ENERGIES OF VENUS IMPACTORS. C. F. Keating, Victoria College, 2200 E. Red River, Victoria, TX, 77901, christopher.keating@victoriacollege.edu.

Introduction: Meteor impacts on Venus occur under vastly different conditions than those of the other terrestrial planets and moons due to the thick venusian atmosphere. The amount of energy that an impactor has when it hits a planetary surface is a function of the impactor's velocity, mass, and the amount of energy it dissipates in the planetary atmosphere. Venus presents an unusual situation where the amount of energy lost to the atmosphere is much more significant than any other terrestrial body in the solar system. This analysis shows that this dense atmosphere results in an 'atmospheric filtering' of impactors with a skewed ratio of crater sizes.

Discussion: This analysis will be concerned with the energies at the moment before the asteroid enters the Venusian atmosphere and at the moment preceding impact.

The changing density of the Venusian atmosphere is modeled with the equation,

$$\rho_{air\ at\ z} = \rho_{air\ at\ surface} e^{-Z/H} \qquad [1]$$

where Z is the meteor altitude and H is the atmospheric scale height. We used a scale height of 15.9 km.

This atmospheric density is used to determine the terminal velocity of object in the Venus atmosphere. Terminal velocity is a function of velocity, mass, cross-sectional area, coefficient of drag and air density and is derived from the equation

$$\tfrac{1}{2} \rho_{air} v^2 A_c C_D = W - F_b \qquad [2]$$

Where W is the weight of the meteor and F_b is the buoyant force. The buoyant force will be assumed negligible for our analysis, because the weight of the meteor is significantly large enough to negate its effects. Solving for velocity gives us,

$$v_{terminal} = (2W/(\rho_{air} A_c C_D))^{1/2}$$

Solving for the critical mass/diameter will provide for $v_{terminal}$.

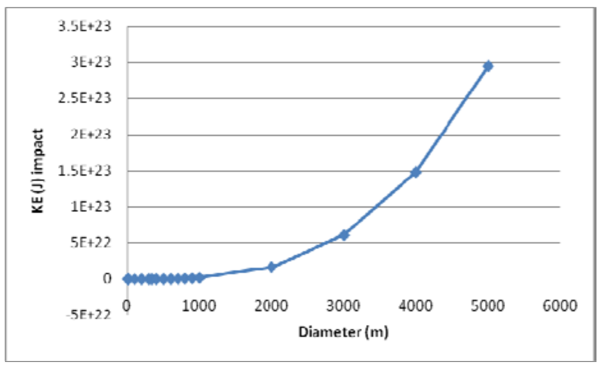
By conservation of energy, the amount of kinetic and potential energy the impactor has as it first begins to enter the atmosphere is, at any given point, equal to the kinetic and potential energies at that point plus the energy dissipated in the atmosphere:

$$KE_o + PE_o = KE_f + PE_f - E_{atm}$$

At the surface, z = 0 m and the KE_f can be equated to impact energy and PE_f is equal to zero. The variable expansion of this equation provides

$$\tfrac{1}{2} mv_o^2 + mgz = \tfrac{1}{2} mv_f^2 - \pi C_D A v_f^2 \rho_{surface} H/(2\sin(\theta))$$

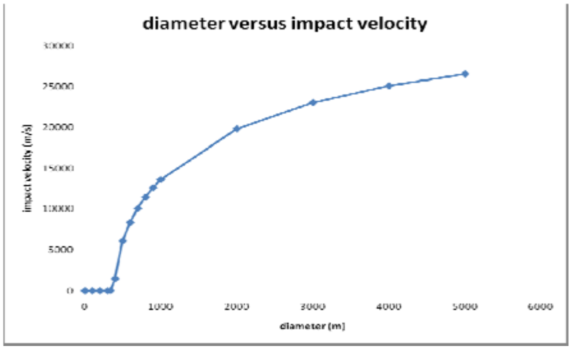
We used a value of 8.85 m/s^2 for the Venus local gravity and a pre-atmosphere velocity of 35 km/s. Solving for KE_f and plotting the results as a function of the impactor's starting diameter gives us the graph plotted below:



This graph shows that meteors of less than 1000 m in diameter are not going to have a considerable KE_f compared to those of larger diameters. The data in this table can be interpolated to illustrate that based purely on energy factors, a meteor of diameter 339.4m will not have a significant amount of kinetic energy when it reaches the surface of Venus. This can be considered the critical diameter in terms of an energy analysis.

Obviously, meteors of diameter less than 340m will still enter the atmosphere, but will achieve a terminal velocity at some point in the atmosphere and loose nearly all of its kinetic energy before reaching the surface.

Using this data we can compute the impact velocity as a function of the original meteor diameter:



This graph also shows the energy at impact rises very rapidly with size above a diameter of 340 m. Even with a natural distribution weighted towards smaller diameters, it can be seen that this energy distribution will allow for few smaller craters and creates a bias of larger ones, which is exactly what is seen in the observational data.

Conclusion: A consequence of this 'atmospheric filtering' is to skew surface age calculations based on crater counts and lead to the conclusion that the surface of Venus is quite young. The reality is that there are few small craters not because of the youth of the surface, but because there is only a small window of diameters that will result in small craters. Some estimates of the Venus surface age are about .5 Ga. [3] [4]. Other estimates give a surface age of 3 – 4 Ga [5] [6]. We believe that these results are consistant with the older estimates of the surface of Venus.

References: [1] Tascione, T. F., (1994) *Intro to the Space Env.*, 90. [2] Melosh, H.J., (1989) *Impact Cratering: A Geologic Process*, 206. [3] Schaber, G. G. et al. 1992) *JGR, 97,* 13257 – 13301. [4] Phillips, R. J. et al. (1992) *JGR, 97*, 15923 – 15948. [5] Schultz, P. H., (1990) *LPSC XXIV*, 1255. [6] Hamilton, W. B., (2003) *Proc. Penrose Conf. IV*.