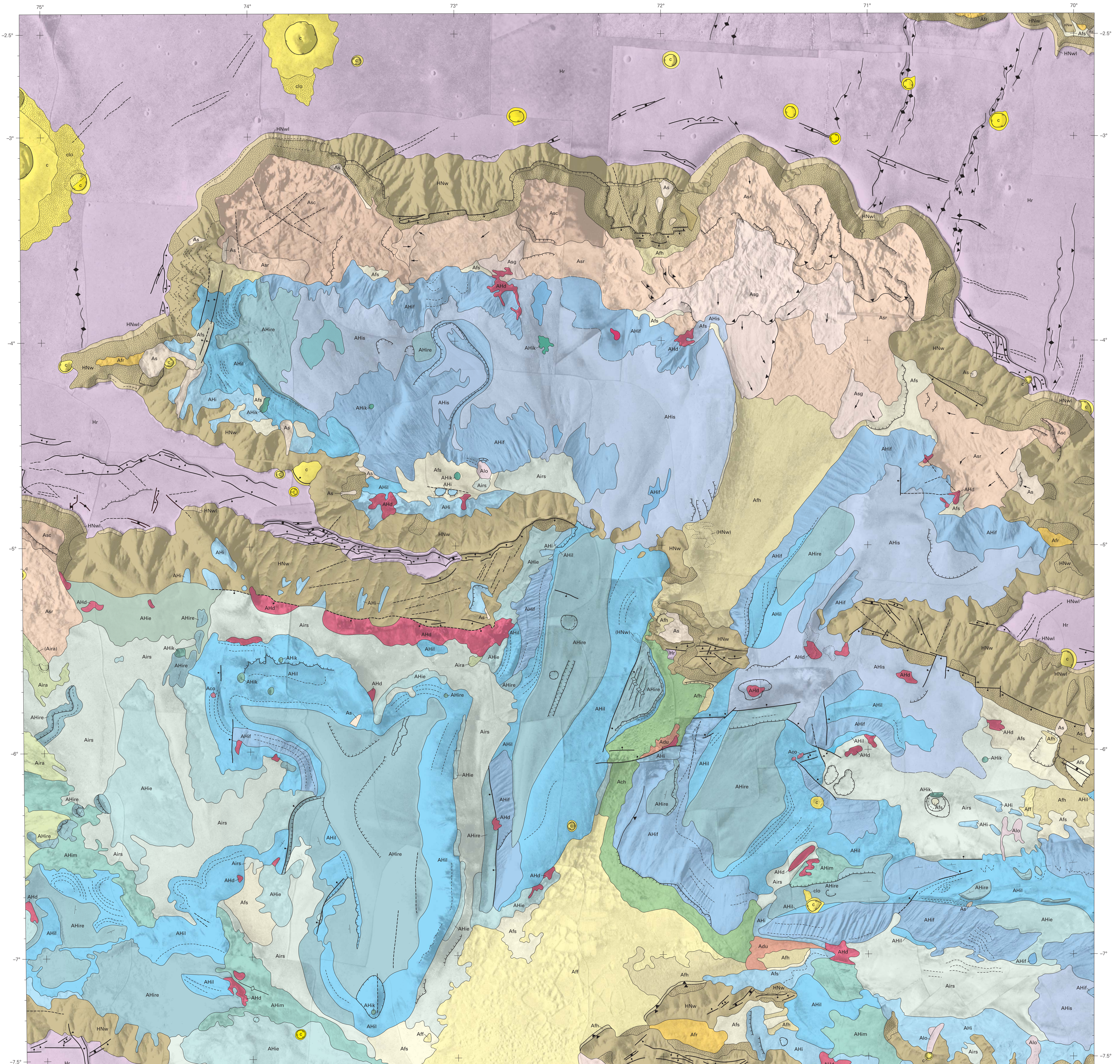


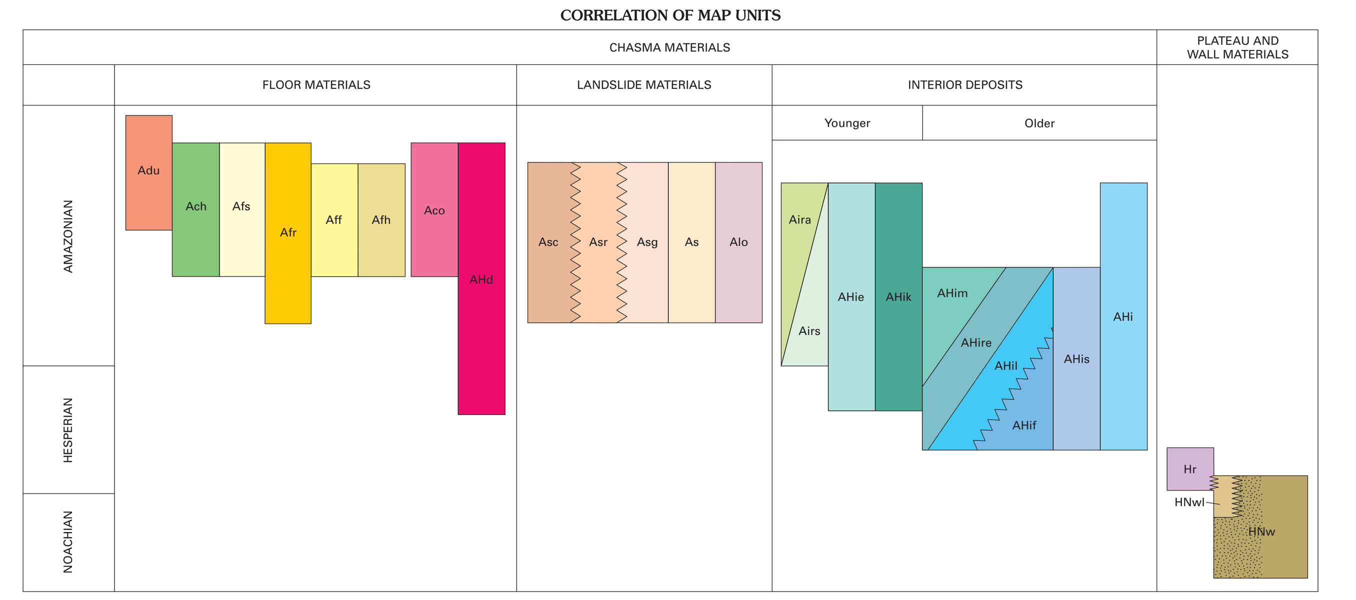
INTERIOR—GEOLOGICAL SURVEY, RESTON, VA—1999

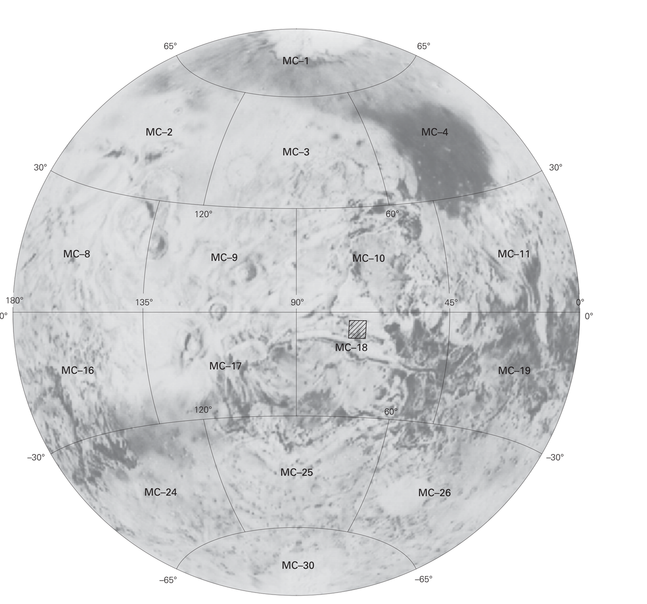
Prepared on behalf of the Planetary Geology Program, Solar System Exploration Division, Office of Space Science, National Aeronautics and Space Administration

Edited by Derrick D. Hirsch; cartography by Michael E. Dingwell

Manuscript approved for publication March 8, 1996

CORRELATION OF MAP UNITS





QUADRANGLE LOCATION

Photomosaic location is shown in the western hemisphere of Mars. An outline of 1:5,000,000-scale quadrangles is provided for reference.

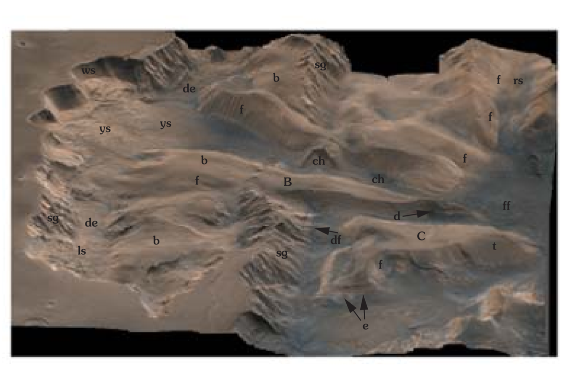


Figure 1. Ophir (left) and central Candor (right) Chasmata viewed from west. Image about 200 km wide. Trough walls and ridge separating Ophir from Candor Chasmata display wall rock with spur-and-gully morphology (sg) and are overlapped by interior deposits, displaying fluted morphology (f). Northern part of Ophir Chasma forms depression (de) into which landslides (ls) fell. Youngest landslides (ys) give rise to channel (ch). Note smooth wall rock at head of scars (ws). Southern part of Ophir Chasma forms bench (b) underlain by older interior deposits, as are mesas of Candor (C) and Baetis (B) Mensae. Mesa caprock is tilted at t. Younger interior deposits lap up onto mesa (unevenly edged material at e) and fill low areas (rolling and smooth interior deposits at rs). Dark outcrops represent necks or vents of mafic vocanic rock at d and band of dark material along fault scarp at df. Other windblown dark material thinly mantles floor, particularly fractured floor at ff. Mosaic of Viking Orbiter images of orbit 912 to 917 combined with topography by Wu (unpublished map, scale 1:500,000) (Bertolini and McEwen, 1990). Vertical exaggeration 2×.

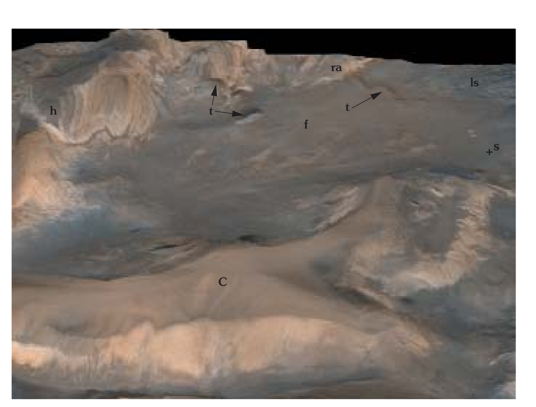


Figure 2. West Candor Chasma viewed from east. Image about 100 km wide. Candor Mensa (C), in foreground, underlain by older interior deposits. Hogbacks at h (lat 6.9° S., long 74.7°) show that older interior deposits are deformed in places and locally include dark layers. Tilted beds (t) form erosional remnants on trough floor (f). Young interior raked material (ra) unconformably overlaps floor and tilted beds. Landslide at ls. Potential landing site (fig. 3) at s. Excerpt of mosaic Viking Orbiter images of orbit 912 to 917 combined with topography by Wu (unpublished map, scale 1:500,000) (Betolini and McEwen, 1990). Vertical Exaggeration 2×.

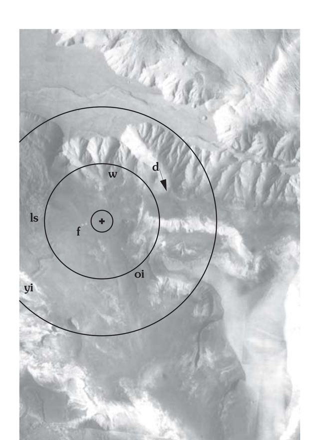


Figure 3. Candor landing site 1 (lat 5.5° S., long 74.5°). Circles represent 5-km, 25-km, and 50-km radius from proposed landing site. 50-km radius permits access to floor material (f), ancient wall rock (w) in north, possibly young dark material (d) in northeast, older interior deposits (oi) in east, younger interior deposits (yi) in west, and landslide material (ls) in northwest. This suite of rocks covers wide span of martian ages and materials.

Figure 4. Candor landing site 2 (lat 5.7° S., long 71.9°). Circles represent 5-km, 25-km, and 50-km radius from landing site. 50-km radius permits access to ancient wall rock (w) in north, older interior deposits (i) in west and east, and wind-blown, dark mafic material (d), perhaps derived from local vents, in south. In addition, landing site is located in channel (ch) and may provide answers concerning channeling processes and volatile history of Mars.

GEOLOGIC MAP OF OPHIR AND CENTRAL CANDOR CHASMATA (MTM –05072) OF MARS

By
Baerbel K. Lucchitta
1999

DESCRIPTION OF MAP UNITS

CHASMA MATERIALS

FLOOR MATERIALS

LANDSLIDE MATERIALS

INTERIOR DEPOSITS

Younger Interior Deposits

Older Interior Deposits

PLATEAU AND WALL MATERIALS

Lineation

Depression

Crater rim—Showing crest

Buried crater rim—Showing crest

Crater materials—Includes floor, rim, and eject blanket of impact craters of all ages. Lower size limit is 2 km for rim-crest diameter

Outer ejecta lobe on some impact craters

INTRODUCTION

The geologic map of Ophir and Central Candor Chasmata is one of a series of 1:500,000 scale maps prepared for areas on Mars that are of particular scientific interest and may serve as potential future landing sites. This map is also part of a set that includes east Candor Chasma, west Candor Chasma, and Melas Chasma. The geologic interpretations are based dominantly on medium- and high-resolution Viking images, many of them stereoscopic, and supplemented by lower resolution apoapsis and other color images. A strip of very high resolution stereoscopic images (~20 m/pixel) crosses the central part of the quadrangle from northwest to southeast and served to clarify detailed relations not obvious on other images. A topographic map with contour intervals of 200 m was also used, as were multidirectional oblique images derived from merged image mosaics and topography (fig. 1) (Bertolini and McEwen, 1990). Geologic relations and interpretations are based on the entire central Valles Marineris map set. The map area is included in the Valles Marineris map of Witbeck and others (1991), but units were defined independently. Age assignments, however, were integrated with those by Witbeck and others and Scott and Tanaka (1986).

PHYSIOGRAPHY

The Valles Marineris system includes a series of troughs just south of the martian equator that trends N. 70° W. for a distance of about 3,000 km, from about longitude 45° to 95°. The troughs are paralleled by many shallow grabens; the entire system appears to be radial to central Tharsis (Carr, 1974; Blasius and others, 1977). Individual troughs are generally 50–200 km wide, but in the central part they merge to form a low region 600 km wide. This map covers most of Ophir and central Candor Chasmata, located in the northern half of this low region. As figure 1 shows, Ophir Chasma is divided into a narrow northern depression and a southern, higher bench. Central Candor Chasma is dominated by two mesas (Candor and Baetis Mensae) rising 6 km above the valley floor. A narrow, northerly trending valley connects Ophir and central Candor Chasmata.

The Lunae Planum Plateau, into which Ophir and Candor Chasmata are entrenched, is at an elevation of 8 to 10 km above Mars datum. The interior mesas locally reach levels only 500 m below the plateau rim (Lucchitta and others, 1994). Trough-floor elevations in the map area range from 2 km, where partly filled by landslide material, to –1 km where near the apparent structural floor. Thus, original trough depths may have been as much as 10 km.

STRATIGRAPHY

INTRODUCTION

Units in the map area are divided into four major groups: (1) materials forming the trough walls and the surrounding plateaus, (2) materials forming the benches and mesas and some trough floors, (3) landslide materials, and (4) trough-floor materials composed of relatively thin surficial deposits. The sequence of emplacement of units has been established with reasonable confidence by superposition and cross-cutting relations, but the composition of units remains conjectural.

PLATEAU AND WALL MATERIALS

INTERIOR DEPOSITS

Older Interior Deposits

naka and Golombek, 1989).

Smooth material (unit AHis) forms the surface unit exposed over most of southern Ophir Chasma and also underlies broad expanses of mesa surfaces elsewhere. It may include fluted, layered, and resistant material and is mapped where these units could not be distinguished because of the lack of steep slopes having good exposure. The undivided unit (unit AHi) was mapped where exposures are too small or indistinct to be assigned more definitely. In places this unit may be younger interior deposits.

Spectral data from color images (Geissler and others, 1990) show that the older interior deposits are relatively red and among the brightest materials in the troughs and that the spectral signature of these units is within the range of those of wall rock. These observations suggest either that both units are mantled by similar reddish atmospheric fallout or that at least some of the layered deposits are composed of reworked wall material.

Thermal inertia measurements of older interior deposits (Skinner and Zimbelman, 1986; Zimbelman and others, 1987) indicate that the mesa surfaces are fine-grained or mantled by fine-grained atmospheric fallout; the thermal inertia values on mesa slopes are similar to those on wall rock, supporting the color observations that suggest similar compositions.

At least five hypotheses have been proposed for the origin of the older interior deposits (Lucchitta and others, 1992): The deposits may be (1) erosional remnants of the same material that makes up the canyon walls, (2) eolian deposits, (3) mass-wasted material, (4) lacustrine material, or (5) volcanic material.

The hypothesis that the deposits are erosional remnants of the canyon-wall material (Malin, 1976) is weakened because of superposition relations, the lack of similar layering in the canyon walls, and the different erosional styles of the two materials (Peterson, 1981; Nedell and others, 1987). The hypothesis of a purely eolian origin (Peterson, 1981) is flawed because some of the deposits are much too regularly bedded and too diverse in albedo, competence, and erosional characteristics to be formed by this mechanism alone. However, trapping of eolian materials on ice-covered lakes and foundering of the ice cover (Nedell and others, 1987) may have occurred.

An origin only by mass wasting from wall rock (Sharp, 1973) is also unlikely because the deposits are more diverse in albedo and competence than wall rock, which appears to be fairly uniform in composition. However, mass wasting probably provided some of the material for the deposits (Lucchitta and others, 1994).

The lacustrine hypothesis readily explains the horizontal bedding and lateral continuity of individual layers, and at the time of canyon formation, substantial subsurface aquifers may have provided large quantities of water (Sharp, 1973; Carr, 1979). However, the likelihood of purely lacustrine deposits is diminished because no channels are seen to empty into the troughs, channels that may have carried the large amount of sediments needed to form the thick layered deposits.

Also not to be ruled out is a volcanic origin of the older interior deposits (Peterson, 1981; Lucchitta, 1990; Witbeck and others, 1991). Compatible with such an origin are the diversity of layers, the low albedo and high competence of some layers (suggesting basalts), and the fluting on light-colored deposits that is similar to fluting on tuffs in terrestrial desert regions. For tuffs, an ash-flow origin appears more likely than an origin by airfall because the layered deposits are restricted to the inside of the troughs. The main evidence against a volcanic origin is the apparent regularity and continuity of the deposits and the lack of obvious vent edifices or calderas (Nedell and others, 1987). However, the continuity and horizontality of the layers could have come from subaqueous volcanic eruptions.

Younger Interior Deposits

These deposits overlie eroded wall rock, older interior deposits, and, locally, landslides, attesting to the presence of a second major unconformity in the troughs (Lucchitta, 1990). The deposits were emplaced after the

LANDSLIDE MATERIALS

FLOOR MATERIALS

STRUCTURE

GEOLOGIC HISTORY

A CANDIDATE LANDING SITE

REFERENCES