VENUSIAN PARABOLIC HALOS: NUMERICAL MODEL RESULTS. C. J. Schaller and H. J. Melosh, Lunar and Planetary Laboratory, The University of Arizona, Tucson, AZ 85721.

Magellan SAR images have revealed roughly 50 craters which have large, parabolic halos associated with them [1]. Using a numerical model in which impact ejecta is sorted by the Venusian atmosphere [2], we have successfully modeled half of these. Results seem to be supported by the terrestrial crater Chicxulub.

Briefly, the model (from [2]) requires the crater-forming impact to be large enough to form an atmosphere-piercing vapor plume. Particles carried aloft by the plume may then follow ballistic trajectories back into the atmosphere, where they will fall at terminal speed. Atmospheric winds will affect the particles' paths; in the case of Venus, the strong, westward-moving winds will tend to carry particles westward. Smaller particles, with a smaller terminal speed, will tend to travel greater distances than larger particles.

It is assumed that the particles are distributed radially from the center of the crater in the form of a power law [2]:

$$\bar{d} = \bar{d}_c \left(\frac{r}{r_c} \right)^{\alpha} \qquad (1)$$

where $\bar{d}$ is the mean particle diameter, $\bar{d}_c$ is the mean reference size which scales the law, r is the distance from the center of the crater, r_c is the crater radius, and α is the empirical power. In order to fit the model to the observed halos, we must choose the correct values for the reference size and the power.

It should be noted that not all Venusian impacts will generate a plume large enough to pierce the atmosphere; Vervack and Melosh [2] have calculated that craters less than 16 km in diameter are not large enough. The ejected particles will not leave the atmosphere, and equation 1 will not necessarily hold.

For each halo to be modeled, we used a crater radius as determined from [3]. We started the calculations (arbitrarily) at 100 km from the crater's center. Since the model has particles traveling only westward, it is reasonable to use the width of the halo as a stopping criterion. Thus, when the initial particle distance, used in equation 1, reached 10% more than half of the halo's maximum width as reported in [1], we stopped the calculations.

There are several potential dimensions to which we could attempt to fit the model. Inspection of the Venusian halos suggests that the best-defined borders are near the crater's end of the halo. We therefore used the distance from the crater's center to the tip of the halo as our primary target dimension. As a secondary dimension, we used the halo's width at the longitude of the crater. The overall lengths and widths of the halos were less important to the fitting process.

We must also consider the depth to which we can see the halos. Campbell et al. [1] suggest a depth on the order of centimeters to meters. We attempted to fit halos at two minimum thicknesses, 1 cm and 10 cm. At thicknesses less than the minimum, the radar does not detect ejecta.

We found that halos with craters less than about 20 km in radius could not be fit to our model, which agrees well with [2]. In addition, although it was possible to match the primary and secondary dimensions to within 10%, at a minimum thickness of 10 cm, we could not match the lengths and widths of the halos. At a minimum thickness of 1 cm, however, we were successful.

We had success with 19 halos at the 1 cm thickness level: Abington, Adivar, Akeley, Akiko, Aurelia, Austen, Ban Zhao, Bassi, Boleyn, Boulanger, Caldwell, Carson, Faustina, Frank, Pimiko, Stowe, Stuart, VonSchuurman, and Yablochkina. From successfully fitting these halos, we find $\alpha = 2.65 \pm 0.03$. For Chicxulub, a range of 2.0 to 2.5 was determined [2] using microtektite data.

We found that the reference sizes for these halos follow a power law of their own, according to crater radius. (See the accompanying figure.) The reference size relationship determined is

$$\log \bar{d}_c = (3.18 \pm 0.34) + (-1.56 \pm 0.26) \log r \tag{2a}$$

or

$$\bar{d}_c \approx 1500 r^{-1.56} \tag{2b}$$

with the scaling coefficient ranging (to one standard deviation) between 3300 and 690 and the power ranging between -1.30 and -1.82.

This power law (2b) fits Chicxulub quite well. With a crater radius of 90 km, Chicxulub's reference size was determined to be between 0.4 and 1.7 m [2]. The dashed line on the figure shows this. The model presented in [2] appears to hold up.

REFERENCES

[1] Campbell D. B. et al. (1992) *JGR*, *97*, 16,249. [2] Vervack R. J. and Melosh H. J. (1992) *Geophys. Res. Lett.*, *19*, 525. [3] Schaber G. G. et al. (1992) *JGR*, *97*, 13,257.

1 cm Minimum Detectable Thickness