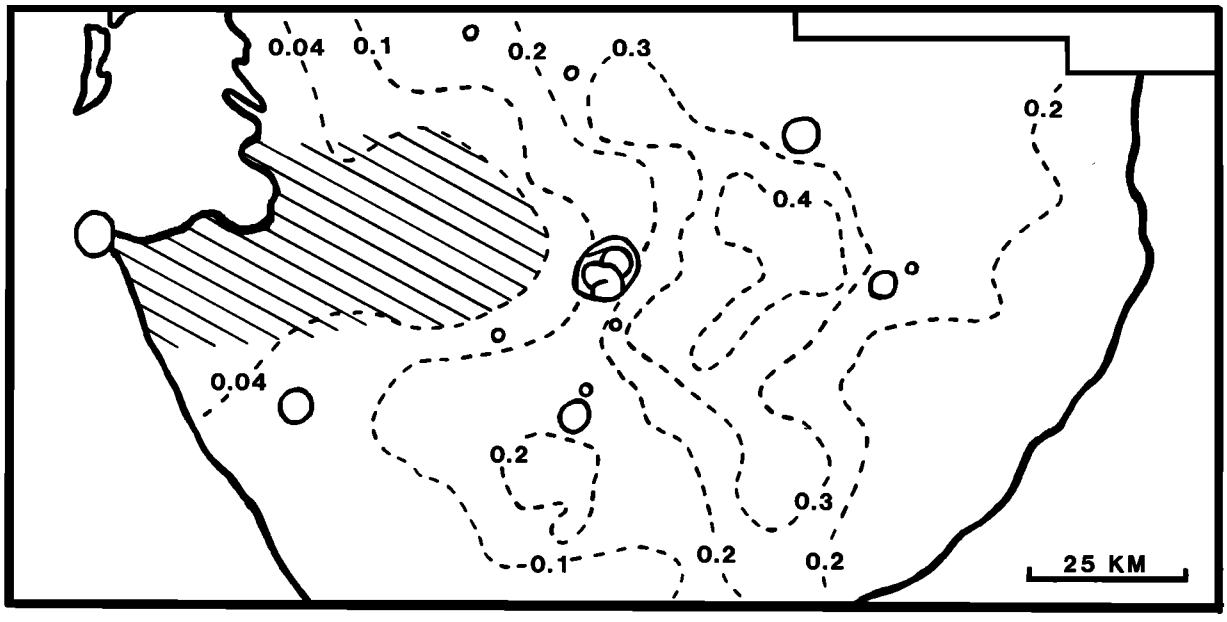

Fig. 7. Isofrequency map for all craters on Hecates Tholus that have a diameter less than 2 km and are of probable impact origin. Contours (number of craters per square kilometer) show that there is an area (denoted by cross-hatching) about 50 × 75 km in extent to the west of the caldera where there is a marked paucity of craters. The 0.04-crater contour is assumed to approximate to the areal extent of the postulated air fall deposit, although ash most likely would extend as far as the 0.1-crater contour. Map prepared from Viking images 651A15–23.

channel argues against a drained lava lake once existing within the crater as a result of flooding by the channel. We do not, however, completely discount the possibility that some of the channels on Hecates may be the central channels of lava flows, merely asserting that potential examples appear to have been modified after formation by erosive processes.

We conclude that the most plausible mechanism for formation of the majority of the channels is fluvial action. The observed branching pattern of the channels (Figures 3 and 5), the variable width and depth of each channel along its length (with the source region rarely the deepest point), and the apparent influence that local and regional topography have over channel directions all suggest a fluvial origin. Many of the channel networks also have digitate-to-parallel patterns which are similar to those associated with fluvial systems recognized elsewhere on Mars [*Pieri*, 1980]. Deciding between a pluvial or sapping mode of formation for the channels is, however, difficult. The existence of many undissected interchannel areas (Figure 5) suggests that a sapping process was responsible [*Pieri*, 1980], but, in the same areas, the amphitheater structure of the source regions which is normally associated with sapping [*Pieri et al.*, 1980] is absent on Hecates. The occurrence of several channels along the same break of slope (Figures 2 and 3) may also corroborate a sapping mechanism, since this may represent a streamline formed where a subsurface water table has intersected the surface.

Although we infer that the occurrence of sinuous channels on Hecates does not in itself indicate explosive activity, nevertheless their existence may have a bearing on understanding the local style of volcanism. Few Martian volcanoes possess such channels [*Reimers and Komar*, 1979], so that their existence on Hecates must indicate atypical conditions at this locality. One possible explanation is that the channels were able to form owing to an easily erodable ash deposit being present on the volcano's flanks, while, for example, Olympus Mons lacks channels of this kind because its flanks are made of resistant lava flows.

Small Crater Distribution—Evidence for a Resurfacing Event

A close analysis of the distribution of craters smaller than 2 km in diameter reveals a remarkable asymmetry on Hecates Tholus. An isofrequency map of these small craters (Figure 7) indicates that the maximum number of craters is in excess of 0.4 craters per square kilometer. Typical values are between 0.2 and 0.3 craters per square kilometer, but to the immediate west of the caldera, the number of craters falls below 0.04 per square kilometer. Because no lava flow fronts or source vents for lava flows can be recognized in the area of low crater frequency, it is unlikely that this paucity of craters west of the caldera is the result of effusive activity.

Resurfacing by a mechanism other than the eruption of lava is also supported by the extensive mantling of large sinuous channels to the west of the caldera and the total absence of smaller channels (Figure 2). Pyroclastic flows can be discounted on the basis of the morphology of this mantle; there is an absence of flow patterns indicative of ground flow, there are no preserved flow boundaries, and there is an apparently gradual thinning of the mantle toward its edges. We believe, however, that these observational data are strong evidence in support of extensive blanketing of the terrain by a volcanic air fall deposit. This interpretation is strengthened by both the proximity of the deposit to the inferred vent area (the summit caldera complex) and the similarity in shape that this hypothesized air fall has to the areal distribution of known terrestrial tephra deposits [*Walker*, 1973*b*].

An estimate can be made of the volume and mass of this