CLEOPATRA CRATER ON VENUS: HAPPY SOLUTION OF THE VOLCANIC VS. IMPACT CRATER CONTROVERSY; A.T. Basilevsky, A.T. Vernadsky Institute of Geochemistry and Analytical Chemistry, Moscow, USSR, and G.G. Schaber, U.S. Geological Survey, Flagstaff AZ 86001

Introduction. Cleopatra is a 100-km-diameter crater on the eastern slope of Maxwell Montes in western Ishtar Terra. For over 12 years, Cleopatra has been the subject of scientific controversy. Discovered during the Pioneer Venus altimetric survey, this feature was initially interpreted as a caldera near the top of a giant volcanic construct, Maxwell Montes [1]. Venera 15/16 data and recent Arecibo radar images show, however, that the Maxwell Montes appear to be more of a tectonic construct, with little or no resemblance to other giant shields known in the Solar System; thus, a nonvolcanic origin of Cleopatra was proposed [2-6]. The similarity of the double-ring structure of Cleopatra to those of other multi-ring impact craters of similar size on Venus and the Moon, Mercury, and Mars was more recently given by Basilevsky and Ivanov [7] as the primarily reason to consider this feature an impact crater.

At the same time, some characteristics of Cleopatra seemed to contradict an impact origin. For example, Schaber et al. [8], suggesting that a definitive verification of a volcanic or impact origin would probably require Magellan data, proposed that the evidence from Venera 15/16 and earlier data for a probable volcanic origin for Cleopatra is substantial. They cited, among other points: (1) the absence of a raised rim and highly backscattering ejecta deposits; (2) the crater's association with plains-forming deposits immediately downslope to the east, interpreted as probable lava flows emanating from a distinct breach in the crater's rim; (3) the excessive depth (2.5 km) and depth-to-diameter ratio (0.028) of the crater, (4) the offset of the inner and outer craters; and (5) the crater's position in what was interpreted as a regional tectonic framework.

Description and Discussion. The long awaited initiation of Magellan mapping at high resolution has made possible the compilation of a very preliminary geologic map of Cleopatra crater and vicinity. Cleopatra is clearly superposed on the ridged terrain of Maxwell Montes. The crater rim is scalloped. Within it are the sloping inner walls, a terrace or outer floor between the inner walls and the elevated peak ring, and a very smooth inner floor inside the peak ring. Outside the crater areas nearest the rim are coarse hummocky and fine-hummocky terrains and smooth radar-bright plains. Associated within the bright plains deposits are radar-dark, planar deposits in topographic depressions north of the crater. The deposits may be pools of shock-melt material similar to those observed within the ejecta blanket of the 100-km-diameter lunar crater Tycho [9]. South of the crater rim, dark-plains deposits appear to be less planar and more closely associated with ridge slopes.

The Magellan data clearly confirm the impact origin of Cleopatra. Magellan images have verified the Venera 15/16-based interpretation of Schaber et al. [8] that the material of the inner floor of Cleopatra passed through a breach in the outer rim of the crater and merge into the plains downslope to the east. Magellan has also revealed what the Venera 15/16 data did not: the extension of this channel-like conduit or rille across the outer floor-terrace, through the central peak ring, and into the innermost, radar-dark floor of the crater. The volume of the plains-forming material has yet to be estimated, but it appears to be substantially larger than can be explained solely by migration downslope of shock melt following the cratering event [7], thus implying a volcanic origin for this material. There is little doubt that Cleopatra crater is the source of the plains-forming material, however.

These new observations return us to the volcanic vs. impact controversy, which may now be resolved through the concept of impact-triggered volcanism. According to this model, a large impact formed Cleopatra, thus explaining its morphologic similarity with other peak-ring basins of impact origin. The impact subsequently triggered volcanic eruptions on the crater floor, while the position of Cleopatra on the relatively steep east slope of Maxwell Montes led to lava outpourings downslope, flooding the ridges of western Fortuna Tessera. Emptying of the magma chamber beneath Cleopatra may have caused crater floor subsidence, which would explain the anomalously great depth of the crater.

Analysis of early, uncalibrated Magellan altimetry data indicates that the inner and outer floors of Cleopatra are at about the same elevation and that the outer crater rim is as much as 2 km above the outer floor (though the relief is varied). However, the equivalence in elevation of the inner and outer floors contradicts the Venera 15/16 altimetric data, which show the inner floor to be about 1 km deeper than the outer or floor. Further analysis of both altimetric sets and their processing techniques should solve this mystery.

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