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THE MENDELEEV CRATER CHAIN:

A DESCRIPTION AND DISCUSSION OF ORIGIN

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SUMMARY

The Mendeleev crater chain formed on a linear weakness in the lunar crust that may have originated before the formation of Mendeleev Crater. Several lines of evidence seem to indicate an endogenetic origin: the linear trend, the symmetrical dumbbell pattern, and the lack of a "bird's foot" pattern and other morphological features of secondary impact craters. The dumbbell pattern may be the result of an explosive volcanic event taking place along a fault subjected to differing degrees of stress.

INTRODUCTION

This study was based on photographs from Lunar Orbiter I and panoramic and metric mapping cameras carried on the Apollo 16 command module. A 113-kilometer-long crater chain was selected for study because of its well-developed dumbbell shape and its straightness. The objective of the study was to determine the origin of the chain and any possible relationships to Mendeleev Crater and lunar tectonic patterns. This work was performed under NASA project S-255 (Lunar Crater Chains).

GEOLOGY OF THE MENDELEEV CRATER AREA

Mendeleev Crater, 274 by 380 kilometers, is located in the lunar highlands at longitude 141° E, latitude 7° N. The surrounding terrain is composed of numerous craters in all stages of degradation (fig. 1).

The crater floor is partly filled with material that may have been partly melted during the impact event. Within the crater, there is a variation in topography from smooth, marelike to hummocky to mountainous. This variation conforms to that proposed by Beals (ref. 1) in a hypothesis for large-scale impacts into a thick crust.

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The western wall of Mendeleev has well-developed slump structures. Extensive smooth slump deposits with low crater density occurring along this floor/wall contact indicate some recent slumping. These deposits partly embay one 20-kilometer crater and contain fresh, light-haloed impact craters less than 330 meters in diameter. Slumping of the other walls does not appear as well developed or as recent as that of the western wall. This difference may be because of the masking effects of ejecta from the crater Schuster, which breaches the eastern wall of Mendeleev.

DESCRIPTION OF THE CHAIN

The 113-kilometer-long Mendeleev chain has a dumbbell shape with one or more large craters at the ends, joined by a line of smaller craters. Crater rims are generally low or absent, except where influenced by variations in pre-crater-chain topography. The inner walls of most craters are smooth. The craters are bowl shaped except for several smaller craters that are conical because of mass wasting off the crater walls. A fine-grained regolith probably covers the inner walls and masks any structure or layering that might be present. There are no visible blocks in the craters or on the surrounding floor of Mendeleev (fig. 2).

The chain, trending N 25° E, is offset laterally 3.6 kilometers between craters 18 and 19 (figs. 3 and 4). Craters range in diameter from 1.2 to 9.3 kilometers, with the largest number occurring in the 2- to 3-kilometer range (table I).

Superpositional relationships and crater densities indicate that the crater chain in Mendeleev is younger than the features that surround it and probably represents the youngest event on the crater floor. Lack of overlapping deposits within individual crater groups and between adjacent craters and the nearly identical state of degradation within the chain indicate that all the craters may have formed contemporaneously.

Approximately 150 kilometers southwest of Mendeleev Crater is another straight, dumbbell-shaped chain of craters that is 177 kilometers long. This chain trends N 45° W across the center of a degraded, subdued crater approximately 180 kilometers in diameter.

DISCUSSION OF ORIGIN

The Mendeleev chain appears to represent a volcanic event that occurred some time after the cratering event which produced Mendeleev Crater. There are several observations that support this theory. The primary evidence for endogenetic origin is the symmetrical dumbbell and the extreme linear trend, which is more pronounced than would be expected for secondary impact craters. The interiors of the craters appear to be mantled with fine-grained regolith that could be interpreted as ejecta from an explosive volcanic event. Similar deposits observed around the margins of several craters within the chain give the area a smooth, mantled appearance. These deposits are not visible away from the crater margins.

Another argument against secondary origin is lack of the characteristic "bird's-foot" pattern and other morphological features of secondary craters (ref. 2). Also, there is no fresh, nearby impact large enough to produce a chain of secondaries of this magnitude. The lack of additional secondary chains is further evidence of a nonimpact origin.

The linear weakness along which the Mendeleev chain developed may have been a fault that was part of the "lunar grid system" (ref. 3). The northeastern trend of the chain, which is neither radial nor concentric to Mendeleev, is the best evidence for this observation. No structure that is both straight and non-radial to the center of impact appears to be associated with the cratering processes. The age of the chain is younger than the structures associated with the impact that formed Mendeleev, thus emphasizing that the chain is not contemporaneous with Mendeleev.

The reason for the dumbbell shape is unresolved. The formation of central uplift pulls material away from the flanks of the crater toward the center (ref. 4). This process would lead to tensional stress in the rock around the edge of the crater floor and compression in the central uplift. Because of the asymmetric orientation of the preexisting fault with respect to the center of cratering, the fault would be subjected to differing degrees of stress. During a subsequent episode of explosive volcanism, the resulting differential strain may have produced varying resistance to magma invasion along the fault and produced the crater size patterns observed.

CONCLUSIONS

Relative ages determined by comparing the degree of degradation of craters in the Mendeleev crater chain with that of Mendeleev Crater indicate that the chain is younger. It may have formed on a linear weakness in the lunar crust that originated before the formation of Mendeleev Crater. The linear trend, the symmetrical dumbbell pattern, and the lack of a "bird's foot" pattern and other morphological features of secondary impact craters indicate an endogenetic origin. The dumbbell pattern may be the result of a volcanic event that occurred along a fault which has been differentially stressed.

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TABLE I.- DESCRIPTION OF INDIVIDUAL CRATERS

Crater number	Form	Width,[a] km	Rim	Floor	Comments
1	Circular; bowl-shaped	3.2	Low	None	
2	Circular; conical	4.0	Low on western side; slopes uphill into crater ejecta on eastern side	None	May be a triplet with 3 and 4; however, wall between 2 and 3 is as high as rim
3	Circular; bowl-shaped	4.8	Same as 2	None	First member of doublet with 4; low wall in between
4	Circular; bowl-shaped	3.2	Low	None	Same as 3
5	Circular; bowl-shaped	2.0	Low	None	Not part of 3 and 4 doublet
6	Circular; bowl-shaped	2.8	High on western side; low on remaining sides	None	Same depth as 7
7	Circular; bowl-shaped	1.6	Same as 6	None	Smaller than 6 but with equivalent depth
8	Circular; bowl-shaped	2.2	Low	None	
9	Irregular elliptical; bowl-shaped	2.2	Low to moderately steep; varies with local topography	None	Rim height variation due to subfloor structure
10	Irregular circular; bowl-shaped	2.4	Low	Small; gently rounded	Some light patches in interior wall due to mass wasting
11	Circular; bowl-shaped	2.4	Low to moderately high; varies with local topography	None	Deeper than 12; same light patches trend into 12
12	Irregular subdued; bowl-shaped	1.2	Very low	Flat	Appears to slope into 11; shallower than 11; some light patches
13	Circular; bowl-shaped	2.4	Low to moderately high; varies with local topography	None	Streaks of mass-wasted material from 13 and rim of 14
14	Circular; bowl-shaped	2.4	Low	Small; flat	Shallower than 13
15	Circular; bowl-shaped to conical	2.0	Low	None	Faint lineaments related to mass wasting in walls
16	Circular; bowl-shaped	2.0	Low	None	Shallower, more bowl-shaped than 15
18	Irregular ovoid; steep sided; conical	5.6	Low	None	Coalesced doublet next rim unit; patches of low crater density unit around rim
19	Anvil-shaped, irregular	4.0	Indistinct	None	Rim masked because crater is on slope of rim unit; possibly coalesced triplet
20	Deformed ovoid; bowl-shaped to moderately conical	2.8	Low	None	Long axis of ovoid parallel to long axis of chain
21	Circular; bowl-shaped	5.2	Low	None	Some light to medium patches on inner wall
22	Truncated circular; bowl-shaped	3.2	Low	None	Member of triplet with 23 and 24
23	Thin polygonal; shallow	3.6	Low	None	Same as 22
24	Truncated circular, bowl-shaped	3.6	Low	None	Same as 22
25	Irregular ovoid; conical	9.3	Moderate to high	None	One impact on rim, main crater has scalloped walls with some mass wasting

[a]Measured normal to long axis of chain.

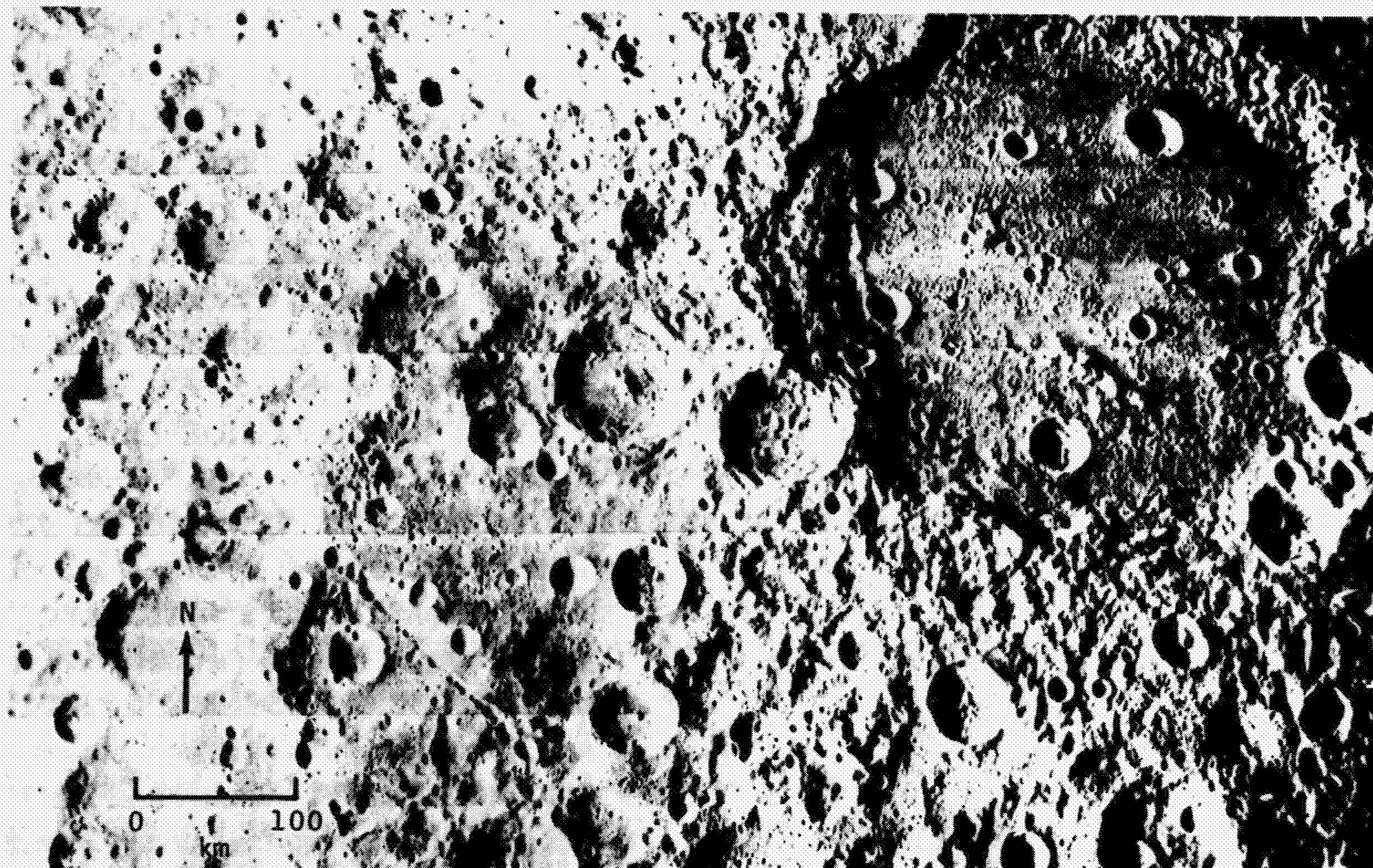
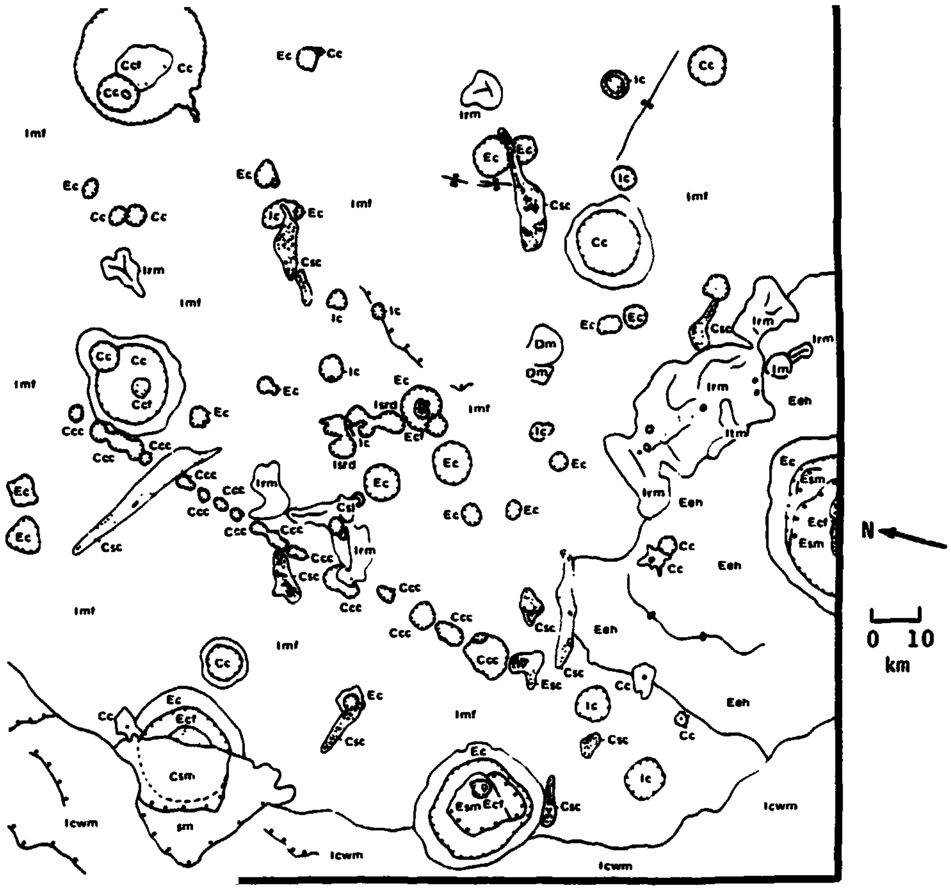


Figure 1.- Lunar Orbiter frame I-136M of the Mendeleev Crater area. The center of the crater Mendeleev is at longitude 141° E, latitude 7° N. The subject of the study is the crater chain that trends N 25° E across the western floor of Mendeleev Crater.

Figure 2.- The crater chain and western wall of Mendeleev Crater. Slump scarps on the west and smooth slump deposits are visible; slump deposits partly fill two 20-kilometer craters located at the crater floor/wall contact (Apollo 16 metric camera frame AS16-0345; resolution, 5 meters).



Explanation

Csm - fresh slump deposits with low crater density

Cc - impact craters

Ccf - floor material of impact craters

Ccc - chain craters

Ec - impact crater

Ecf - crater floor; flat, high crater density

Icwm - crater wall of Mendeleev

Irm - flooded floor ridge material; line denotes ridge crest

Itm - terrace material; forms flat, highly cratered terraces in Irm

Imf - floor material of Mendeleev

Csc - secondary craters

Csl - slide material from Irm; partly fills some craters

Esm - slumped crater walls

Eeh - hummocky ejecta

Ic - impact crater

Isrd - shallow rimless collapse depressions

sm - slump material; age uncertain

Dm - material of low, domal hills, age uncertain

Ridge in Eeh unit

Fault; ball on downthrown side

Shallow troughlike rilles

Crater rim

Contact

Figure 3.- Geologic map of a portion of Mendeleev Crater, compiled from Apollo 16 metric and panoramic photographs.

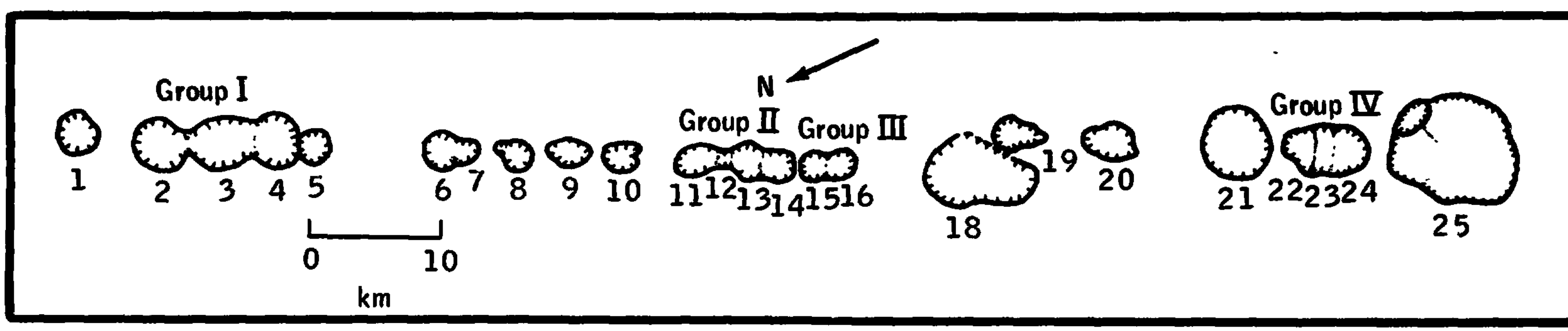


Figure 4.- Crater numbering key. See table I for crater descriptions.