JETTING AND THE ORIGIN OF TEKTITES; A. M. Vickery, Lunar and Planetary Laboratory, University of Arizona, Tucson, AZ 85721

The scientific consensus is that tektites were produced by impacts on the earth, but the exact mechanism by impacts might form tektites is still unclear. The most widely cited mechanism is jetting, which results from the extremely high pressures generated at the intersection of two bodies whose surfaces converge obliquely at high speed. In this work, the theory of jetting for thin plates is extended to the case of the impact of a sphere onto a half-space. The calculations are done for the impact of a silicate sphere onto a silicate target for impact speeds of 15, 20, and 25 km/sec, spanning the range of reasonable impact speeds for asteroids. The angle of impact is varied from 0° (normal impact) to 75°. The mass jetted, the jet velocity, projectile fraction in the jet, the azimuthal distribution of the jet, and the phase of the jetted material (vapor or liquid) are calculated as functions of time. The total mass jetted and the overall mass-averages of jet velocity, etc. are also calculated. For the 75° impacts, there is a very fast, early jet (with a small jet in the back-range direction), followed by a significantly slower, but much longer lasting jet. The initial portion of the jet has an elevation angle of ~ 3° above the horizontal; the elevation angle increases with time up to a maximum of ~35°. These results agree at least qualitatively with the results of impact experiments on ice at 75° (P. H. Schultz, personal communication). Thus the use of this simple model gives results that agree in general with the available experimental data.

The initial, vapor portion of the jet is the fastest and has the highest mass flux; it is postulated that this portion of the jet can drive away atmosphere ahead of it, so that the liquid portion of the jet is ejected into a much rarified atmosphere. This overcomes one of the major problems for the theory of the terrestrial impact origin of tektites, which is how to propel molten material through the atmosphere for distances of hundreds to thousands of kilometers without the melt breaking up into a fine mist because of turbulent interactions with the air (Adams, 1965).

The results also show, however, that the jet comprises roughly half projectile material, which is strongly at odds with the observation that tektites, with one exception (Morgan, 1978), show no detectable projectile contamination. Although the jetting model used is quite simple, so that there is considerable uncertainty in the absolute projectile fraction, no reasonable variation in the assumptions will allow for a jet comprising only target material. This result seems intuitively obvious in retrospect, because jetting by definition requires the intimate interaction of impactor and target, and so the jet must contain a significant fraction of the projectile material. This leads to the firm conclusion that jetting cannot have produced tektites.

Jetting may, however, have produced the spherule beds recently found in Archean Greenstone belts in South Africa and Australia (Lowe and Byerly, 1986; Lowe et al., 1989). The largest of the South African spherule beds originally extended over an area at least 30 km by 100 km, ranges in thickness from a few centimeters to 1 m, and comprises 0.1 to 4 mm diameter spherules. The spherules were apparently deposited rapidly and simultaneously in a wide variety of sedimentary environments as a single fall layer. There is no evidence for volcanic or volcaniclastic material. The beds show extreme, though variable, Ir enrichment, and at least two of the beds are also enriched in Pd, Os, Pt, and Au in roughly chondritic proportions. The major element compositions are consistent with a mixture of underlying rock types and chondritic material.

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