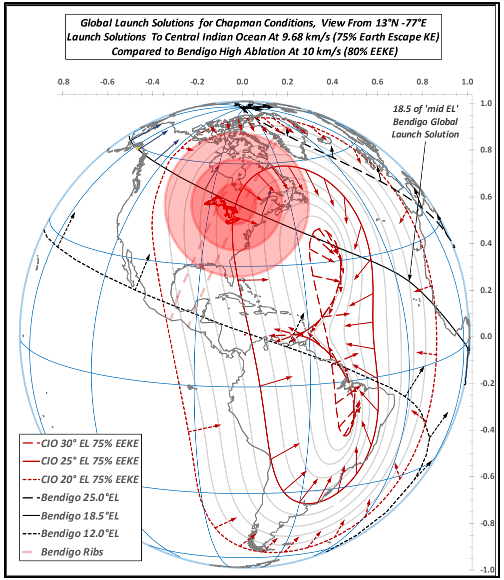
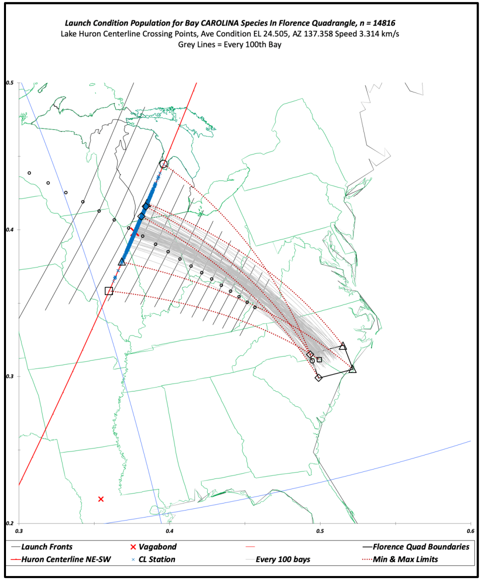
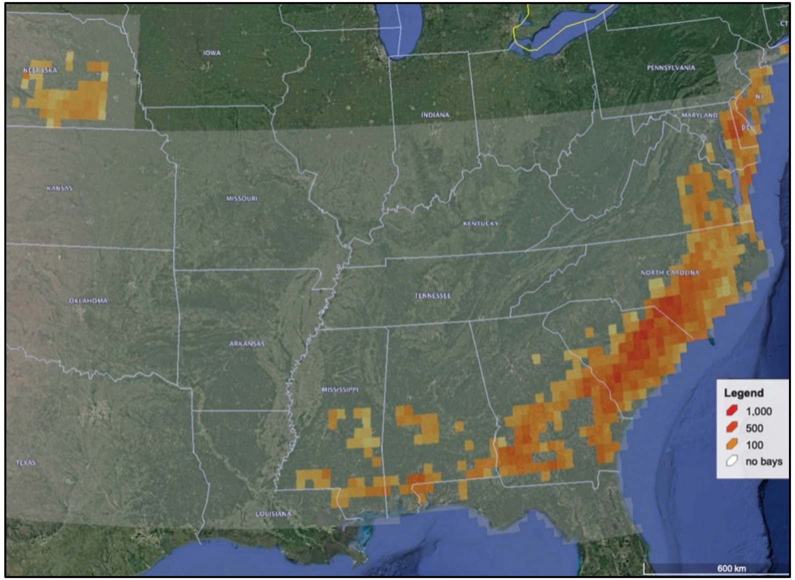
LiDAR-Mapped Giant Sand Blanket and Ablated Tektites Suggest Same Source

Thomas H. S. Harris, GE AstroSpace, Lockheed Martin, Boeing Helicopter, retired





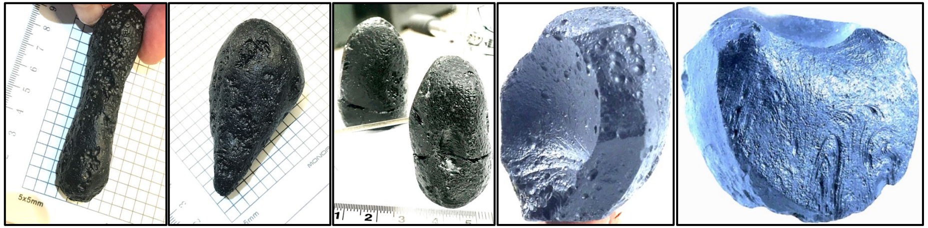


Observation-based speculation of North American Great Lakes as a mid Pleistocene impact structure, parent of the Australasian tektites and Carolina bays

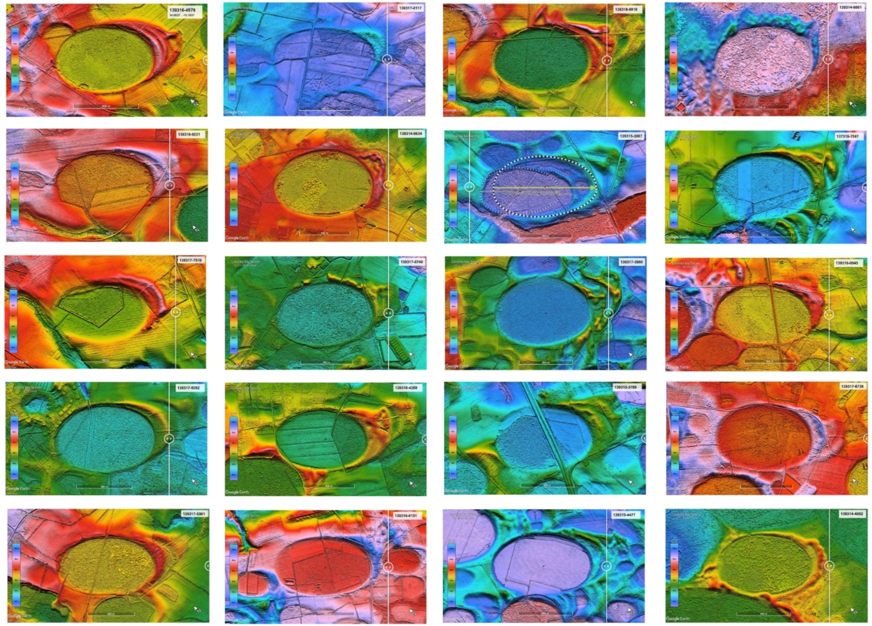
Sand Blanket & Australasian Tektites Suggest Same Source

Thomas H. S. Harris, GE AstroSpace, Lockheed Martin, Boeing Helicopter, retired

Top row, left to right: familiar dumbbell, teardrop and 3 fragment-form indochinites. Plastic deformation after brittle fracture reveals transport thermal cycling, requiring persistent energy source. Naturally ablated Australasian tektites (bottom row of 3) were reproduced using tektite glass (next to bottom 3) to determine reentry conditions of atmospheric reentry speed and elevation angle. Volatiles at the target are indicated by broad Australasian tektite dispersal & reentry speed >= 10 km/s or 80% of Earth's escape KE for a majority of the 30 to 60 billion tons or 0.17 km³ of estimated AA tektite melt (B. P. Glass, D. R. Chapman).



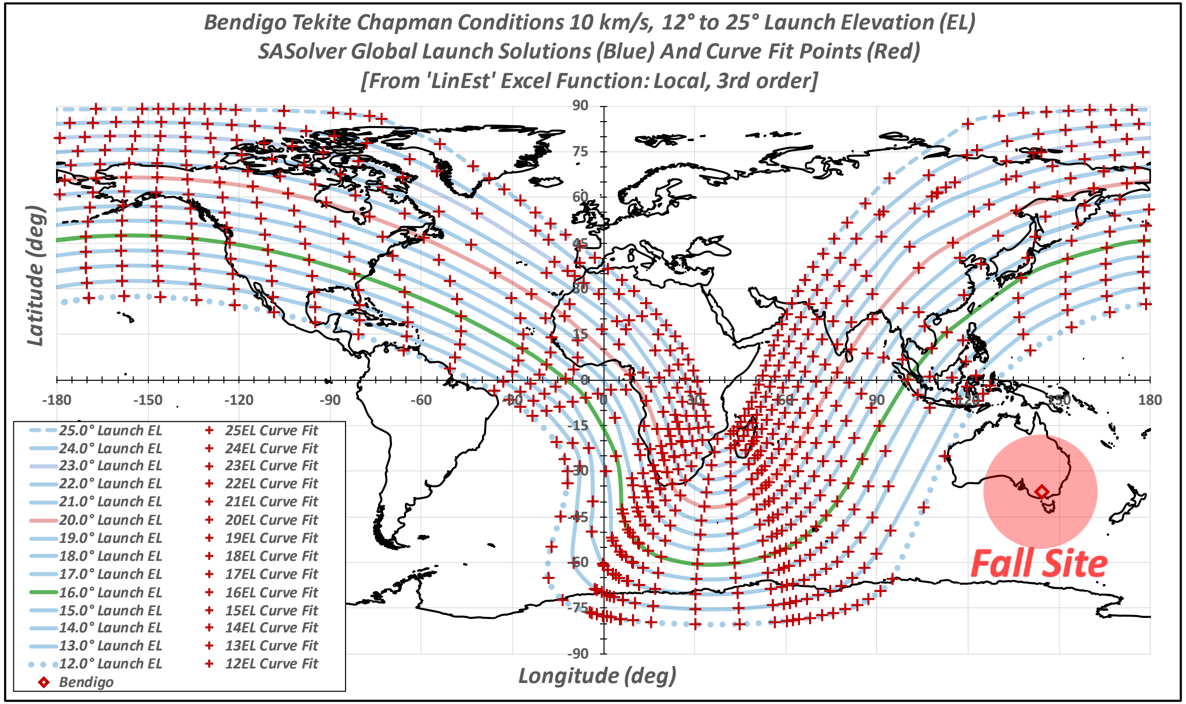
4 columns of 5 Carolina bays with similar rim features, Cintos.org LiDAR



Australasian Tektites (AAT)

- Australasian Tektites (AAT)
  - 30 to 60 Billion tons distal impact ejecta melt glass, devolatilized, vacuum quenched.
  - Central strewnfield region is S. E. Asia, microtektites to Antarctica, Madagascar, ¼ of Earth's surface…
  - Fragment-form AAT show post-solidification plastic deformation consistent with high-voltage arcing damage.
  - Implied electromagnetic (EM) involvement suggests ionized volatiles (i.e., disrupted H2O ice).
  - Distal ejecta tektites follow suborbital laws of motion, not proximal ejecta blanket distribution profile in continuous thickness from the crater rim (NASA's 1960s error of omission).
  - Reentry at 10 km/s (80% Earth escape KE) implies vaporized silicates, but AAT are largely unfractionated except for furthest-south microtektites, near South Pole. How does partitioning allow non-vaporized melt to reach 10 km/s? (not all shock…)
  - EM 'rail-gun' effect may have altered transport KE via addition *or* subtraction, per Harris (2021a) LPSC 52.
  - 789 ka mid Pleistocene Transition Impact ejecta melt, w/ 1.6 Ga shocked zircons & other rare, unmelted mineral grains
  - Precursor signal of the Brunhes-Matuyama geomagnetic reversal is co-eval with AAT event : -)
- Global climate cycle change from 40 ka to 100 ka seems to have started *before* 789 ka, as did the benthic extinction ramp up in every ocean basin during the Pleistocene. Both effects also peaked at the mid Pleistocene transition, pinned at the Brunhes-Matuyama geomagnetic reversal precursor signal.

Suborbital Analysis Of Australasian Tektites (AAT)



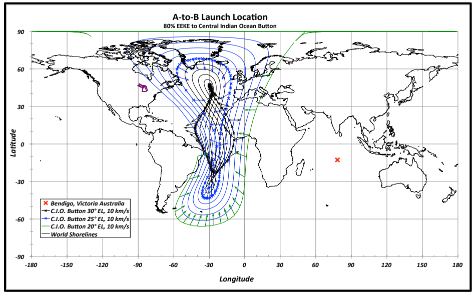
- The best-characterized reentry case for S.E. Australia ablated ‘button’ tektites is for high ablation specimens of the Port Campbell repository from the Bendigo region, the red diamond at lower right, per Chapman & Larson (1963).
- *A*-given-*B* Bendigo button launch solution curves for 10 km/s speed and 12° to 25° elevation (EL) are shown for 1° EL increments, with the most likely launch being in the midrange of those values, center of the swath on the map[1,2].
- The single Bendigo case doesn’t narrow down the possible region of origin. Another tektite fall site with defined ablation should indicate intersecting launch regions on continental landmass….

1) *Davias, Harris (2022) GSA Special Papers Vol. 553, ch. 24.*

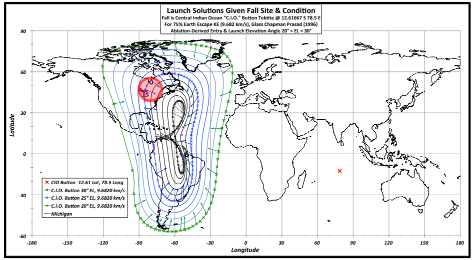
2) *Harris (2022) GSA Special Papers Vol. 553, ch. 23.*

Suborbital Analysis Of Australasian Tektites (AAT)

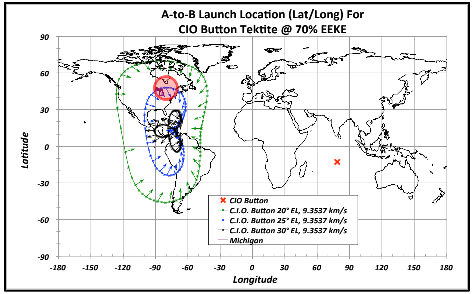
80% Escape KE

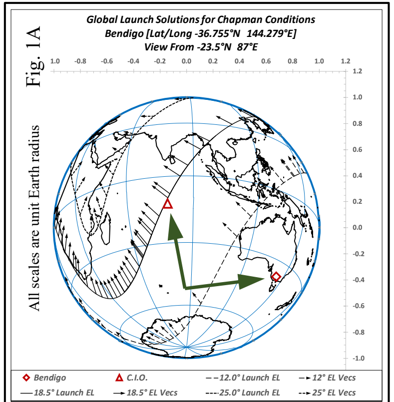


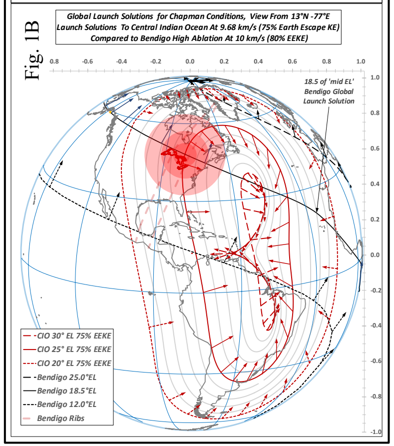
75% Escape KE



70% Escape KE

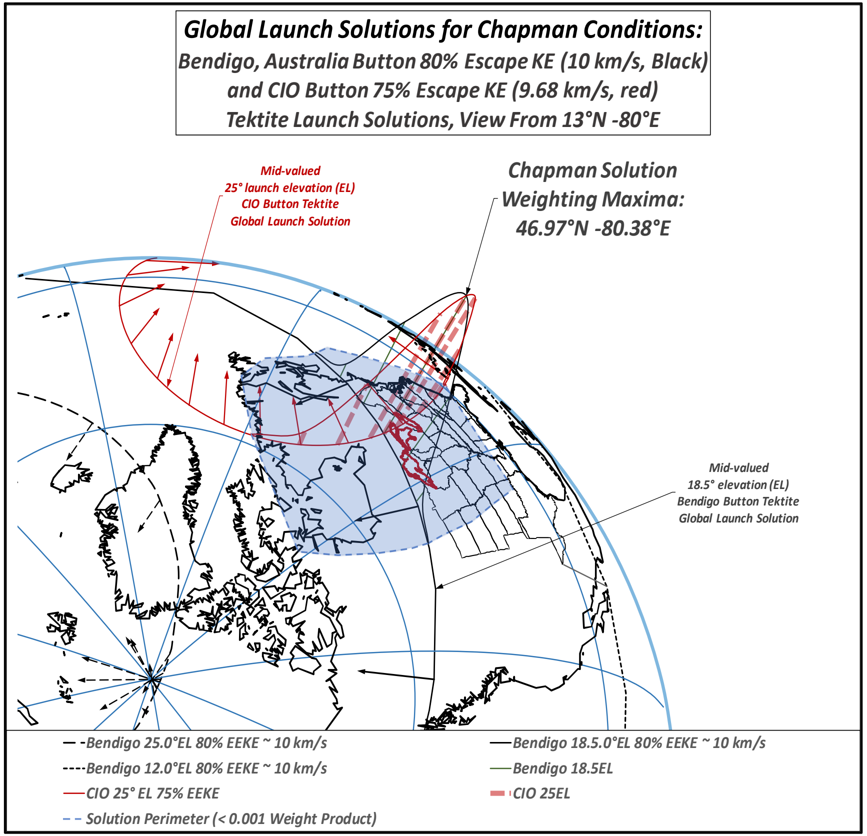






- A well preserved Australasian ablated 'button' tektite was found in the **Central Indian Ocean (CIO)**, per Glass, Chapman, Prasad (1996).
- The **CIO button** reentered at **less speed than the Bendigo** ablated button tektite, and **between 20° and 30° elevation**. There is no known way to determine azimuth of a tektite fall.
- The CIO ablated button tektite case narrows down the possible region of AAT origin. "Chapman condition" (per Chapman '62-3-4) **launch solutions for the CIO button and the Bendigo button intersect at right angles over the N. A. Great Lakes.**
- This is **derived directly from physical evidence of the tektites themselves**, along with analytic, numeric & test results on tektite ablation, and from the physical mechanics that govern suborbital motion. ("…it's the law…")
- **Implication: we have focused the AAT source search on the wrong side of Earth for 5+ decades based on an error of omission made repeatedly in the 1960s and missed until now.**

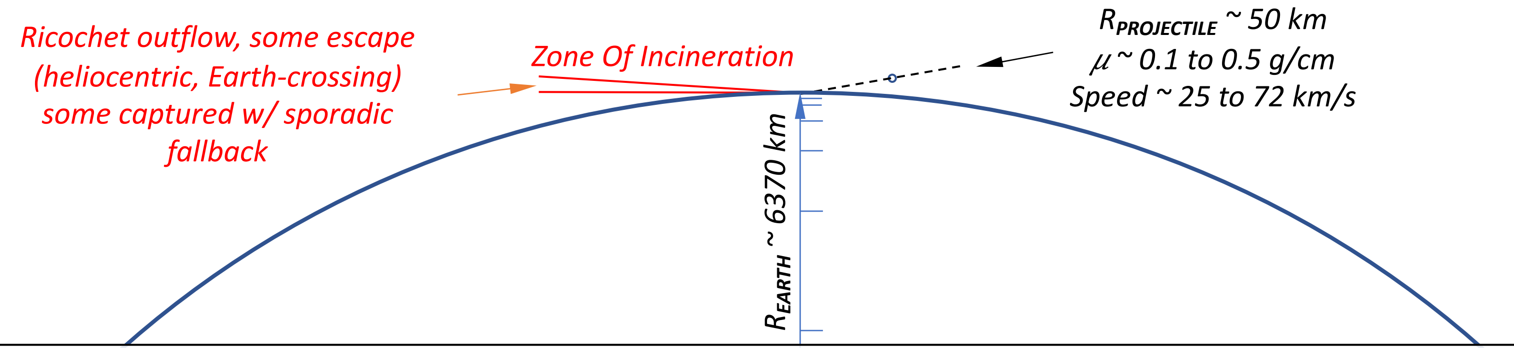
Suborbital Analysis Of Australasian Tektites (AAT)



Modified from Harris, LPSC 52 (2021)

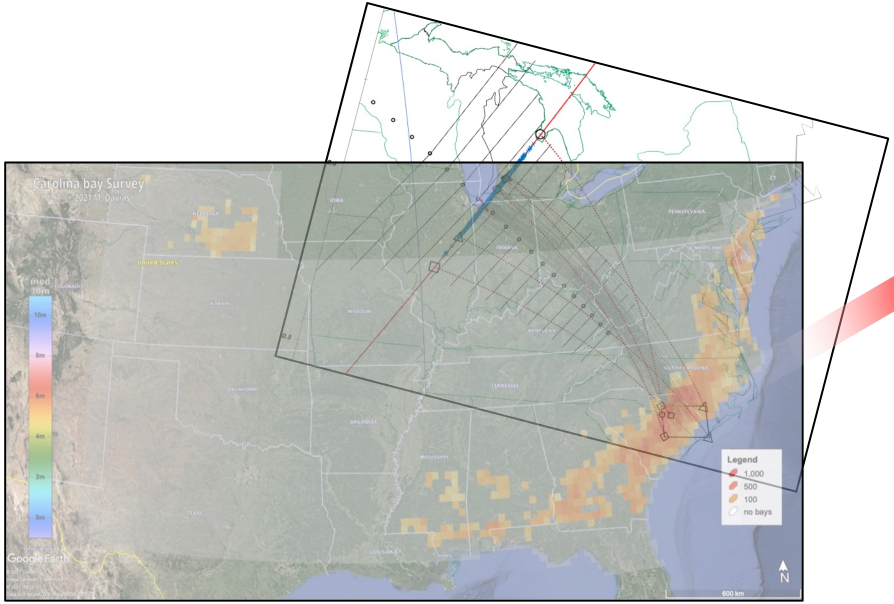
Ablated Tektites and Sand Blanket Indicate Same Source

What imprint is created by a large, low density cosmic projectile after an oblique impact into thick ice?



- Oblique impacts:
  - Increase involved target surface & volatile overburden *convoluting the imprint*,
  - Decrease excavation efficiency (potentially decreasing overall imprint energy),
  - Early-stage excavation outflow has downrange momentum coupled from oblique impact, later-stage excavation is cross-track momentum (‘butterfly’ ejecta pattern).
- H2O ice has very low impedance to hypervelocity shock, quickly absorbing heat and post-shock speed. This *convolutes* and reduces damage effects in target substrate.
- Comets are lower average density than water, *convoluting the imprint.*
- Comet impact into a continental ice sheet at oblique angle… what happens?

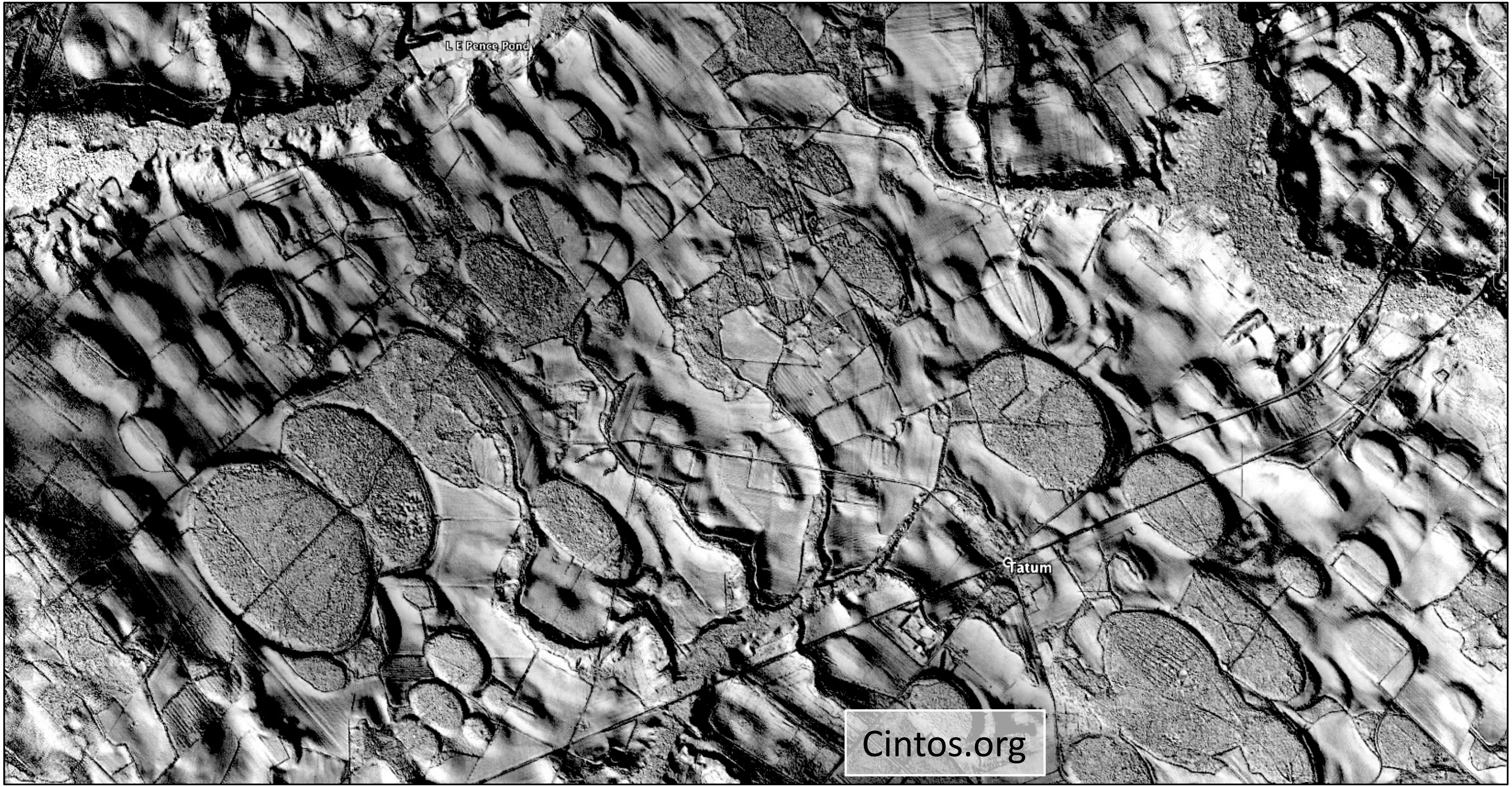
Carolina Bays….



Carolina Bays Condensed Review

For a more complete treatment of Carolina bays see Cintos.org with accompanying work by M. E. Davias.

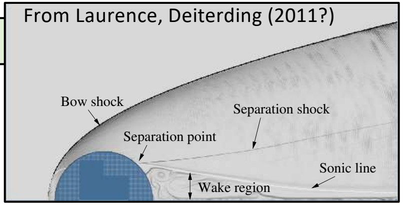
- **1600 cubic km of angular to sub-angular grain texture, nearly pure quartz allochthonous sand, in a 2-to-10 m thick shallow subsurface blanket spread across 400,000+ square km, through a range of altitudes from slightly below sea level to 600+ meters. Playa could put upper height at 1000+ meters)**
- **The sand unit has no bedding structure or biotic detritus, is often tightly interlocked and shows monotonous bulk uniformity & large, sometimes 'frosted' or fractured angular to sub-angular grains.**
- **Tens of thousands of shallow basins are expressed in the upper contact of the shallow subsurface blanket, conforming to *just 6 perturbed elliptical planform shapes* aligned in systematic orientation by region, with log-normal size distribution from a few hundred meters to several km in major axis length.**
- **The perturbed ellipses (Davias Archetypes) are reproducible with Suborbital Analysis and perturbational technique of ballistic targeting error probability. Carolina bays (CBays) are nearly identical to circular error probability (C.E.P.) diagrams, derived by launch condition variation and observed fall point delta.**
- **This feature set of the geologic record needs interdisciplinary consideration to explain its observed details: single-discipline explanations fall short. Astronomic signatures in the CBays imply suborbital mechanics as a significant governing influence in their expressed topology, with pressure gradients and Gas Dynamics of an impact expansion plume as suggested actors influencing Carolina bay emplacement.**
- **This is a serious situation due to the gigantic scale and relatively recent formative epoch of 789 ka.**

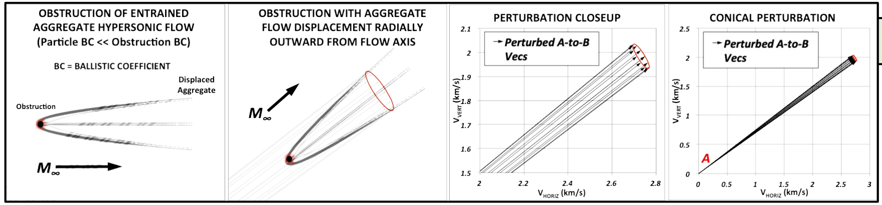

L E Pence Pond
Tatum
Cintos.org

Suborbital Analysis Of Carolina Bays:

- Suborbital Obstruction Shadowing (Harris GSA 2015) **recreates Carolina bay ovals and orientations using combined Gas Dynamics and suborbital ballistic targeting 'conic perturbation' analysis**
- **All six Davias Archetype bay planforms are are easily reproduced with minor launch perturbation**
- **Contemporary volume of the sand is ~1600 km^3 while the Australasian tektite mass equates to roughly 0.17 km^3**
- **Implied sand launch speed range of ~ 3.2 km/s < $|\underline{V}|_{SAND/AGGREGATE}$ < 3.8 km/s.**
- **Lake Huron's contemporary area is ~60,000 km^2**

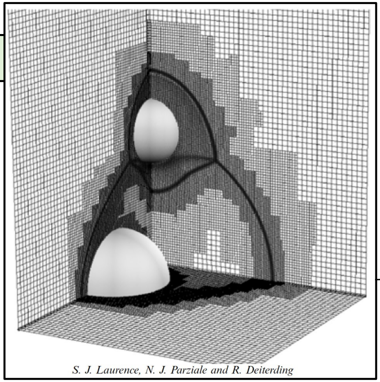
Frame 1



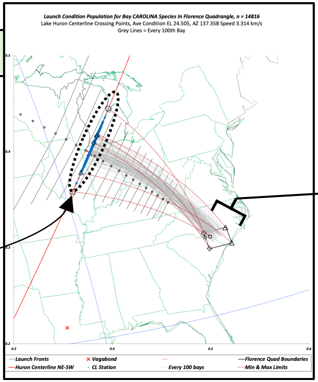


Frame 2

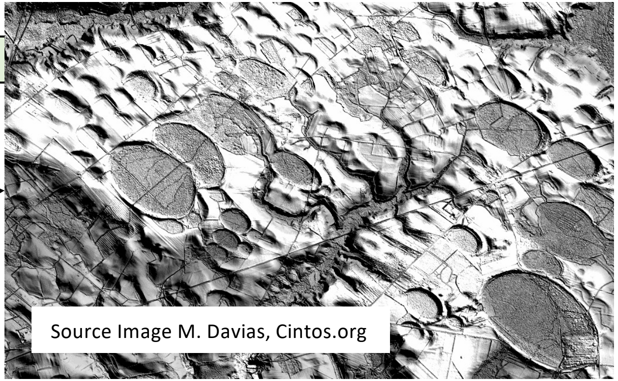
Frame 3



Frame 4



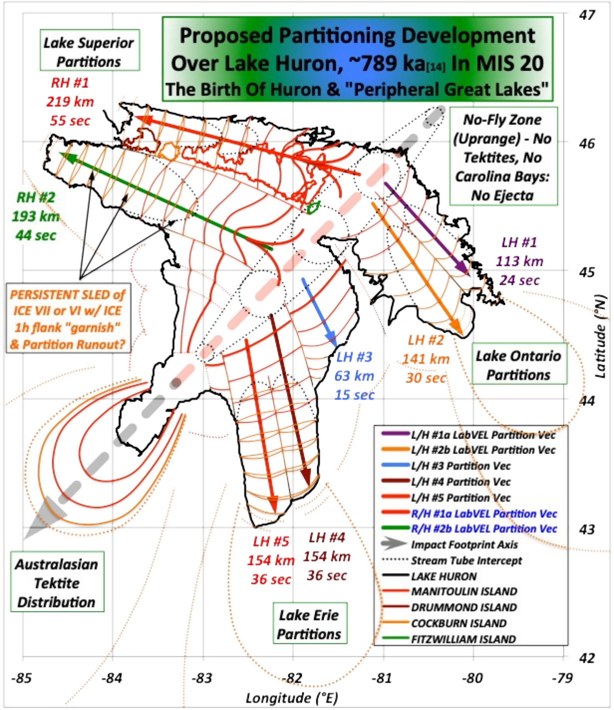
Frame 5



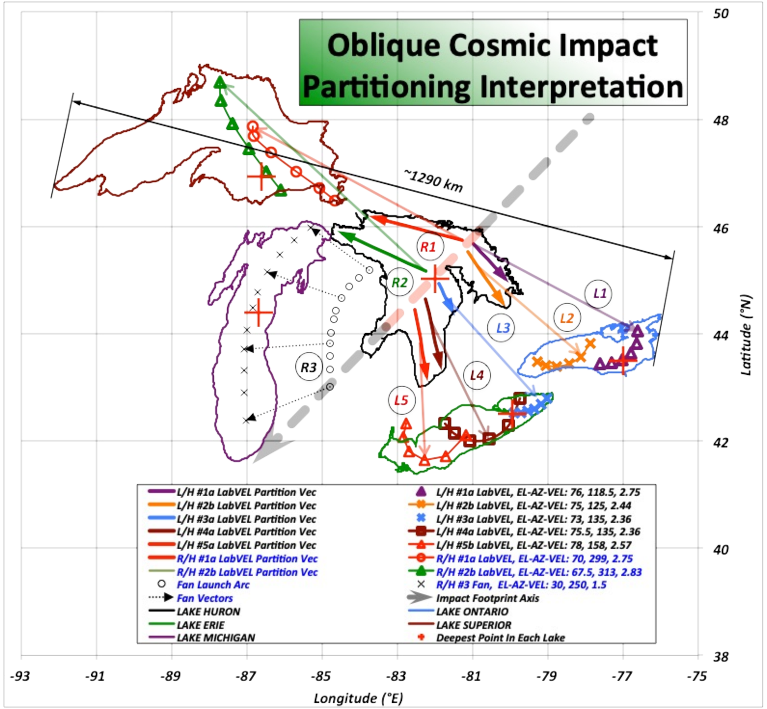
Possible Cosmic KE Partitioning Scenario Over Lake Huron

'Linear features' of Lake Huron are 'directed' toward each basin of the 'peripheral' N. A. Great Lakes.

Proposed Shock Partitioning Into Ice Above Lake Huron



Layout of the N. American Great Lakes



KE Partitioning Scenario Over Lake Huron

Spontaneous Comminution From Rapid Decompression & Stored Potential, Or… "Endogenic Comminution" (Rager et al. 2014).

- **Porous hydrated sandstone absorbs potential energy when compressed and heated.**
- **Impact compression and added heat migrate pore water toward the critical point above the vapor dome of H_2O.**
- **Impulsive depressurization (ice removal) triggers pore water flash to steam and explosive comminution.**

A.H. Rager et al. / Earth and Planetary Science Letters 385 (2014) 68–78 71

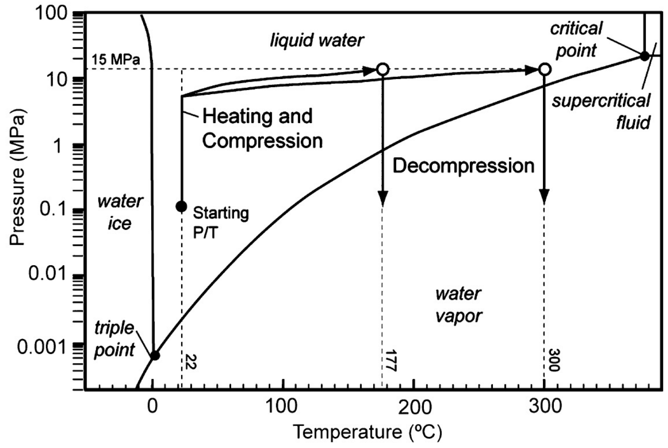
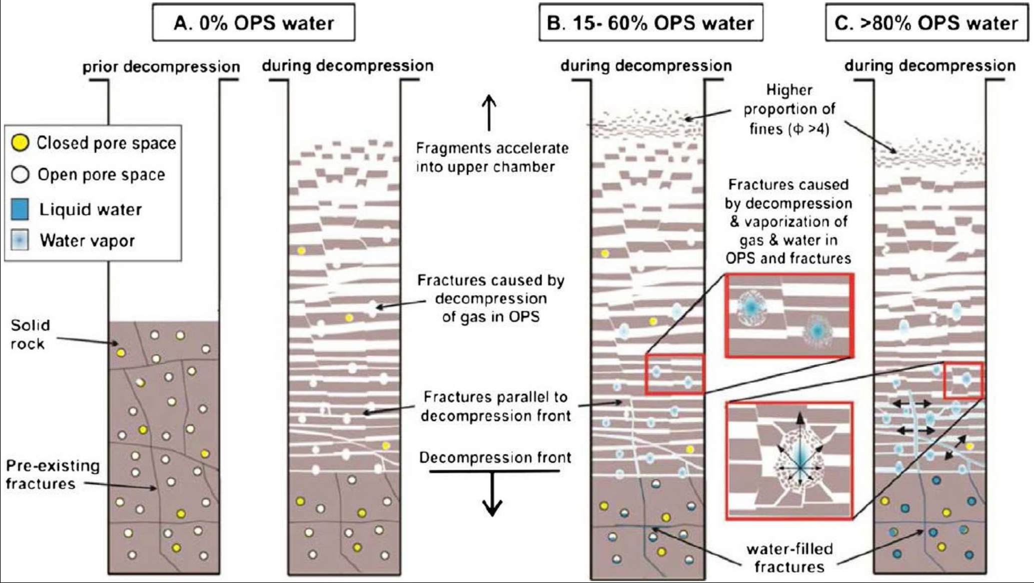


Fig. 5. Experimental pressure and temperature conditions. Samples were first pressurized to about 10 MPa, then pressurized and heated to 15 MPa and 177 or 300 °C to keep the samples above the vaporization curve for water until instantaneous decompression.

A.H. Rager et al. / Earth and Planetary Science Letters 385 (2014) 68–78



Sand Blanket and Tektite Siblings
Discussion & Conclusion

- ***Suborbital Analysis (SA)*** **of two independent geologic signals from opposite sides of Earth implies they are siblings.**
  - **The Australasian tektites (AAT) indicate the N. American Great Lakes as their source region per the *A*-given-*B* (inverse) suborbital problem[1,2].**
  - **The N. American Carolina bay landform with its repetitive ovoid depressions indicate a similar source region per *A*-given-*B* suborbital assessment.**
- **When considered separately, the above results have little relevance or apparent meaning within contemporary Earth sciences.**
- **Considered together, they suggest the long-sought home of the Australasian tektites may lie in plain sight, too big to see, convoluted by oblique impact of a low-density projectile, with of-epoch ice involvement and subsequent scour-cycle modification.**

1) *Davias, Harris (2022) GSA Special Papers Vol. 553, ch. 24.*
2) *Harris (2022) GSA Special Papers Vol. 553, ch. 23.*

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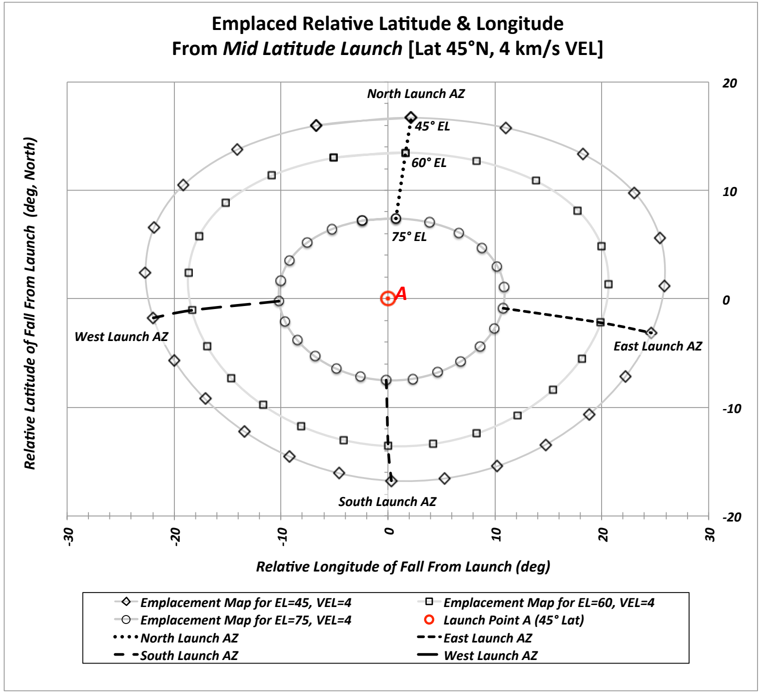
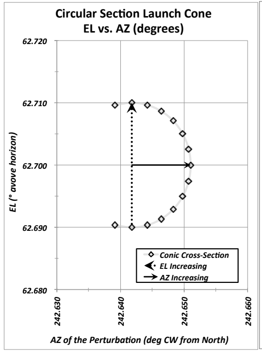
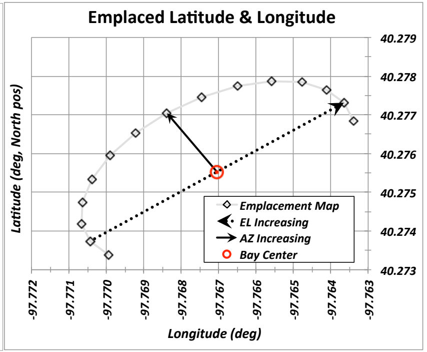
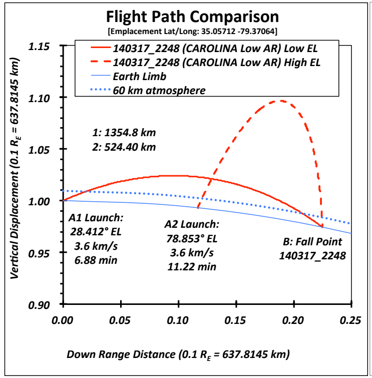
Appendix 1: Suborbital Analysis Of Carolina Bays:

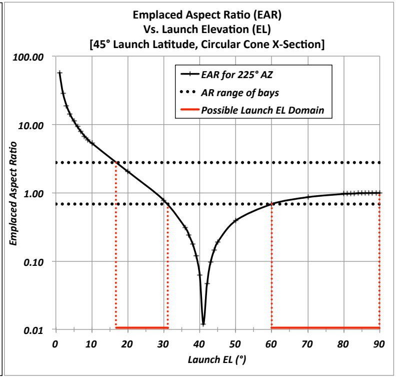
It is helpful to observe ejecta fall patterns of specific symmetric launch conditions







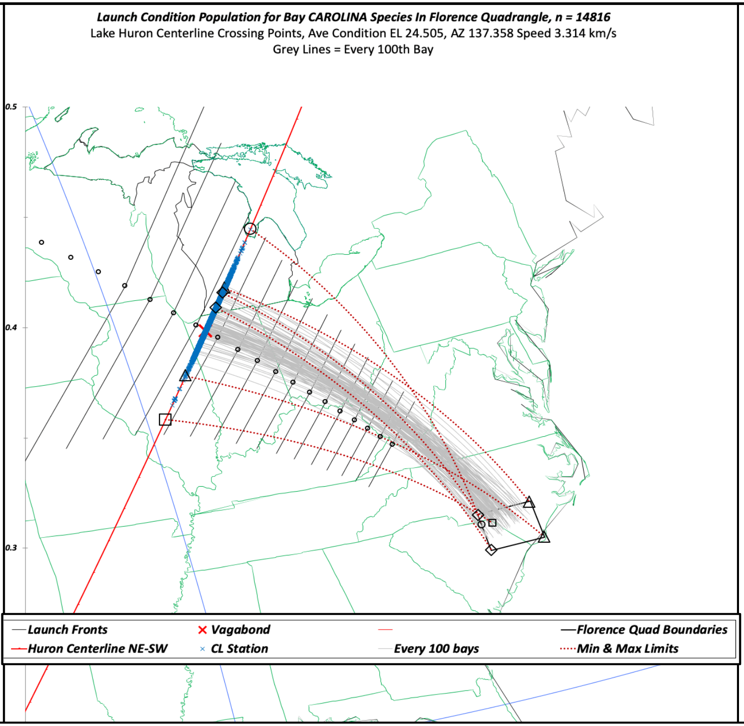




Appendix 1: Suborbital Analysis Of Carolina Bays:

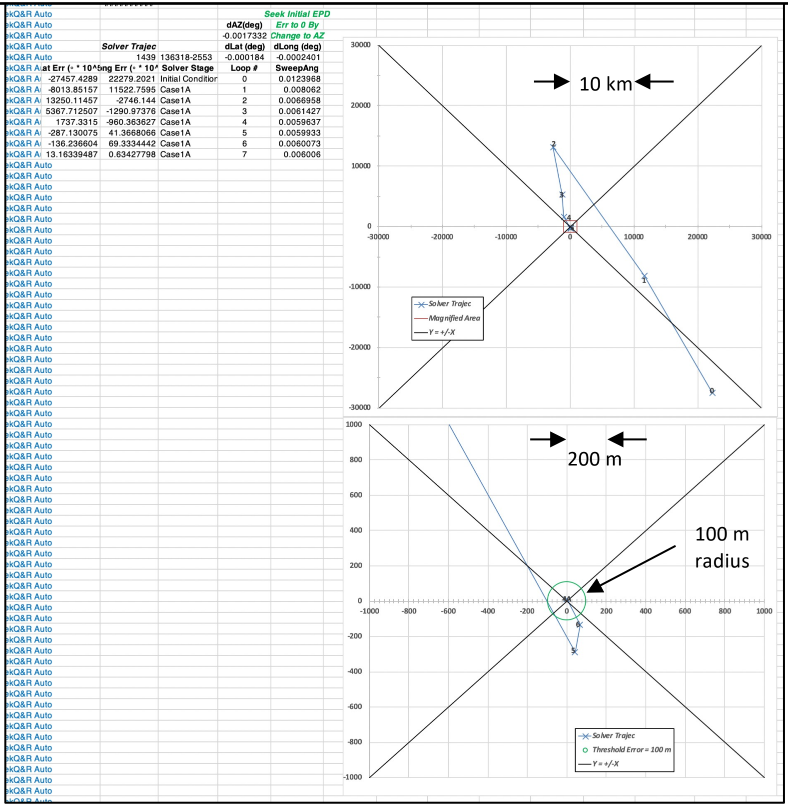
Using Aspect Ratio, Bearing And Speed Or Reference Line Crossing For High-Confidence Example Bays (n = 14816) Of The Florence Quadrangle

Solver Finds Launch Elevation (EL), Azimuth (AZ) and Speed (VEL) Based On Cbay Aspect Ratio, Surveyed Bearing & Location Of Bay Per Cintos Survey.



*Launch point set along the red downrange line has hybrid stats as functions of both The **Carolina bays** and the expression of **Lake Huron**. Each **Davias archetype** bay group has unique launch stats along this line.*

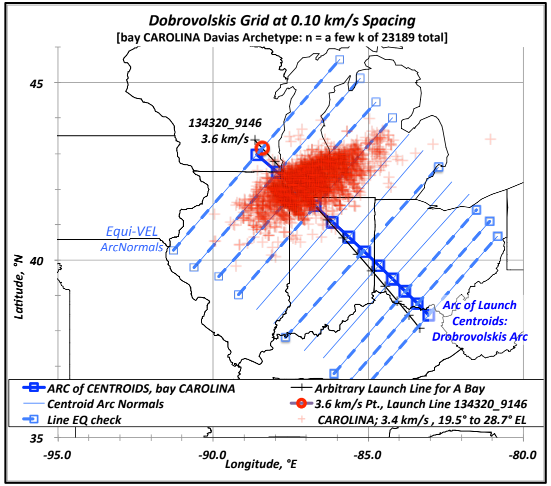
Solver Iterates To Minimize Fall Site Error For Varying Launch Point Along Lake Huron's Extended N.E.-to-S.W. Axis Or Centerline. Error Threshold Set At 100m.

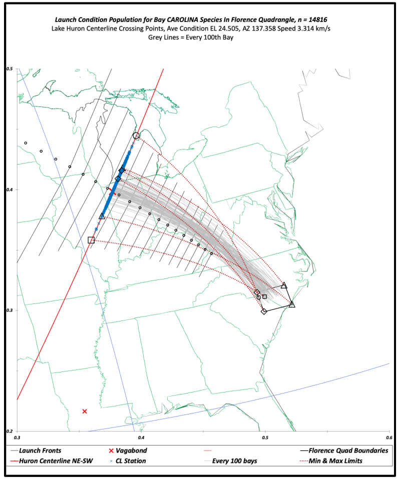


Appendix 1: Suborbital Analysis Of Carolina Bays:

A linear source is implied, from Great Lakes region spreading S.W. roughly half-way to east Texas

- **When solved for all the same launch speed, the bay launch points cluster to the southwest of Lake Huron, per left frame below.**
- **It is also possible to specify a single line as the NE-to-SW 'bisector' or 'centerline' of Lake Huron at ~225° bearing (lower right frame), to solve trajectories w/ associated launch conditions (EL-AZ-VEL) of all bays where they cross that line. This constrains suborbital transport speed *based on Lake Huron's shape*: average speed = 3.324 km/s for n of 14816 high confidence Bay Carolina samples from M.E. Davias. The average azimuth forms a sub-perpendicular angle with Lake Huron's centerline (acute to the south of CL), implying a net down-range momentum current speed of ~0.4 km/s, or 24.0 km/min to the S.W. This is consistent with Schultz & Gault (1990).**





Appendix 1: Suborbital Analysis Of Carolina Bays:

Reproduction of Davias Archetype Planforms, Fox Hunter bay, Delaware example (Bell archetype)

Fox Hunter Bay, DE Survey #155302_6061

		Bay Bell EL	AZ	VEL	LAT	LONG		
					aim point 38.90074446	-75.65427148		
		57.50000	112.90000	3.52701	39.0588533	-75.5308100	20.6	km
		57.50000	113.89900	3.52701	38.89368322	-75.68405648	1.41	km
		57.45200	113.856000	3.5270073	38.90067439	-75.65415303	88.2	cm
This is the launch from Huron Approach		57.45255	113.85600	3.527007	38.90074231	-75.65427295	33.12	cm
Centroid		57.4526	113.856	3.527007	38.90074607	-75.65426284	33.12	cm
DR	SE	57.461650	113.856000	3.5270293	38.9000562	-75.65245499	174.91	m
UR	NW	57.443450	113.856000	3.5269863	38.90133923	-75.65583613	152.36	m
R/H	SW	57.452550	113.863800	3.5270073	38.89924067	-75.6552756	191.27	m
L/H	NE	57.452550	113.847450	3.5270073	38.90187518	-75.65350342	141.39	m

Lower this to soften corners of Bell

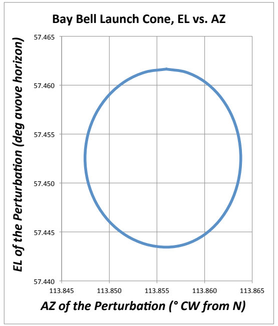
Coefficient	*R/H Coefficient*	*L/H Coefficient*	*Downrange Coefficient*	*Uprange Coefficient*	*V~|AZ|^2 Coefficient*	
0.91	0.78	0.855	0.022	0.021	0.082	
Del EL	Del AZ	Del AZ	Del VEL Plus	Del VEL Minu	ABS(AZ)	
0.01	0.01	0.01	0.001	0.001	0.001	km/s

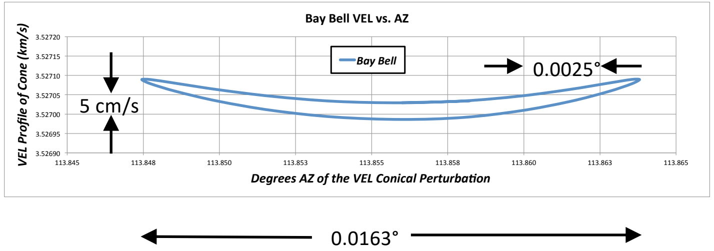
R/H Coefficient	*L/H Coefficient*	*VEL Downrange Coefficient*	*VEL Uprange Coefficient*	*V~|AZ|^2 Coefficient*	
0.75	0.76	0.38	0.36	0.07	
Del AZ	Del AZ	Del VEL Plus	Del VEL Minu	ABS(AZ)	
0.01	0.01	0.001	0.001	0.001	km/s

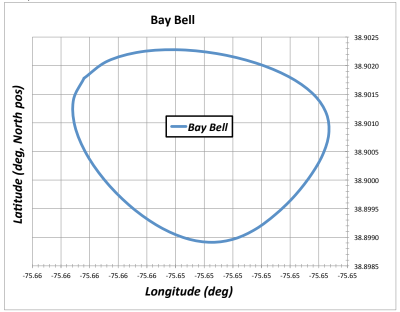
Launch Location	lat	long
Huron Approach	44.55474	-82.63253
	deg (neg-south)	deg (neg = west)

Unit Radius Circle

degrees	X	Y				EL	AZ	VEL	Lat	Long	kml contatenation	
-15	0.965926	-0.258819			-15	57.461340	113.853787	3.5270340	38.90207422	-75.65568358	0.000000	-75.655684,38.902074,.
0	1.000000	0.000000	DR	SE	0	57.461650	113.856000	3.5270293	38.9017803	-75.6560986	0.000000	-75.656099,38.901780,.
15	0.965926	0.258819			15	57.461340	113.858019	3.5270340	38.9014034	-75.6562823	0.000000	-75.656282,38.901403,.
30	0.866025	0.500000			30	57.460431	113.859900	3.5270469	38.9009427	-75.6562576	0.000000	-75.656258,38.900943,.
45	0.707107	0.707107			45	57.458985	113.861515	3.5270639	38.9004414	-75.6560478	0.000000	-75.656048,38.900441,.
60	0.500000	0.866025			60	57.457100	113.862755	3.5270798	38.8999497	-75.6556968	0.000000	-75.655697,38.899950,.
75	0.258819	0.965926			75	57.454905	113.863534	3.5270895	38.8995170	-75.6552584	0.000000	-75.655258,38.899517,.
90	0.000000	1.000000	R/H	SW	90	57.452550	113.863800	3.5270893	38.8991847	-75.6547839	0.000000	-75.654784,38.899185,.
105	-0.258819	0.965926			105	57.450195	113.863534	3.5270781	38.8989797	-75.6543137	0.000000	-75.654314,38.898980,.
120	-0.500000	0.866025			120	57.448000	113.862755	3.5270578	38.8989117	-75.6538719	0.000000	-75.653872,38.898912,.
135	-0.707107	0.707107			135	57.446115	113.861515	3.5270327	38.8989736	-75.6534668	0.000000	-75.653467,38.898974,.
150	-0.866025	0.500000			150	57.444669	113.859900	3.5270087	38.8991452	-75.6530966	0.000000	-75.653097,38.899145,.
165	-0.965926	0.258819			165	57.443760	113.858019	3.5269915	38.8993986	-75.6527566	0.000000	-75.652757,38.899399,.
180	-1.000000	0.000000	UR	NW	180	57.443450	113.856000	3.5269863	38.8997010	-75.6524412	0.000000	-75.652441,38.899701,.
195	-0.965926	-0.258819			195	57.443760	113.853787	3.5269925	38.9000658	-75.6521507	0.000000	-75.652151,38.900066,.
210	-0.866025	-0.500000			210	57.444669	113.851725	3.5270096	38.9004381	-75.6519332	0.000000	-75.651933,38.900438,.
225	-0.707107	-0.707107			225	57.446115	113.849954	3.5270335	38.9008041	-75.6518254	0.000000	-75.651825,38.900804,.
240	-0.500000	-0.866025			240	57.448000	113.848595	3.5270583	38.9011549	-75.6518642	0.000000	-75.651864,38.901155,.
255	-0.258819	-0.965926			255	57.450195	113.847741	3.5270784	38.9014828	-75.6520767	0.000000	-75.652077,38.901483,.
270	0.000000	-1.000000	L/H	NE	270	57.452550	113.847450	3.5270893	38.9017770	-75.6524700	0.000000	-75.652470,38.901777,.
285	0.258819	-0.965926			285	57.454905	113.847741	3.5270892	38.9020219	-75.6530253	0.000000	-75.653025,38.902022,.
300	0.500000	-0.866025			300	57.457100	113.848595	3.5270793	38.9021964	-75.6536968	0.000000	-75.653697,38.902196,.
315	0.707107	-0.707107			315	57.458985	113.849954	3.5270631	38.9022770	-75.6544170	0.000000	-75.654417,38.902277,.
330	0.866025	-0.500000			330	57.460431	113.851725	3.5270460	38.9022421	-75.6551071	0.000000	-75.655107,38.902242,.
345	0.965926	-0.258819			345	57.461340	113.853787	3.5270331	38.9020780	-75.6556906	0.000000	-75.655691,38.902078,.
360	1.000000	0.000000	DR again	SE	360	57.461650	113.856000	3.5270293	38.9017803	-75.6560986	0.000000	-75.656099,38.901780,.
375	0.965926	0.258819			375	57.461340	113.858213	3.5270340	38.8987509	-75.65028872	0.000000	







Each Davias archetype planform has its own distortion from purely elliptical. Those distortions can be represented by subtle variations in launch speed around the perimeter of the 0.01° half angle launch perturbation cone of only a few 10s of cm/s for roughly 3.5 km/s average launch speed, one part in 10,000 or less. The ‘smile’ speed profile as a function of launch azimuth to mimic the Bay Bell archetype suggests boosted speed at the azimuth margins, or reduced speed in the central azimuth, or perhaps some combination.

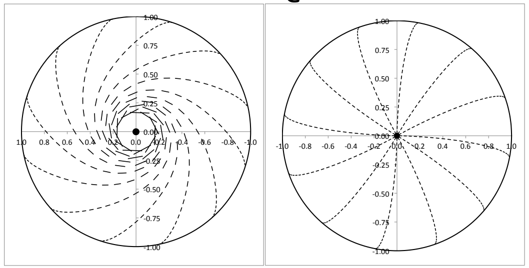
A slight linear increase in speed with increasing elevation (about 1/3 the amplitude of the speed variation with azimuth) is assumed to represent an expanding hemispheric plume with increased impedance near horizontal where there is more atmosphere to displace. This ’informed speculation’ is just a guess, one of many possibilities.

Appendix 1: Suborbital Analysis (SA) & Ejecta Fall Patterns

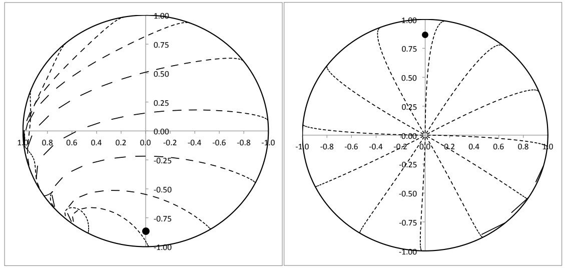
Harris[1] (Upper) vs. Dobrovolskis (1981) In Lower Frames

- **Fall pattern convolution due to planetary rotation varies by kinetic energy (KE) and launch latitude: higher launch KE typically produces fall pattern 'folds' & 'wrap-around'. This is the classical *A*-to-*B* suborbital problem programmed for Earth's coefficients.**
- **Moldavites, Ivory Coast and North American tektites mostly lie within Dobrovolskis' (1981) 3 rings (15%, 30% and 45% Escape KE).**
- **Australasian tektite (AAT) are > 2x beyond Dobrovolskis' (1981) outer ring (~80% escape KE or more).**

Polar launch @ 45° EL



30° latitude launch @ 45° EL



Harris[1]

After

Dobrovolskis2

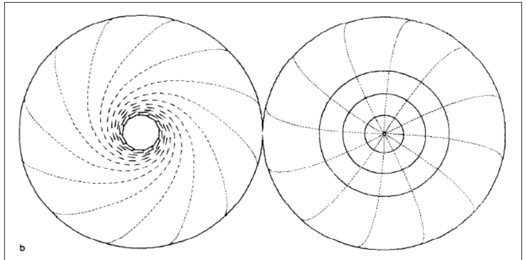


FIG. 6. Same as Fig. 5, but for an impact at the north pole of a planet rotating at the dimensionless rate (a) ω = 0.01; (b) ω = 0.05; (c) ω = 0.25; (d) ω = 0.50.

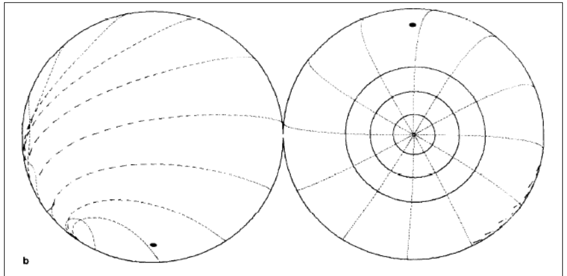
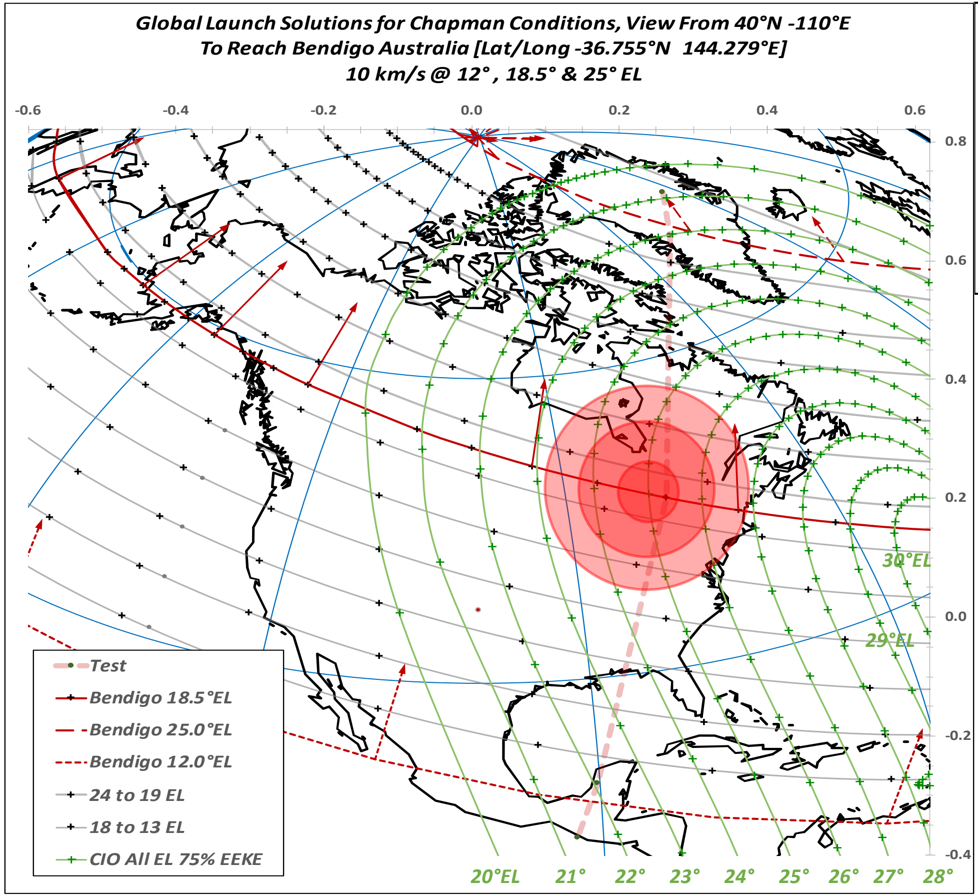


FIG. 9. Same as Fig. 8, but for an impact 60° away from the north pole.

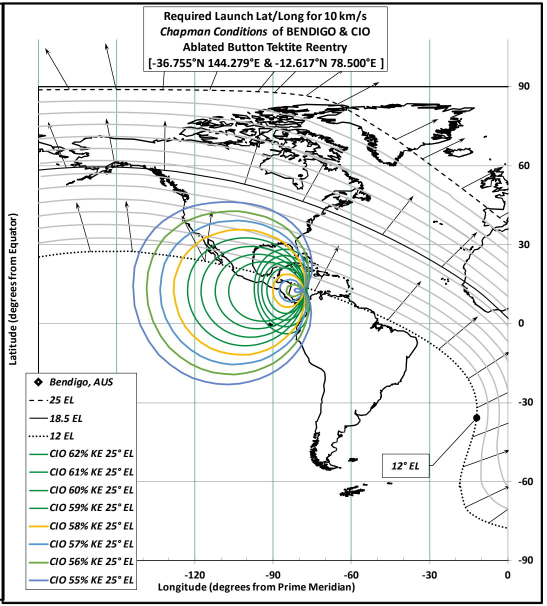
1) Harris, T.H.S., 2021, Terrestrial ejecta suborbital transport and the rotating frame transform, in Foulger, G.R., Hamilton, L.C., Jurdy, D.M., Stein, C.A., Howard, K.A., and Stein, S., eds., In the Footsteps of Warren B. Hamilton: New Ideas in Earth Science: Geological Society of America Special Paper 553, p. 1–22, https://doi.org/10.1130/2021.2553(23).

Appendix 1: Suborbital Analysis Of Australasian Tektites (AAT)



At left: incremental values of launch elevation (EL) produce individual launch solutions curves for Chapman's launch/reentry speed. Launch Solutions to Bendigo, Victoria Australia at 10 km/s are the thin, dark red curves, w/ the mid-valued 18.5° Elevation (EL) the solid dark red. Left-most green curve is 20° EL for the Central Indian Ocean (CIO) ablated button tektite, while the set of green curves are 9.68 km/s (75% Escape Kinetic Energy) at 1° incremental launch elevations per lower margin, to 30° EL at far right of image.

Right: Kinetic Energy (KE) launch solution curves of 1% increment from 62% (largest, purple) to 55% escape KE for the CIO button tektite, converging near Central America. Overlap with the Bendigo button launch solution swath (upper left to lower right) decreases as KE decreases.



Appendix 1: Tektite Suborbital Analysis

- **The inverse suborbital problem (*A*-given-*B*) solved for the Glass, Koeberl (2006) microtektite fluence centroid using a near-vertical launch of 83.9° elevation produces a cusp, the thick black dashed curve, 90° through 270° launch AZ. A spread through this range of launch conditions populates the AA microtektite distal ejecta strewn field. The horizontal component (~1.12 km/s) compares to the Schultz, Gault (1990) downrange marching speed of hemispheric plume expansion from oblique impact into volatiles.**
- **The rest of the strewn field may be populated at very similar KE from the same Lake Huron source location.**