DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

PREPARED IN COOPERATION WITH THE
JET PROPULSION LABORATORY, CALIFORNIA INSTITUTE OF TECHNOLOGY
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION AND THE
USAF AERONAUTICAL CHART AND INFORMATION CENTER

NOTES ON BASE

This base chart was produced in consultation with Dr. Gerard P. Kuiper and the staff of the Lunar and Planetary Laboratory, University of Arizona. Photography and trajectory information was supplied by the Jet Propulsion Laboratory. Elevation data was compiled by the University of Manchester under Air Force Contract. This is one of a series of seven Ranger VIII charts compiled from television records of the Ranger VIII cameras.

CONTROL

The lunar features on this chart are positioned to conform with the selenographic latitude and longitude coordinates based on selenocentric measurements made by ACIC and published in ACIC Technical Paper No. 15, "Coordinates of Lunar Features," March 1965. Supplementary positions are developed in the chart area as an extension of the primary control.

NAMES

Feature names are adopted from the 1935 International Astronomical Union nomenclature system as amended by Commission 16 of the I.A.U., 1961 and 1964. Supplementary features are associated with the named features through the addition of identifying letters. Craters are identified by capital letters.

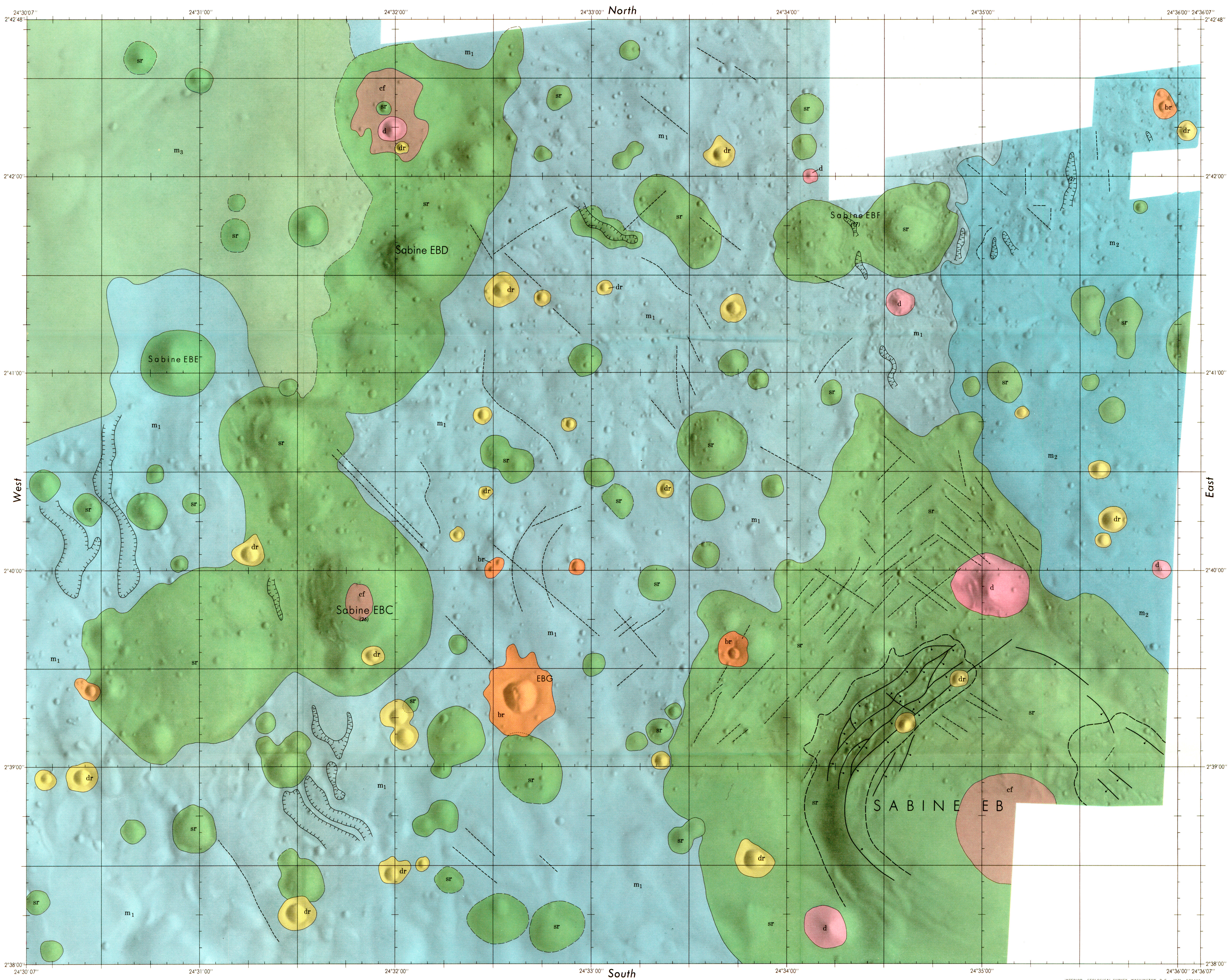
ELEVATIONS

The depths of craters were determined by the shadow measuring technique, utilizing Ranger VIII photography. Depths are shown in meters.

Depth of crater (rim to floor) .... (26)

PORTRAYAL

The configuration of the relief features shown on this chart is interpreted from Ranger VIII television records. The pictorial portrayal of relief forms is developed using an assumed light source from the west, with the angle of illumination maintained equal to the angle of slope of the features portrayed. Cast shadows are eliminated to enable complete interpretation of relief forms.



Lunar base chart RLC 11, 1st edition, 1966, by the USAF Aeronautical Chart and Information Center, St. Louis, Missouri, 63118

SCALE 1:5000
MERCATOR PROJECTION

1000 0 1000 2000 FEET
100 0 100 200 300 400 500 METERS

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Geology compiled 1967-69 from Ranger VIII photographs A59, A60, B89, B90, P13-19 (California Inst. Tech., Jet Propulsion Lab., 1966); Lunar Orbiter II photographs M69, M70, H70. Work performed under contract WO-5171, Jet Propulsion Laboratory

EXPLANATION

br

Material of bright-rimmed craters

Characteristics
Rim deposits appear brighter than surrounding surface material; rim crests relatively high and sharp; rim profile concave upward

Interpretation
Impact craters. Impact-altered rock and scattered blocks below the limit of photographic resolution on rims; exposed bedrock and talus on walls and floors

dr

Material of dark-rimmed craters

Characteristics
Sharp with well-defined rim deposits that appear no brighter than surrounding material; rim crests relatively high; rim material smooth appearing; rim profile concave upward; details of walls not visible

Interpretation
Impact craters. Dark appearance caused by aging of once-bright deposits; aging mechanism not clear

d

Dimple crater material

Characteristics
Appears as bright as the surroundings; walls convex upward steepening into a central pit or funnel; very low rims and smooth walls; intermediate in sharpness between dr *and* sr

Interpretation
Random distribution shown on Orbiter photographs suggests that craters are of primary impact origin and that present dimple form is the result of degradation and mass wasting. Dimple form may develop in those craters whose depth is nearly the same as the thickness of the surficial fragmental layer - approximately 5 m over most of the mare material - so that extensive slumping of loose material occurs on the walls. Alternatively, may be collapse craters over drained lava tubes (Kuiper and others, 1966)

cf

Crater floor material

Characteristics
Gently sloping, smooth; occurs in interiors of three large subdued craters; few superposed craters; material no brighter than surroundings

Interpretation
Unconsolidated, fine-grained debris winnowed from the crater rim and walls by mass wasting

sr

Material of subdued-rimmed craters

Characteristics
Continuous rim material around the craters mantles and smooths adjacent topography; rim crests broad and convex upward. A patterned texture or meshwork of lineaments characterizes most rims, walls, and floors of craters greater than 50 meters in diameter

Interpretation
Impact craters that have been subdued by subsequent impact and mass wasting

m_3

Mare material

Characteristics
Flat to slightly undulating terrain having relatively few subdued craters; topographically lower than adjacent unit m_1*; appears to have few lineaments*

Interpretation
A thick deposit of impact-produced debris or pyroclastic materials filling structurally controlled depression and overlying a solid substrate of volcanic flows

m_2

Mare material

Characteristics
Gently rolling to strongly undulating terrain; few lineaments; crater density slightly lower than on m_1*, and slightly higher than on* m_3*; topographically lower than unit* m_1

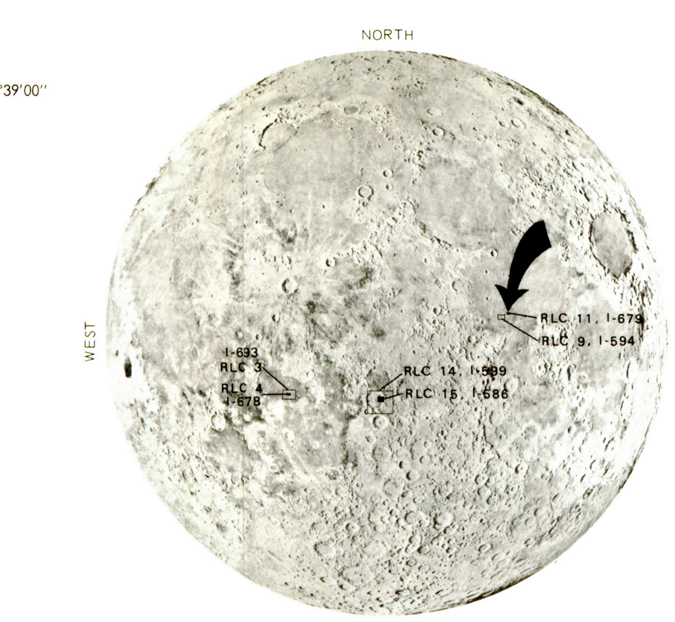
Interpretation
Relatively thick accumulations of impact-produced debris in structurally controlled low area overlying a solid substrate of volcanic flows. Undulations may be craters in various stages of degradation

m_1

Mare material

Characteristics
Rolling, cratered, terrain slightly higher than surroundings; lineaments numerous; irregular depressions common

Interpretation
Relatively thin accumulation of impact-produced debris in structurally uplifted areas overlying solid substrate of volcanic flows. Lineaments may be surface expressions of planar structural features, such as faults or dikes. Depressions may be structurally controlled collapse features or surficial scars left by the downslope movement of weakly consolidated material



INDEX MAP OF THE NEAR SIDE OF THE MOON SHOWING REGIONS MAPPED GEOLOGICALLY FROM RANGER PHOTOGRAPHS

Large arrow indicates area of this report. First number refers to base chart (RLC-11). Second number refers to published geologic map (I-679)

Contact
Dashed where approximately located
Dotted where buried

Fault
Bar and ball on downthrown side. May be displacement due to slumping

Lineament
Very indistinct ridge, scarp, or depression. May be surface expression of fault, dike, or lava flow front

Depression
Line marks base of steepest slope. Relatively shallow depression commonly having crater-like enlargements along its length; located near the periphery of unit m_1*. May be structurally controlled collapse feature or surficial scar left by the downslope movement of weakly consolidated material*

Block field
Area covered with angular blocks 5-7m in diameter

GEOLOGIC SUMMARY

This 1:5,000-scale geologic map is one of a series made from photographs transmitted by the Ranger VIII spacecraft. The Sabine EB region, in the southwestern part of Mare Tranquillitatis, is adjacent to the Sabine DM area, which was mapped at a scale of 1:50,000 by Trask (1969). The geology of parts of the map area was evaluated by H.H. Schmitt (in Shoemaker, 1966, p. 326-331) and Kuiper, Strom, and LePoole (1966, p. 91-93, p. 115-117). For this study Lunar Orbiter II photographs were used to fill in details on the south and west sides of the map area where the Ranger data are poor. One of the main objectives of the study was to assess the applicability of lunar geologic mapping at this scale and resolution.

The Sabine EB region is a rolling plain which consists entirely of crater and mare materials. The areal density of craters, though variable within the region, is sufficiently high so that craters are the dominant morphologic feature. Crater morphology ranges from bright, sharp-rimmed craters to pan-shaped depressions. Superposition relations indicate that the bright-rimmed craters (unit br) are youngest and that such craters are degraded in time to shallow, subdued depressions (unit sr) and presumably to total destruction. It appears that the bright rim deposits, characteristic of the younger craters, darken with time until their albedo is the same as that of the surrounding material (unit dr). Degradation of craterrims probably is caused by superposed impacts, burial by ejecta from more distant younger craters, and downslope movement of surficial materials. A few craters (unit d) have convex-upward walls which appear to have formed by inward slumping late in the degradation process. In our opinion, most of the craters are of impact origin, although some irregular depressions may be collapse structures.

The largest crater, Sabine EB, dominates the geology of the southeastern quadrant. Its relatively great age is reflected in the subdued form of the rim and wall and by the superposition of the other three crater types. Along the rim and wall a mantle of blocks occurs along with slump terraces. These blocks are interpreted as crater ejecta, lumps of cohesive breccia in the rim deposits, or boulders indigenous to the surficial material which have been exhumed as the finer material is winnowed downslope by mass wasting. The winnowed material is believed to collect in the topographic low of the crater floor to form unit cf. Although Kuiper, Strom, and LePoole (1966, p. 91) concluded that this crater formed by collapse, it is interpreted here as a degraded impact feature.

Studies at smaller scales (Morris and Wilhelms, 1967) indicate that the mare material consists of volcanic flows that have been stirred and comminuted by impact after their emplacement.

The mare here is divisible into three units: m_1, characterized by a greater areal density of subdued craters than the other two mare units and by numerous lineaments and irregular depressions; m_2, a smooth undulating unit, topographically lower than m_1 and with fewer lineaments; and m_3, a smooth relatively flat unit, also topographically lower than m_1 and with fewer lineaments. The relative density of craters on these units suggests that unit m_1 is the oldest and m_3 the youngest. Much of the mare material in Mare Tranquillitatis has been assigned to the Imbrian system (Morris and Wilhelms, 1967; Wilhelms and McCauley, 1971), but small patches with markedly lower crater density, such as unit m_3, may be as young as Eratosthenian.

Lineaments are most conspicuous in unit m_1 and in the crater Sabine EB. In both occurrences the dominant trends are northwest and northeast; these trends are conspicuous elsewhere on the Moon (Strom, 1964 a,b). The predominance of these features in unit m_1 may be due to tectonic activity prior to deposition of units m_2 and m_3 or to differences in material properties. The lineaments in Sabine EB probably reflect rejuvenation of structural planes of weakness established early in lunar history.

In general, geologic mapping of the maria at the 1:5,000 scale is more difficult than at smaller scales mainly because morphologic differences among geologic units are slight and are obscured by the surficial layer of loose material. However, important geologic details are recognizable at high resolution and aid significantly in interpreting smaller scale maps.

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GEOLOGIC MAP OF THE SABINE EB REGION OF THE MOON

By
P. Jan Cannon and L. C. Rowan
1971

For sale by U.S. Geological Survey, price $1.00