IMPACT DISRUPTION OF MAGMA OCEAN CRUST. Geoffrey F. Davies, Dept. Earth Planetary Sciences and McDonnell Center for Space Sciences, Washington University, St. Louis, MO 63130.

Whether or not a magma ocean can accumulate depends on whether or not an insulating crust can form and survive on the magma surface. Even if a crust forms by virtue of strength or buoyancy, it must still survive the accretionary bombardment which is presumably responsible for forming the magma in the first place. The competition between impact disruption and impact heating was briefly examined by Minear (1), and the results of a more detailed analysis are reported here.

The necessity for an insulating crust arises from the high radiative heat flow from exposed magma which, if maintained, would freeze a magma ocean in decades (2), and from the high convective heat flux from a magma body in which a continuously foundering crust cools the interior. Estimates from boundary layer theory show that the latter process would freeze the ocean in a few centuries.

Accreting bodies are assumed to have a mass distribution given by

$$dN/dm = C\, m^{-q} \qquad (1)$$

and the "crater" radius, R, is assumed to depend on projectile radius, r, as

$$R = c\, r^{a} \qquad (2)$$

The form of the results depends on the parameter $b = (1 + 2a/3 - q)$. For $b < 0$, the rate of impact resurfacing is singular if (1) applies down to $m = 0$. Thus the resurfacing rate is sensitive to the lower cutoff mass: presumably the mass for which r is less than the thickness of any existing crust. Values of q are 1.7 - 1.85 (3), so this situation applies for $a = 1$. For $b > 0$, the resurfacing rate has no singularity, but is still dominated by the effect of small projectiles.

If the crust is a chill margin which thickens by conduction after impact disruption, then the ratio, H, of impact heating rate to heat loss rate increases with accretion rate. For estimated lunar accretion rates, $a = 1$, $q = 1.8$ and a largest accreting body with $r = 100$ km, bodies as small as meters must be able to disrupt the crust to ensure that $H < 1$, the condition for a magma ocean to fail to accumulate. For $a = 1.2$, $q = 1.75$, the largest accreting body must be less than $r = 100$ km for the same condition to result.

If the crust is a buoyant cumulate layer which thickens at a constant rate after impact, then H is independent of accretion rate but is proportional to the cumulate thickening rate. Estimates indicate that thickening rates of cm/year are required to assure magma accumulation.

The analysis leaves the possibility of accumulation of a magma ocean open, but dependent on some poorly known parameters.

(1) Minear, J.W. (1980) Proc. Lunar Planet. Sci. Conf. 11th, 1941-1955.
(2) Herbert F. et al. (1977) Proc. Lunar Sci. Conf. 8th, 573-582.
(3) Safronov V.S. (1972) NASA TTF-667, 206 pp.