

## SELECTIVE EJECTION: ARE TEKTITES LAUNCHED UP LOW-DENSITY ENTRY WAKES?

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**Introduction:** The chemical, isotopic, and physical properties of tektites, as well as their ages, geographical distribution, and association with known impact events, has allowed some inferences about how they formed. However, a detailed physical model of tektite origin that explains all observed attributes is still lacking. Among the observations that must be explained are, 1) Asymmetry; all three main strewn fields with known impact craters are offset from the presumed source, and the fourth (Australasian tektite field) is offset from the geographic location of its peak concentration 2) Rarity; there are only four known main tektite strewn fields compared to about two hundred confirmed impact craters on Earth, 3) Derived from near-surface target rocks based on cosmogenic nuclide studies; 4) Minor meteoritic component, 5) Very low volatile content, 6) Compositionally homogeneous, 7) Rapidly quenched from melt, 8) Reduced chemistry, 9) Ballistic and aerodynamic shapes [1].

**Entry wake ejection hypothesis:** Our hypothesis is that tektites originate from the highest-velocity material in the ejecta curtain that is accelerated from near ground zero immediately after the impact. The vast majority of these ejecta fragments encounter dense and stationary air where they are rapidly decelerated by aerodynamic drag. However, there is one direction in which there is little drag on an object launched from the surface, and that is the high-temperature, low-density, expanding wake associated with the object that traversed the atmosphere just prior to impact. The drag force that slows down ejecta scales as  $\rho v^2$  where  $v$  is velocity of the ejecta relative to the medium through which it is moving, and  $\rho$  is the density of the medium. The lower drag on ejecta launched into the wake is due to the much lower density, as well as the lower relative velocity due to the high velocity outward flow within the wake that generates a ballistic plume analogous to those observed on Jupiter after the impact of fragments of Comet Shoemaker-Levy 9 (SL9). In the case of SL9, condensation from the vaporized impactor was entrained into the plume, which collapsed in the uprange direction with some Coriolis rotation. The pattern of this collapsed plume was offset from the point of impact, and is analogous to the strewn field of tektites associated with impacts on Earth [2].

**Consistency with tektite attributes:** 1) Tektites are derived from ejecta through the uprange wake, thus the strewn field is offset in that direction. 2) The wake must have an elevation angle that aligns with the ejection angle of the early high-speed ejecta (about 45°). Tektites are rare because objects can arrive from any direction, but only a small fraction has this entry angle. 3) The highest-speed early ejecta source is derived from shallow target rocks. 4) Tektites ejected through the wake encounter meteoritic ablation vapor and are contaminated by it. 5) Wake temperatures are thousands of degrees, and have high opacities due to ionization and cations from ablation products. Heat transfer to ejecta is efficient but the partial pressure of volatiles in the wake is low and volatiles boil out of molten ejecta. 6) Hypervelocity fluid flow of melt as it accelerates through wake leads to rapid mixing and homogenization. 7) Molten ejecta makes abrupt transition to ballistic suborbit in the vacuum of space as it exits the top of the plume, and quenches due to radiative cooling before reentry. 8) The superheated molten ejecta fragments are reduced by free electrons associated with meteoritic ablation vapor in the expanding wake. 9) Molten blobs with various spin states in the turbulent hypervelocity flow of the wake are abruptly released into freefall when they exit the top of the plume where their shapes are preserved when they quench to glass. Preliminary hydrocode simulations provide support for and constraints on this model.

**References:** [1] Koeberl C. (1994) Tektite origin by hypervelocity asteroidal or cometary impact. *Large meteorite impacts and planetary evolution, GSA Special Paper* 293:133-151. [2] Boslough M. B. and Crawford D. A. (1997) Shoemaker-Levy 9 and plume-forming collisions on Earth. *Annals of the New York Academy of Sciences* 822:236-282.