IMPLICATIONS OF CRATER DISTRIBUTIONS ON VENUS. W. M. Kaula, University of California, Los Angeles.

The horizontal locations of craters on Venus are consistent with randomness. However, (1) randomness does not make crater counts useless for age indications; (2) *consistency* does not imply necessity or optimality; and (3) horizontal location is not the only reference frame against which to test models. Re (1), the apparent smallness of resurfacing areas means that a region on the order of one percent of the planet with a typical number of craters, 5-15, will have a range of feature ages of several 100 My. Re (2), models of resurfacing somewhat similar to Earth's can be found that are also consistent and more optimal than random: i.e., resurfacing occurring in clusters, that arise and die away in time intervals on the order of 50 My. These agree with the observation that there are more areas of high crater density, and fewer of moderate density, than optimal for random. Re (3), 799 crater elevations were tested; there are more at low elevations and fewer at high elevations than optimal for random: i.e., 54.6% below the median. Only one of 40 random sets of 799 was as extreme.

1. An evident inference of both catastrophic and equilibrium models [1,2] is that crater density is not useful as a measure of relative ages of different areas: only for areas at the extremes of the distribution are there found evidences of features such as recent uplifts and volcanic flows with low crater density and of degradation and discordant fractures with high crater density. If actuality is closer to the equilibrium random resurfacing model [2], the reason for this is apparently that the typical scale of tectonic and volcanic activity is comparable to the patch area $a < 0.0003$, or $150,000$ km^2. If meaningful statistical discrimination requires about 5 to 15 craters, then the areas must be about $| 10 / 763 | \times 0.875 \times 460 \times 10^6 = 5 \times 10^6$ km^2: about 30 Phillips "patch" [2] areas. Within most areas of 5 million km^2 on Venus there typically is a wide range of geomorphic features, implying a wide range of tectonic and volcanic activity. If the scale of events is comparable to the patch area of 0.15×10^6 km^2 or smaller, then normally an area of 5×10^6 km^2 will contain a great range in age among its features, up to 1.5 Gy or more. Inference of a kinematic sequence from imagery then implies appreciable age differences between earlier and later patterns. Such temporal differences are constraints on physical models; for example, a feature of high gravity: topography ratio, implying dynamic support, should be expected to be late in the kinematic sequence for its area, while a fractured and relaxed geomorphic unit should be several 100 My old.

Counts were therefore made of the distribution in age of surviving craters within blocks of a $= 0.01$, or areas about 5×10^6 km^2, generated by the ER model of random occurrence of craters at a rate of 888 per resurfacing time (1.78/My), and random volcanic patches of a $= 0.0003$. Sixty runs of 5.4 resurfacing times (2.7 Gy) were made; in each run, 4800 craters and 18,000 volcanic patches were generated.

Thus, for example, the 75% quartile for an area with five craters is about equal to the 25% quartile for an area with fifteen craters, so there is about a 6% probability that the area with five craters still has a crater older than the oldest in the area with fifteen craters. But even with as few as five craters, there is a rather high probability that a 5 million square kilometer area contains features as old as 500 My. At the other extreme, the probability of a youngest crater under 50 My is greatly enhanced for areas with more than 10 craters.

2. To test the consistency of the crater distribution with cluster occurrence, Monte Carlo models were computed in which craters occur randomly in location x, y and time t over a planet lifetime T, and in which clusters occur randomly with respect to other clusters, and have a Gaussian distributions of specified rms radius σ of resurfacing events about their centers. The rate of occurrence of clusters relative to cratering was assumed proportional to $\exp(-t/\lambda)$. To save computer time, the planet was assumed flat and square, and wrap around to the opposite side made for resurfacing patches located less than their radii from the edge. Counts of surviving craters in areas 0.01 of the total area were kept, to test against crater counts in 5×10^6 km^2 areas on Venus, by sampling with multiple circles [2]. Fits to this Venus data appreciably *better* than random distribution were obtained with a range of cluster sigmas σ 0.1 to 0.2 of planet dimension (areas 3 to 12 percent of the total); decay constants λ T/3 to T, and probability

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intervals on the order of $T\sigma^2/4$: i.e., sufficient to be well-distributed over the planet in a time $T/4\pi$, close to the canonical resurfacing time.

3. The distribution of 799 crater elevations on Venus was compared to that of 3720 points at uniform intervals (pi/54=3.33°). All elevations were calculated from the 120-degree harmonic expansion of Borderies [3], which interpolates smoothly across gaps in the altimetry. A distinct bias toward lower elevations was found; thus, 54.6% of craters are at elevations below the median (178 meters below the mean). Such an extreme distribution was obtained in only one of 40 random selections of 799 elevations. The bias toward lower elevations is consistent with resurfacing events being associated with higher areas, but not markedly so.

[1] Schaber et al (1992) *JGR, 97,* 13,257; [2] Phillips et al (1992) *JGR, 97,* 15,923; [3] Borderies, N. (1992) informal communication.