SPLASH-FORM TEKTITES: ORIGIN IN IMPACT PLUMES

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Although the impact community commonly attributes the formation of splash-form tektites to pressure-induced melting during crater formation [e.g., 1], there are problems with this hypothesis. Impact melts are formed either at the crater floor or at the interface between the projectile and the target. However, ^{10}Be ($t_{½}$ = 1.5 Ma) is found in soil-like concentrations in tektites [2], which rules out formation at depths lower than ~50 cm. The general absence of siderophile contamination of tektites [3] is inconsistent with formation by jetting at the interface between the projectile and the target.

A temperature of ~2300 K is required to melt tektitic material and reduce its viscosity to 50-100 poise [4]. Glasses collected near craters contain ubiquitous clasts and relict mineral grains. Heat is distributed heterogeneously in impact events and the products with high melt contents cooled too quickly to allow heat to diffuse to the centers of cm-size clasts. In contrast, splash tektites are essentially free of unmelted minerals. One can sometimes recognize the size of the precursor grains in tektites and they are soil size, ~40 μm; at temperatures of ~2300 K, diffusion of heat to the centers of such grains occurs in 1 s.

As noted in previous studies, it is certainly easier to form tektites if the target surface is covered by dry soil at the time of formation; loess deposits, which are widespread during periods of global cooling, are ideal [5]. Wet soils require much more energy to melt because of the high latent heat of H_2O vaporization. Important in the following model, loess is more easily mobilized by air turbulence than are normal soils and sediments. Of interest is recent work indicating global cooling, and thus loess formation, at ~15 Ma ago, the age of the moldavites [6].

My working model for the formation of splash tektites is that they form from loess-like soils entrained by strong air currents at the base of an impact plume formed above a series of small overlapping craters; soil particles were then melted by conduction within the hot central region of the plume.

Some tektitic material was entrained by the high-velocity gas into near-Earth space and fell out thousands of km from the center of the plume. This requires gas speeds of 2-5 km s^{-1}; for N_2 at 3 km s^{-1} the gas-kinetic temperature is ~10000 K; tektitic melts could not have been at this temperature long without vaporization. In fact, a sizable fraction of the gas velocity may have been translational, produced by explosive acceleration of the gas at ground level. If half the velocity were translational, the remaining velocity would correspond to a temperature of 2500 K.

Advantages of this plume model are that 1) because the entrained dust originates on the immediate surface, it readily accounts for the soil-level ^{10}Be contents; 2) because the sampled area is much larger than the footprint of a single, bowl-shaped crater, it can more easily account for the relatively large quantity of soil required to account for the tektites in the Australasian field; 3) it accounts for the absence of large particles in splash tektites; and 4) it offers a mechanism for launching splash tektites above the atmosphere.

References: [1] Stöffler D. et al. 2002. MPS 37: 1893. [2] Ma P. et al. 2004. GCA 68:3883. [3] Wasson J. 1991. EPSL 102:95. [4] Wasson J. 2003. Astrobiology 3: 163. [5] Wasson J. and Heins W. 0993. JGR 98: 3043. [6] Shevenell A. GGG 9: Q02006.