Suborbital Obstruction Shadowing & Transport Imprint Matching

Poster Table Hand-out: T.H.S. Harris[1]

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Emplacement origin within the geologic record may be shown as catastrophic vs. gradual based on composition [1]. A technique is presented to identify (ID) ejecta emplacements from large-scale cosmic impact via morphometric composition of suborbital signatures, including basic shapes, emplaced locations $\boldsymbol{B_i}$, orientation, etc. ID validity increases with frequency $\boldsymbol{n}$ of recurring suborbital signature shape function $\boldsymbol{\phi}$ (i.e. Eigenshape, Phi or Zahn-Roskies, or Fourier function) and inversely with deviation from that emplaced shape function $\boldsymbol{\phi}$. Each transport process significantly affecting observed $\boldsymbol{\phi}$ must be modeled for high validity, high confidence of suborbital transport orogeny.

For transport motive potential of disrupted target supplied by adiabatic expansion of shock-energized target volatile overburden [2], bulk target mass [3], the bolide [4], or a combination, the transported mass may lack any imprinted shock signature. During outflow of shocked volatiles, pieces of disrupted target become entrained within the outflow, their relative acceleration varying inversely with Ballistic Coefficient (BC) [5]. Smaller particles (low BC) are accelerated more quickly than larger ones (higher BC) [5,6], the former overtaking the latter during energized volatile outflow.

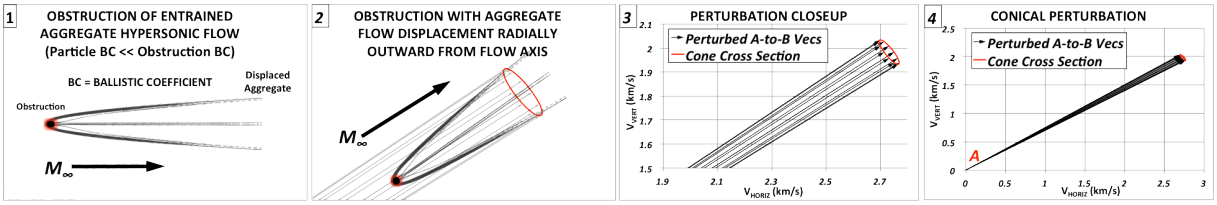

Figure 1: Hypersonic outflow obstruction model of ascent phase Suborbital Imprinting. Left to right, 1) shock cone of generic obstruction (red) showing displaced aggregate flow, 2) shock cone causes radial perturbation of velocity (VEL) relative to flow axis, 3) perturbed VEL vectors nearly identical in magnitude & nearly parallel, 4) launch VEL vector cone vertex at origin, launch point A (red).

Suborbital signatures may imprint on ejecta in two stages [7,8]. Stage 1 takes place early in ascent (Fig. 1). Hypersonic bow shock of a large obstruction displaces smaller entrained aggregate radially outward from the flow axis, modelled by simple conical perturbation of launch conditions. For a suspected regional scale ejecta emplacement, Δ (delta) elevation and Δ azimuth (ΔEL, ΔAZ) are orders of magnitude less than unity (i.e. ≤ 10^{-4} rad) and the Δ |velocity| (Δ|VEL|) required to match the observed emplacement shape $\boldsymbol{\phi}$ is also ≤ |VEL| x 10^{-4}, all for a valid (realistically small) obstruction-to-blast scale ratio. Stage 2 imprinting is the convolution of suborbital mechanics during ballistic flight, as stage 1 Δ values produce non-linear, launch state dependent emplacement mapping (fall site variation) $\boldsymbol{\phi}$. EL, AZ and speed deltas give worst-case target error in suborbital ballistics analysis. In this case $\boldsymbol{\phi}$ is given and the deltas are calculated for a circular or nearly circular cone.

References:

[1] Alvarez L W et al. (1980) Extraterrestrial Cause for the Cretaceous–Tertiary Extinction *Science* 208 (4448)

[2] O'Keefe J D et al. (2001) Damage and Rock-Volatile Mixture Effects on Impact Crater Formation International *Journal of Impact Engineering* 26 543-553

[3] Kenkmann T et al. (2011) Experimental Impact Cratering in Sandstone: the Effect of Pore Fluids *11th Hypervelocity Impact Symposium* No.97

[4] O'Keefe J D, Ahrens T J, (1982) Cometary and Meteorite Swarm Impact on Planetary Surfaces *Journal of Geophysical Research* V87 #B8 6668-6680

[5] Lin S C (1966) Cometary Impact and the Origin of Tektites *Journal of Geophysical Research* V71 #10

[6] Rager A H et al. (2013) The Effects of Water Vaporization On Rock Fragmentation During Rapid Decompression… *Earth and Planetary Science Letters* 385 (2014) 68-78

[7] Harris T H S (2015) Suborbital Obstruction Shadowing *Geological Society of America Fall Meeting* 260536

[8] Harris T H S (2015) Suborbital Imprint Matching *Geological Society of America Fall Meeting* 260547