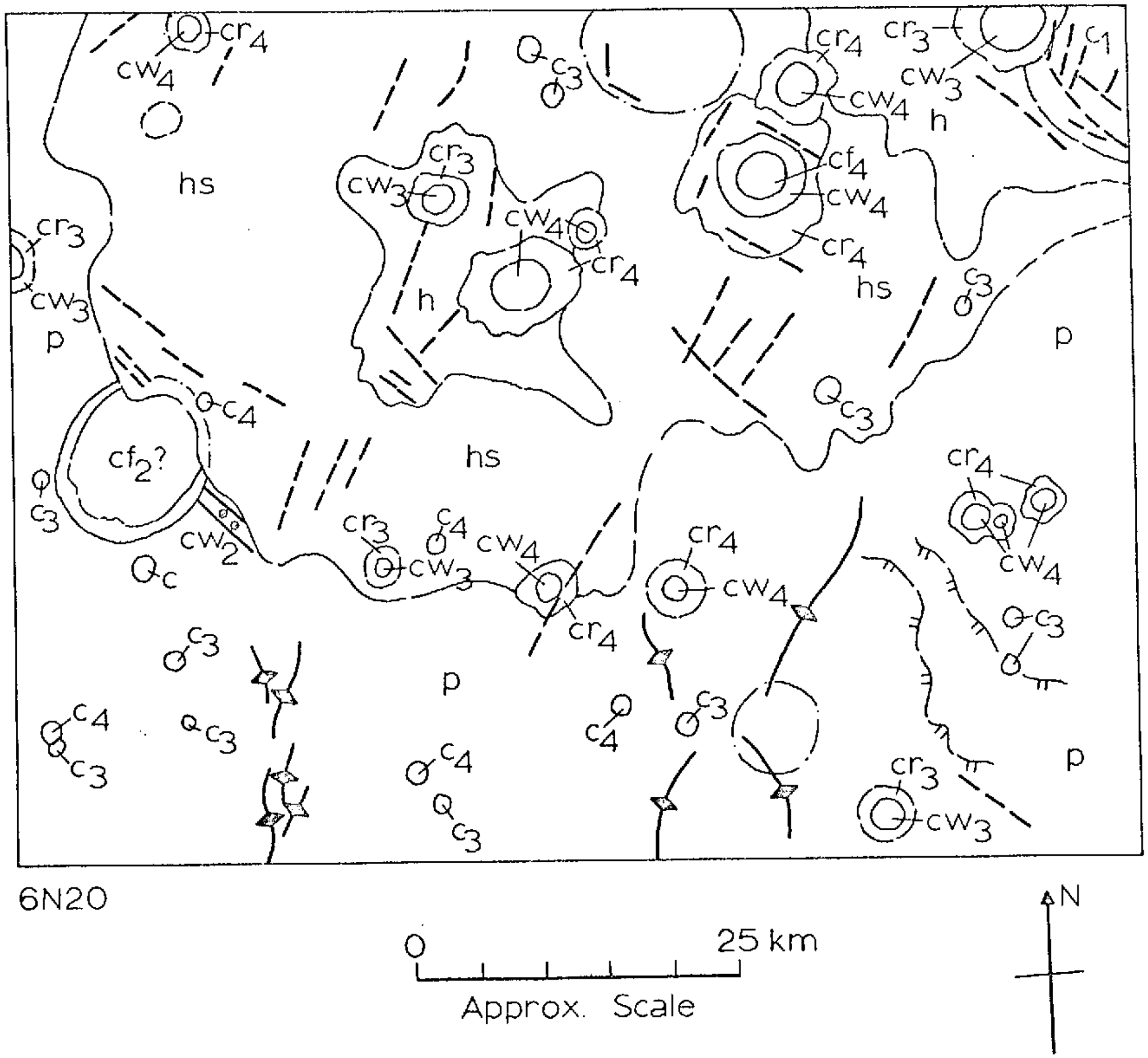
p
cw4
cr4
ca1
fp
(cf1)
cr3
cw3
cr1
cr4
cw4
c3
c
fp
c3
6N18
0
25 km
Approx. Scale
N

DeHon Fig. 1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hs
cr3
cw3
p
h
c3
p
c4
c3
cf2?
hs
c3
cw2
cr3
c4
cw4
cr4
cr4
cw4
Qc
cw3
cr4
cw4
c3
c3
c3
p
c4
c3
c4
c3
c4
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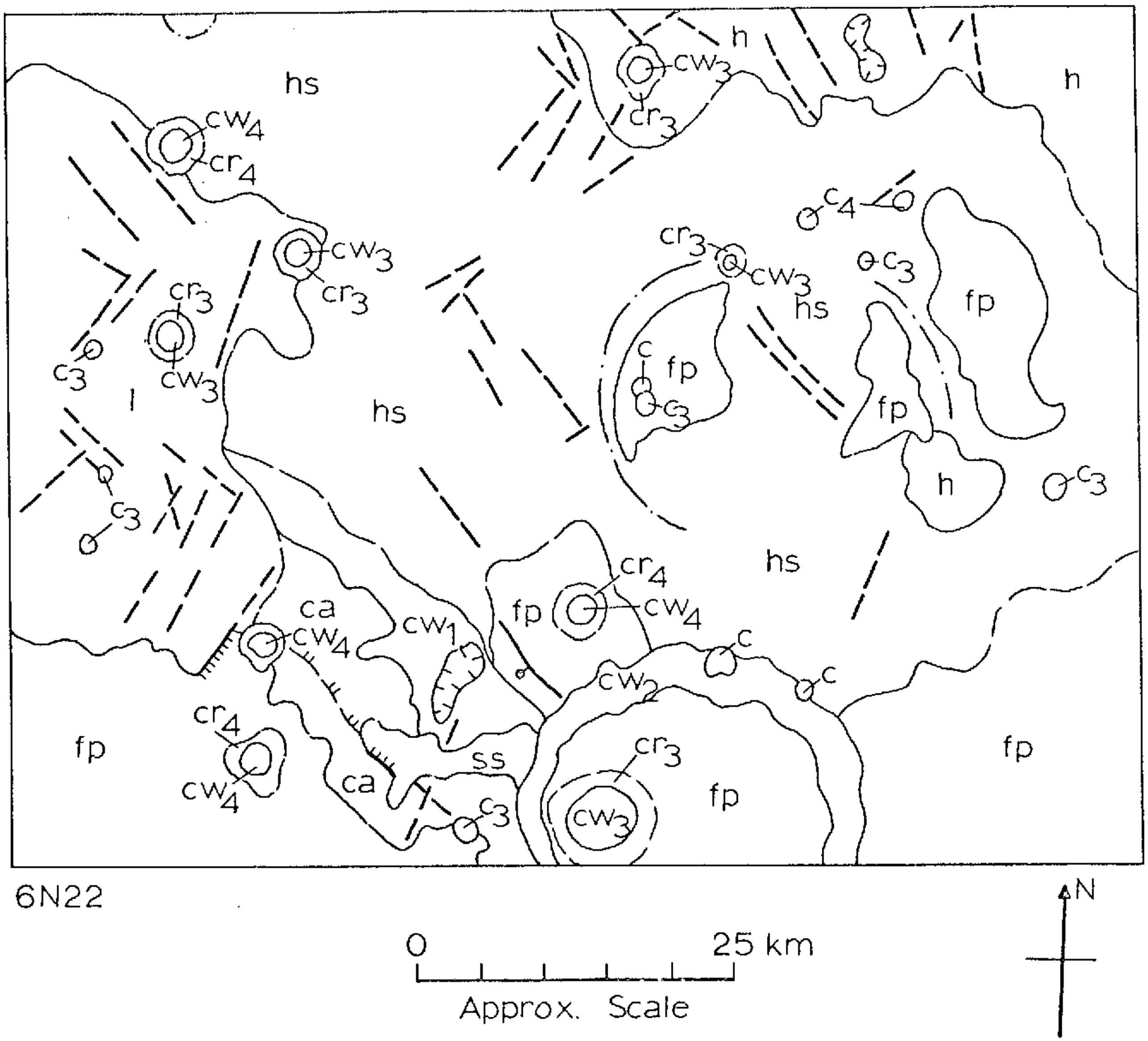
p
cr3
cw3
6N20
0
25 km
Approx. Scale
N

DeHon Fig. 2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h
cw3
cr3
cw4
cr4
c4
c3
c
fp
l
ca
cw1
cw2
ss
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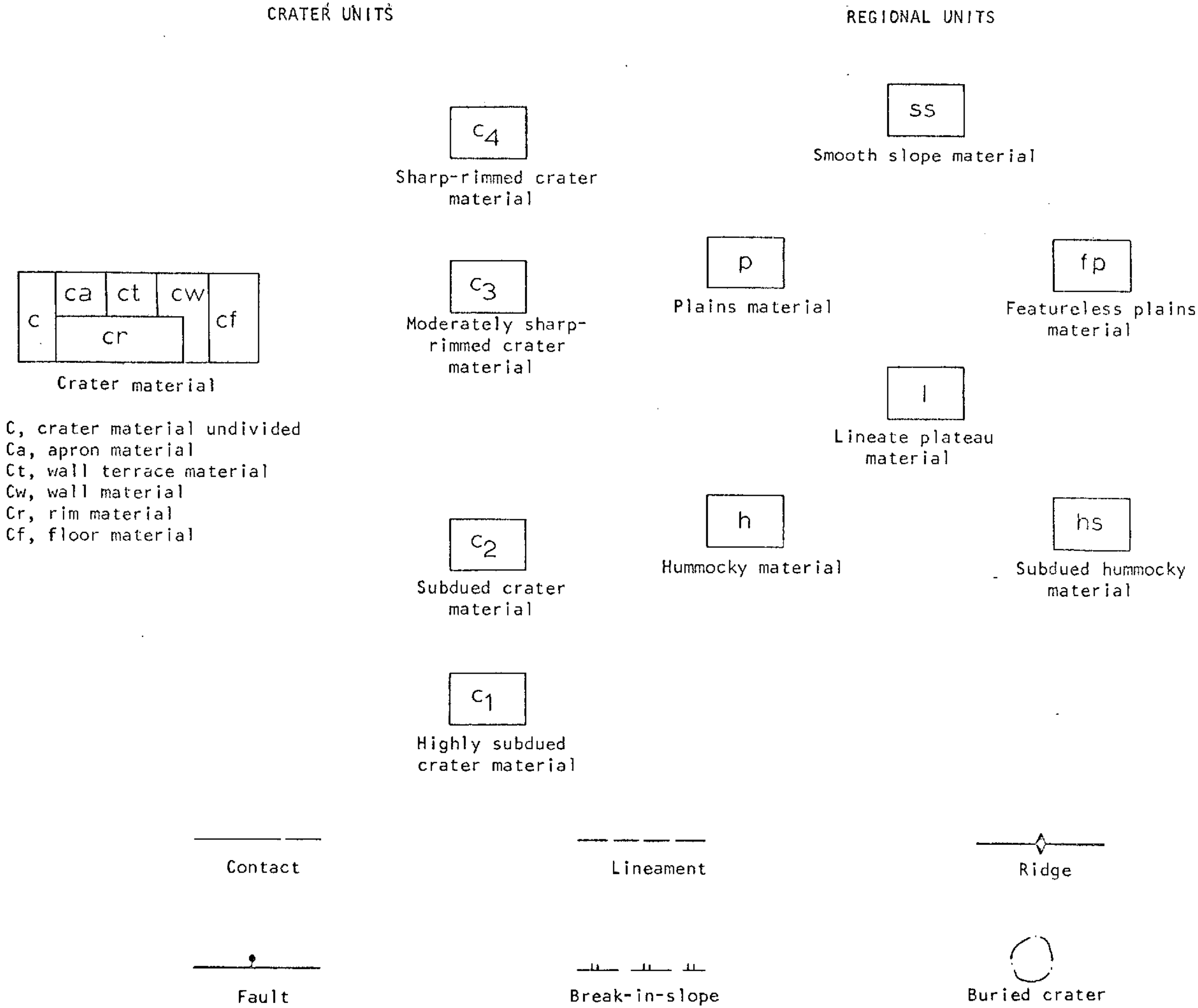
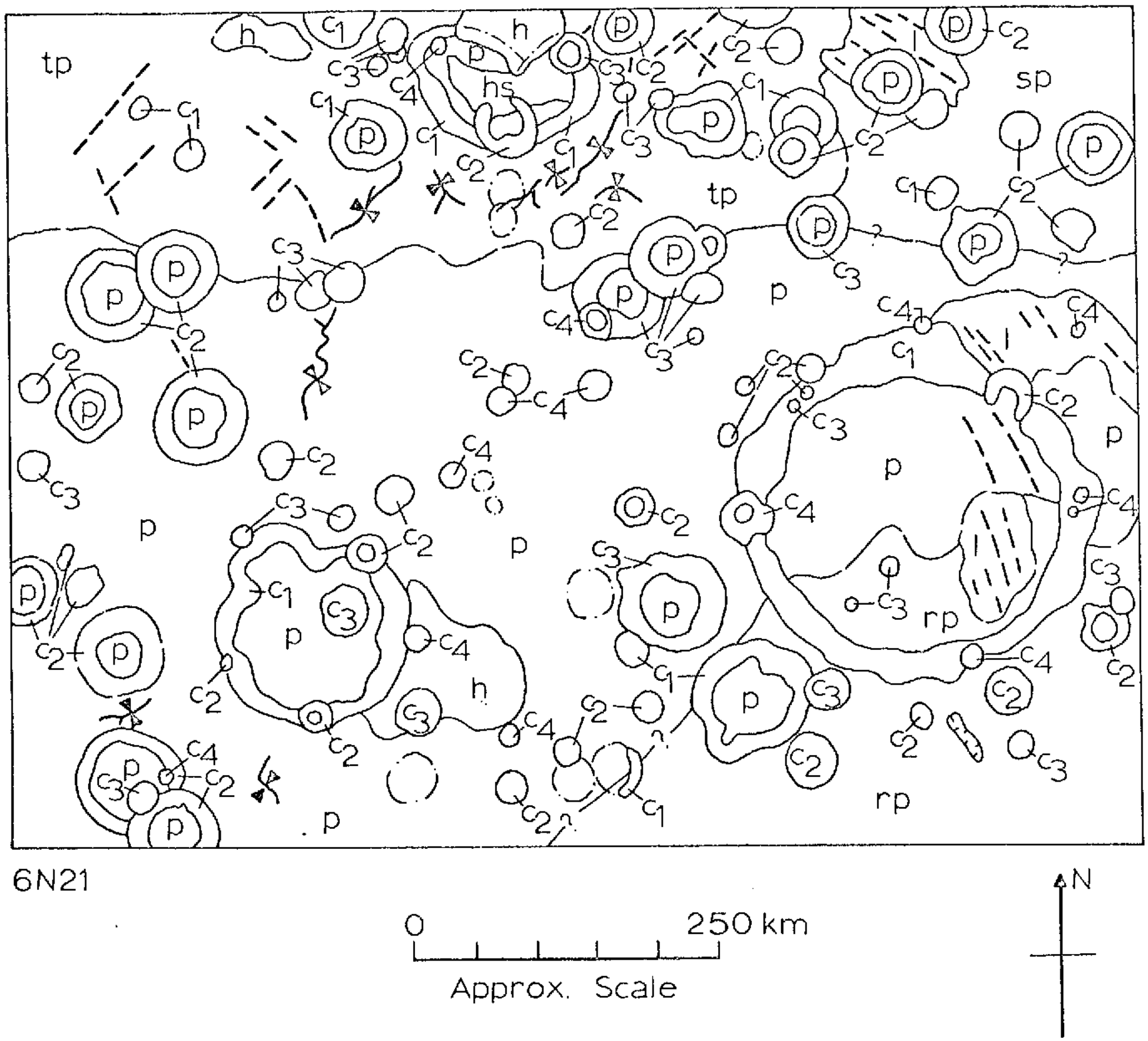
0
25 km
Approx. Scale
N

DeHon Fig. 3


CRATER UNITS
REGIONAL UNITS
c4
Sharp-rimmed crater material
ss
Smooth slope material
ca
ct
cw
c
cr
cf
Crater material
C, crater material undivided
Ca, apron material
Ct, wall terrace material
Cw, wall material
Cr, rim material
Cf, floor material
c3
Moderately sharp-rimmed crater material
p
Plains material
fp
Featureless plains material
l
Lineate plateau material
c2
Subdued crater material
h
Hummocky material
hs
Subdued hummocky material
c1
Highly subdued crater material
Contact
Lineament
Ridge
Fault
Break-in-slope
Buried crater

DeHon Fig. 4



DeHon Fig. 5

EXPLANATION

CRATER UNITS

c_4
Sharp-rimmed crater material

c_3
Moderately sharp-rimmed crater material

c_2
Subdued crater material

c_1
Highly subdued crater material

REGIONAL UNITS

p
Plains material

sp
Smooth plateau material

l
Lineate plateau material

h
Hilly plateau material

tp
Textured plateau material

rp
Rolling plains material

Contact

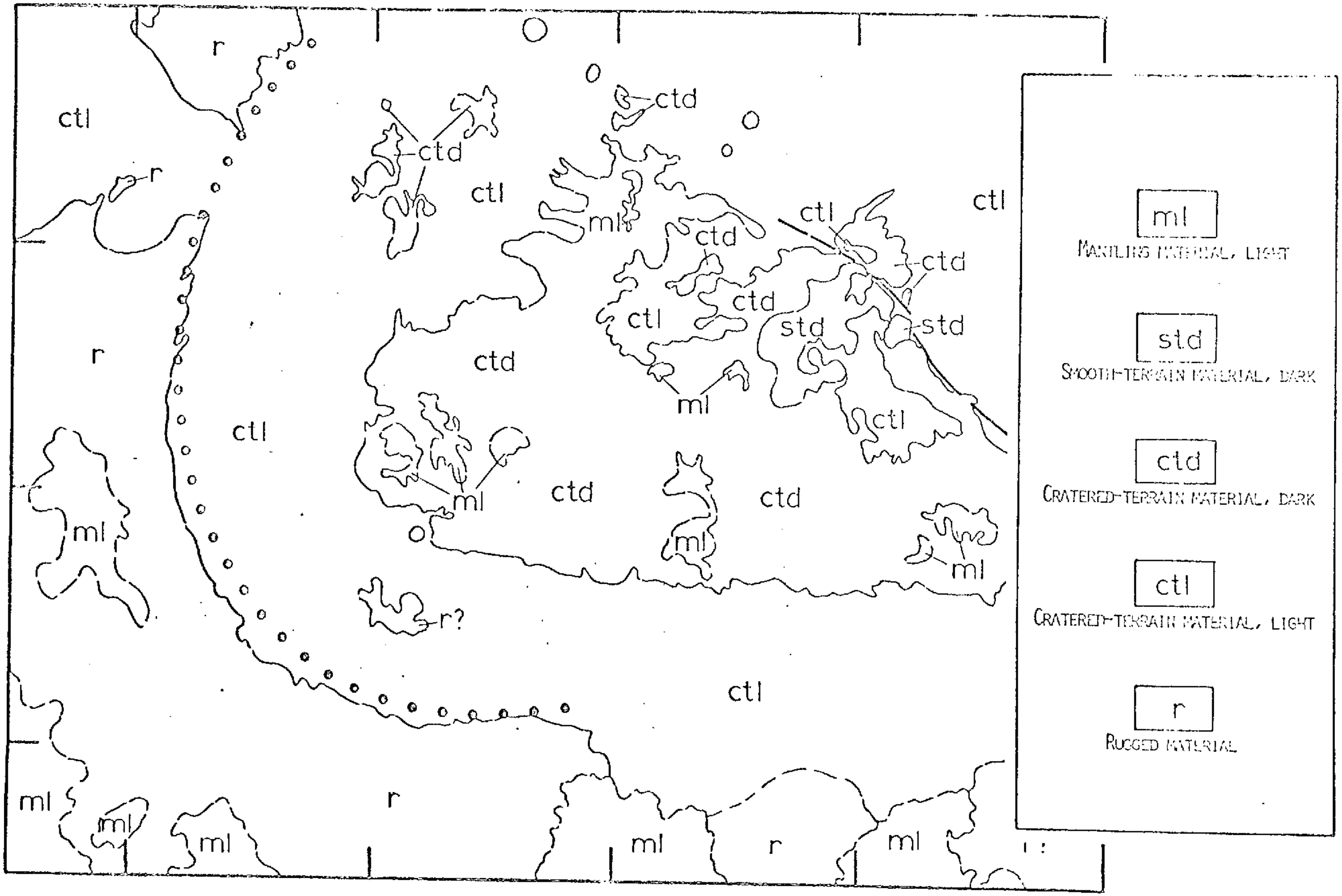
Lineament

Trough

Buried crater

15

DeHon Fig. 6


ml
MANTLING MATERIAL, LIGHT
std
SMOOTH-TERRAIN MATERIAL, DARK
ctd
CRATERED-TERRAIN MATERIAL, DARK
ctl
CRATERED-TERRAIN MATERIAL, LIGHT
r
RUGGED MATERIAL
ctl
r
ctd
ctl
ml
ctd
ctl
ctd
ctd
ctl
std
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DeHon Fig. 7

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