

PART D

"D-CALDERA": NEW PHOTOGRAPHS OF A UNIQUE FEATURE

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A unique D-shaped structure at latitude 18°40' N, longitude 05°20' E was discovered during the Apollo 15 mission within one of several smooth, dark patches in the hilly region between Montes Haemus and Montes Apenninus. Its unusual shape and interior morphology have generated much interest among selenologists (refs. 30-10 and 30-11). Orbital photographs and visual observations (sec. 28) were planned for the Apollo 17 mission to acquire additional information pertaining to the setting and detailed characteristics of this structure. Photographs of the area were obtained by using the metric and Hasselblad cameras (with both color and high-speed black-and-white film); no panoramic camera photography of the region was planned because the area had been adequately covered with the same camera during the Apollo 15 mission. The purpose of this report is to give a brief description of the Apollo 17 photographs of the D-shaped structure and its surroundings.

The patches of dark material between Montes Haemus and Montes Apenninus are separated by hilly and rugged units that are segmented by fractures radial to Mare Imbrium. Two of these fractures bound the area of the D-shaped structure. The Apollo 17 low-Sun photographs of the area indicate that a horst, at least 150 km long and 30 km wide (fig. 30-11), has been uplifted relative to the surroundings. The fault on the western side of the horst continues southward into eastern Mare Vaporum, as suggested by a prominent mare ridge system (fig. 30-11).

The dark patches filling the valleys between the foothills of the mountains have been previously mapped as Imbrian mare material (ref. 30-12). Flow structures and collapse depressions evident in the Apollo 17 low-Sun photographs further suggest that they may be basalt flows (fig. 30-12(a)). Thus, the units are most probably volcanic in origin and younger than the surrounding and underlying highlands (ref. 30-13).

The D-shaped structure is a depression, 2 km wide and 3 km long. The feature is approximately 300 m deep and displays a raised rim that is 1.5 km wide. The floor is occupied by two different morphological units:

1. A flat unit that is subdivided into two albedo units, gray and white; the latter forms an annulus around the gray unit (ref. 30-11). Apollo 17 visual observations (sec. 28) and color photographs indicate that the whole floor has a bluish tone.

2. Approximately 50 disconnected, smooth, bulbous structures of various sizes; these structures produce a blister-like appearance.

There is a 1-km-diameter crater west of the D-shaped structure that, before the Apollo 17 mission, was believed to have a dark halo. The Apollo 17 low-Sun photographs indicate that the darkening is probably due to slope effects; the crater is near the border of an 18-km-wide dome that encircles the D-shaped structure (fig. 30-12(b)) and that appears to have fewer craters on it than on the surrounding mare (fig. 30-12(c)). It is proposed that the D-shaped structure is a collapse caldera atop an extrusive volcanic dome. It is further proposed to adopt the informal name "D-Caldera" to designate the feature.

From the preceding description, the following sequence of events may be reconstructed to explain the formation of observed features (fig. 30-13).

1. The Imbrium event clearly affected the triangular-shaped region between Montes Haemus to the east and Montes Apenninus to the west. Pre-Imbrian terrain was faulted, most of the major faults being radial to the Imbrium basin. Deposition of Imbrium ejecta is evidenced by the linear ridge units, also radial to the basin. The ejecta is probably kilometers thick because it masks preexisting structures (fig. 30-13(a)).

2. Faulting must have continued as a result of adjustment of the crust after formation of the Imbrium basin. At some later date, basaltic lavas migrated to the surface along the fractures and formed relatively thin mare patches; older highland

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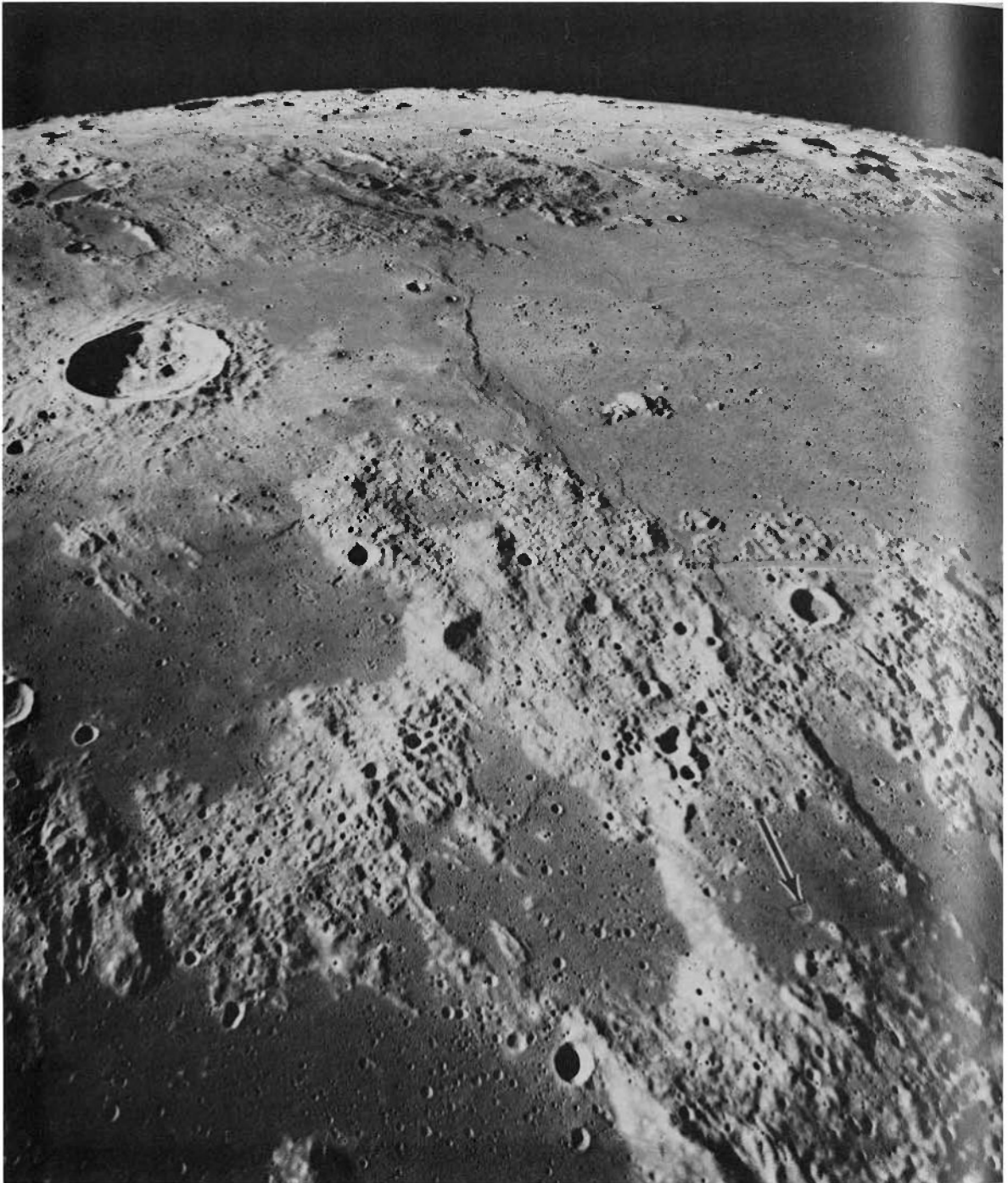


FIGURE 30-11.—Oblique view (looking southward) showing most of Mare Vaporum (upper right) and the 40-km-diameter crater Manilius (upper left). Four of the dark patches of mare material between Montes Haemus and Montes Apenninus are in the lower half of the photograph. The D-shaped structure is indicated by an arrow. The fault that separates the two patches in the lower right continues into Mare Vaporum, as indicated by the mare ridge in the upper middle portion of the photograph (Apollo 17 metric camera frame AS17-1671).

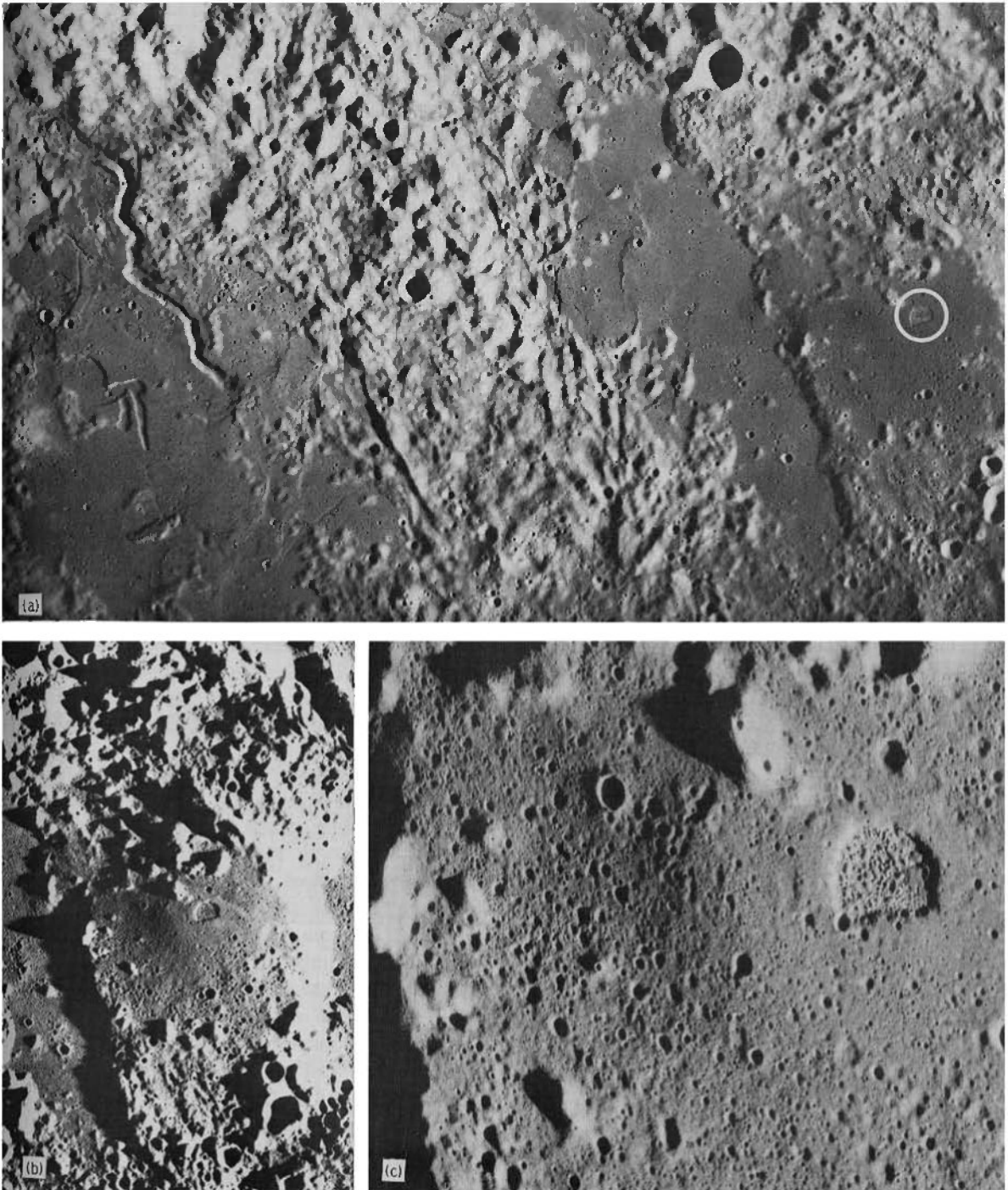


FIGURE 30-12.—Three views of the D-shaped feature. (a) Dark patches atop highland units have flow scarps and mare ridge structures (right of center) and collapse depressions and flow channels (left edge) similar to basaltic lava flow. The straight part of the D-shaped structure (circled) is 3 km long (Apollo 17 metric camera frame AS17-1822). (b) Low-Sun-angle view of the area surrounding the D-shaped structure, showing the dome that encircles it (Apollo 17 metric camera frame AS17-1237). (c) The small, bulbous domes in the floor of the D-shaped depression are shown in this view taken during the Apollo 17 mission using the Hasselblad camera with very-high-speed black-and-white film. The dome that encircles the structure displays fewer craters than does the surrounding mare surface (AS17-154-23672).

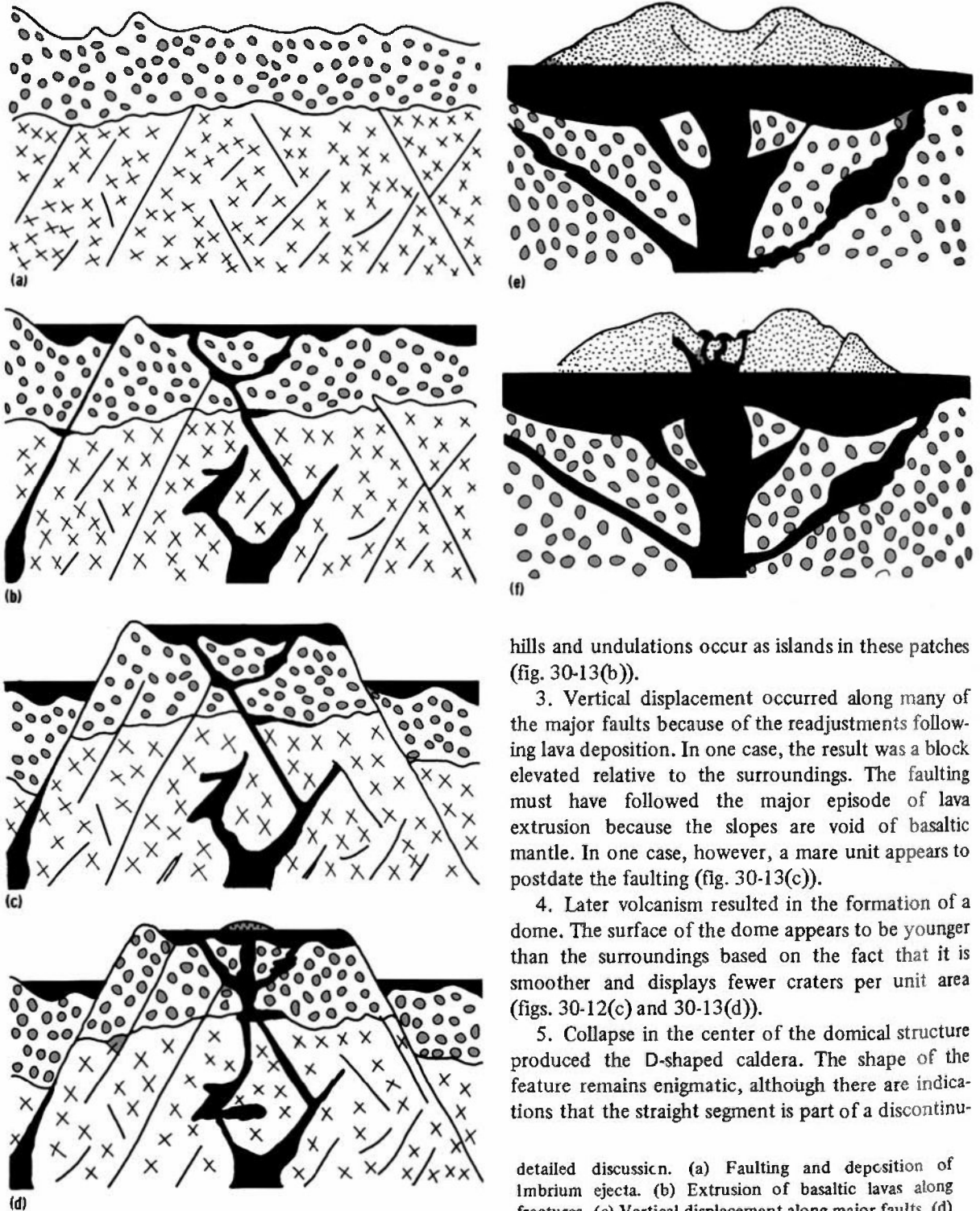


FIGURE 30-13.—Schematic illustration of the stages of faulting and subsequent volcanism that led to the formation of the D-shaped collapse caldera. See text for

hills and undulations occur as islands in these patches (fig. 30-13(b)).

3. Vertical displacement occurred along many of the major faults because of the readjustments following lava deposition. In one case, the result was a block elevated relative to the surroundings. The faulting must have followed the major episode of lava extrusion because the slopes are void of basaltic mantle. In one case, however, a mare unit appears to postdate the faulting (fig. 30-13(c)).

4. Later volcanism resulted in the formation of a dome. The surface of the dome appears to be younger than the surroundings based on the fact that it is smoother and displays fewer craters per unit area (figs. 30-12(c) and 30-13(d)).

5. Collapse in the center of the domical structure produced the D-shaped caldera. The shape of the feature remains enigmatic, although there are indications that the straight segment is part of a discontinu-

detailed discussion. (a) Faulting and deposition of Imbrium ejecta. (b) Extrusion of basaltic lavas along fractures. (c) Vertical displacement along major faults. (d) Formation of dome by late-stage extrusion. (e) Formation of D-shaped caldera by collapse. (f) Formation of bulbous floor structures by minor extrusions.

ous fault in the mare unit (fig. 30-12(b)). It is probable that the depression would have been circular had that fault not existed (fig. 30-13(e)).

6. The collapse appears to have been followed by numerous small extrusions that formed the bulbous structures in the caldera floor (fig. 30-13(f)). These positive features appear to be small domes, and

several seem to have repeated the collapse sequence as they display apex craters (ref. 30-11).

The preceding sequence, which is deduced from the characteristics of the region studied, may be pertinent to lunar volcanic processes that result in the formation of small-scale domes and collapse depressions.