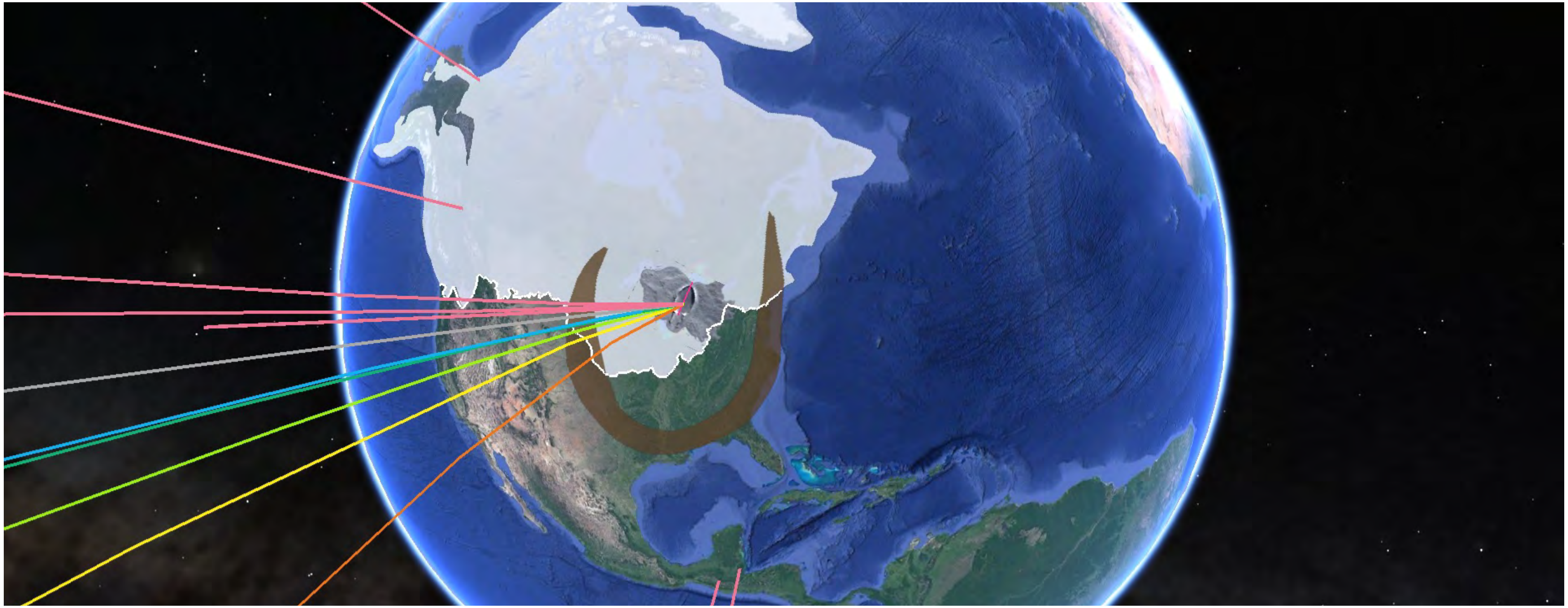
An Incomprehensible Cosmic Impact at the Mid Pleistocene Transition

Searching for the Missing Crater Using Australasian Tektite Suborbital Analysis and Carolina Bays' Major Axes Triangulation



Paper No. 81-1

Michael E. Davias michael@cintos.org Thomas H.S. Harris

GSA 2019
22-25 September
Phoenix, Arizona, USA

Incomprehensible

Douglas Johnson, President of Columbia's Geology Department observed:

> sands of feet, six to eight thousand or more in some cases. The largest meteorites known to have reached the earth measure less than a score of feet in maximum diameter.

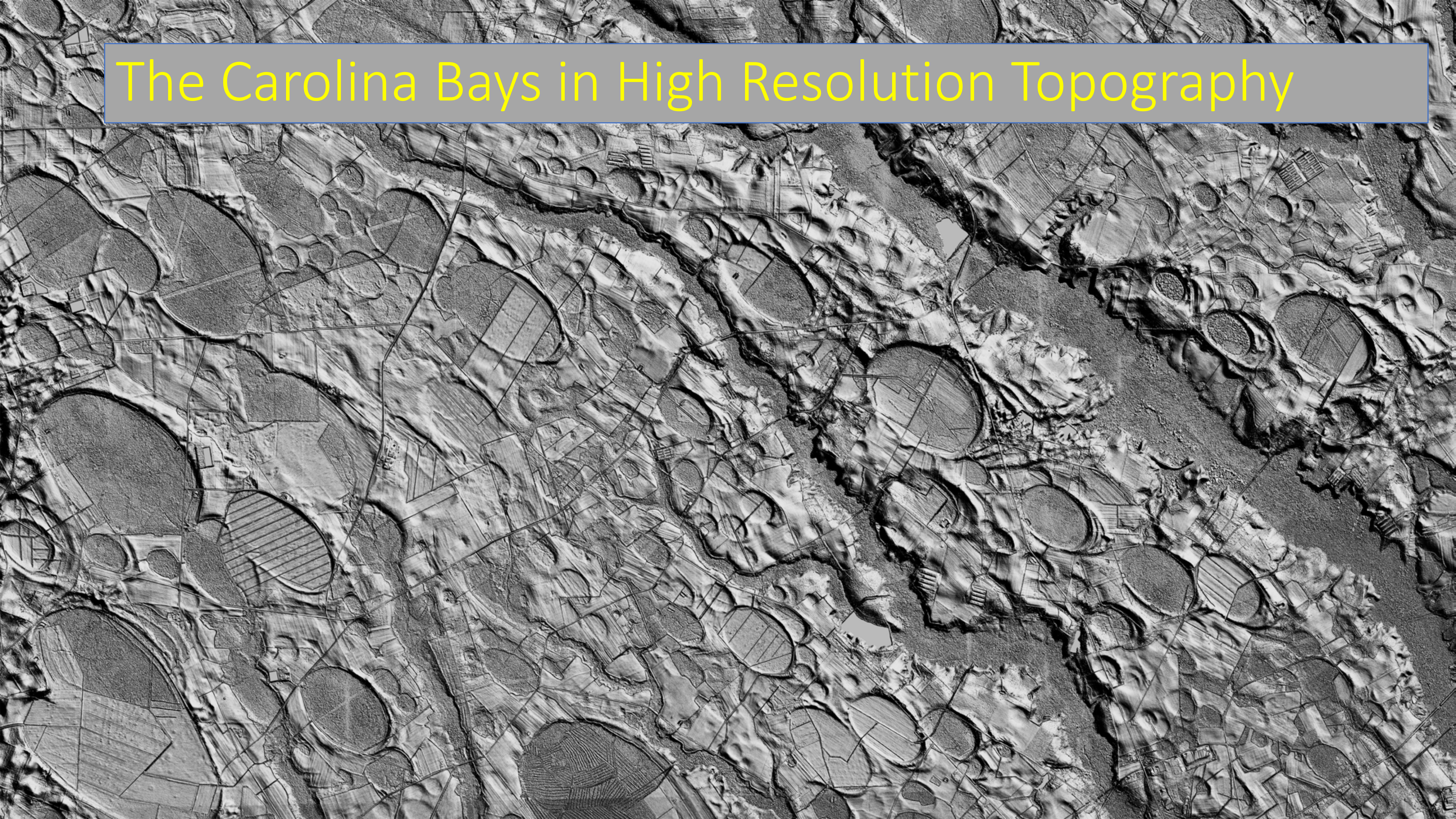
In Science In Progress, edited by G. A. Baitsell, Yale University Press, 1940 317 pp

The Carolina Bays in 1930 Aerial Photography

- ©Fairchild Aerial Surveys for the Ocean Forest Company: Aerial view taken in 1930 (12x8 km)

Arctic Tundra Freeze-Thaw Lakes

The Carolina Bays in High Resolution Topography



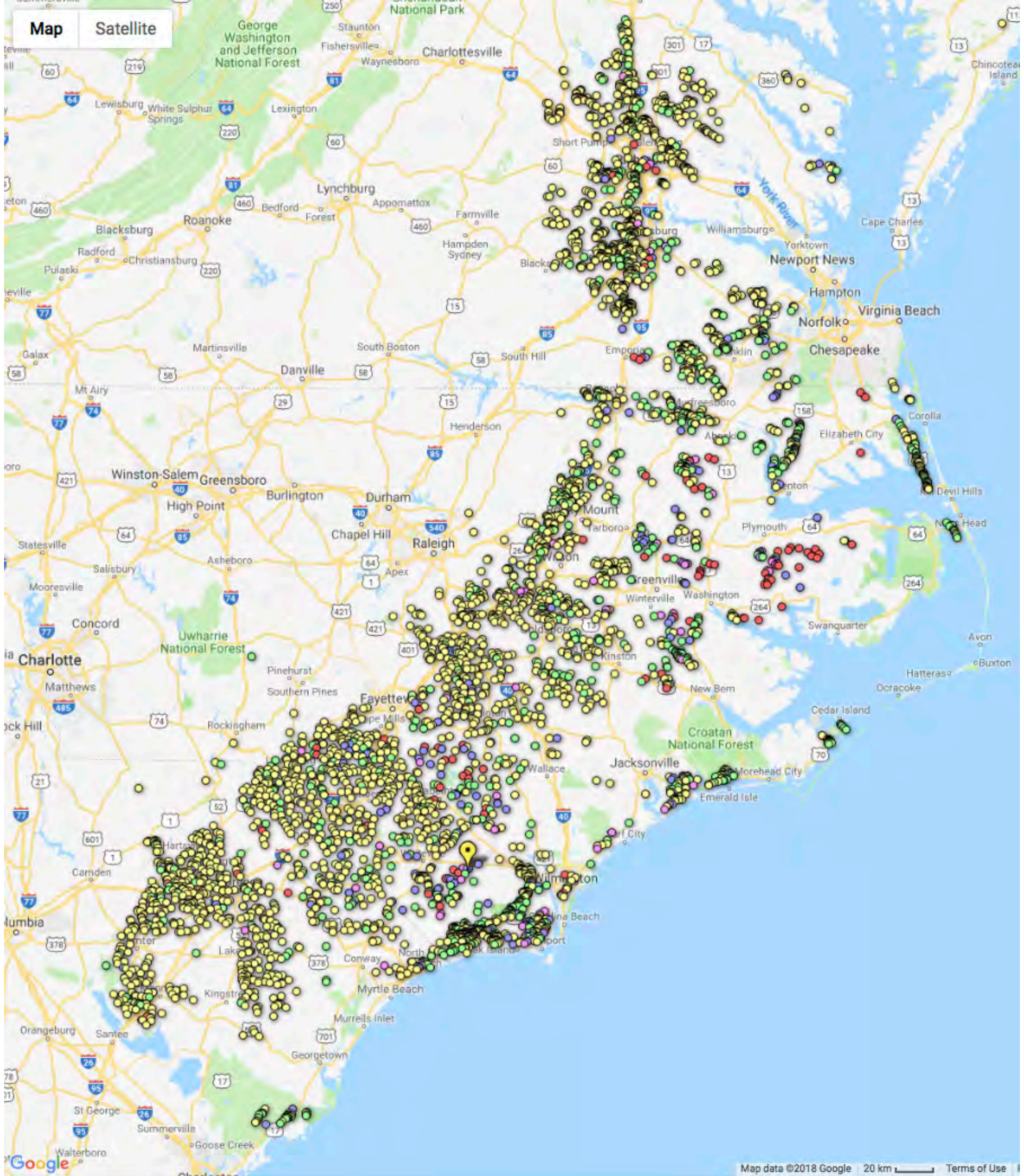
Carolina bay Survey

Visualization for all *bayCarolina* archetype bays measured

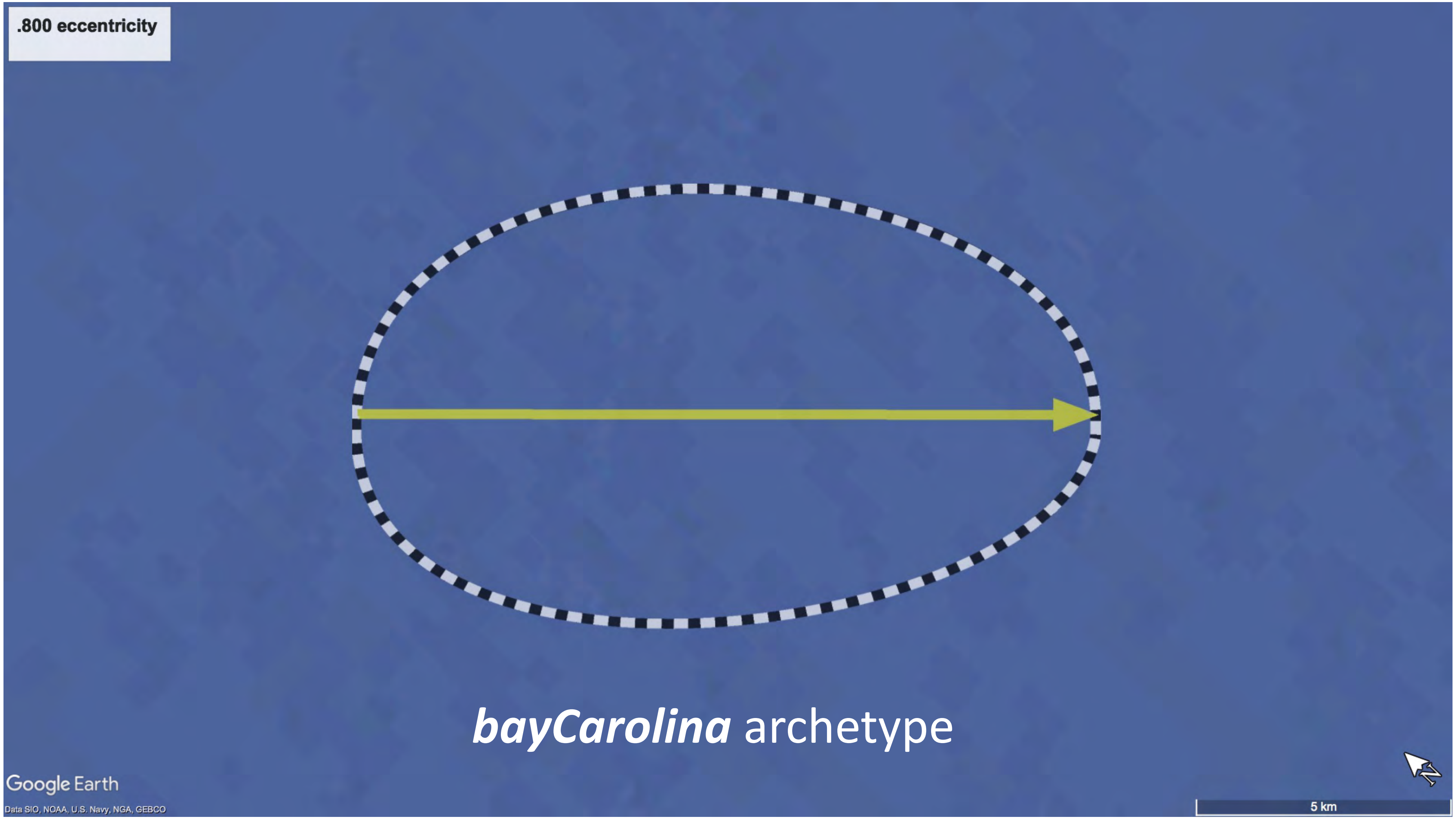
Google will be turning off the Fusion table facility at the end of 2019. That on-line database has been utilized by me to hold the 50,000 + row database and present bays for users to interrogate.

Each placemark presents a popup with measured bay data.

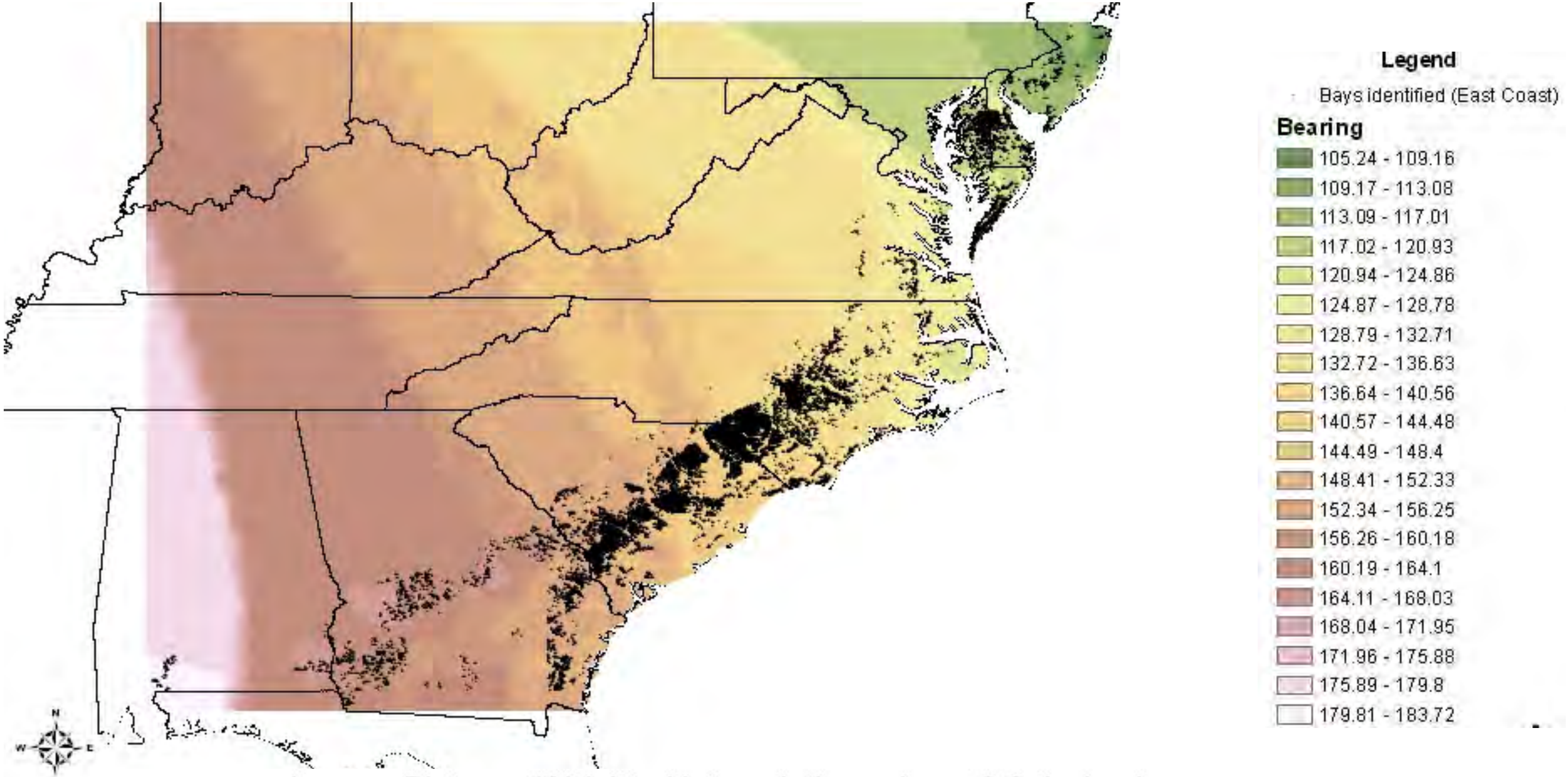
cintos.org/Survey



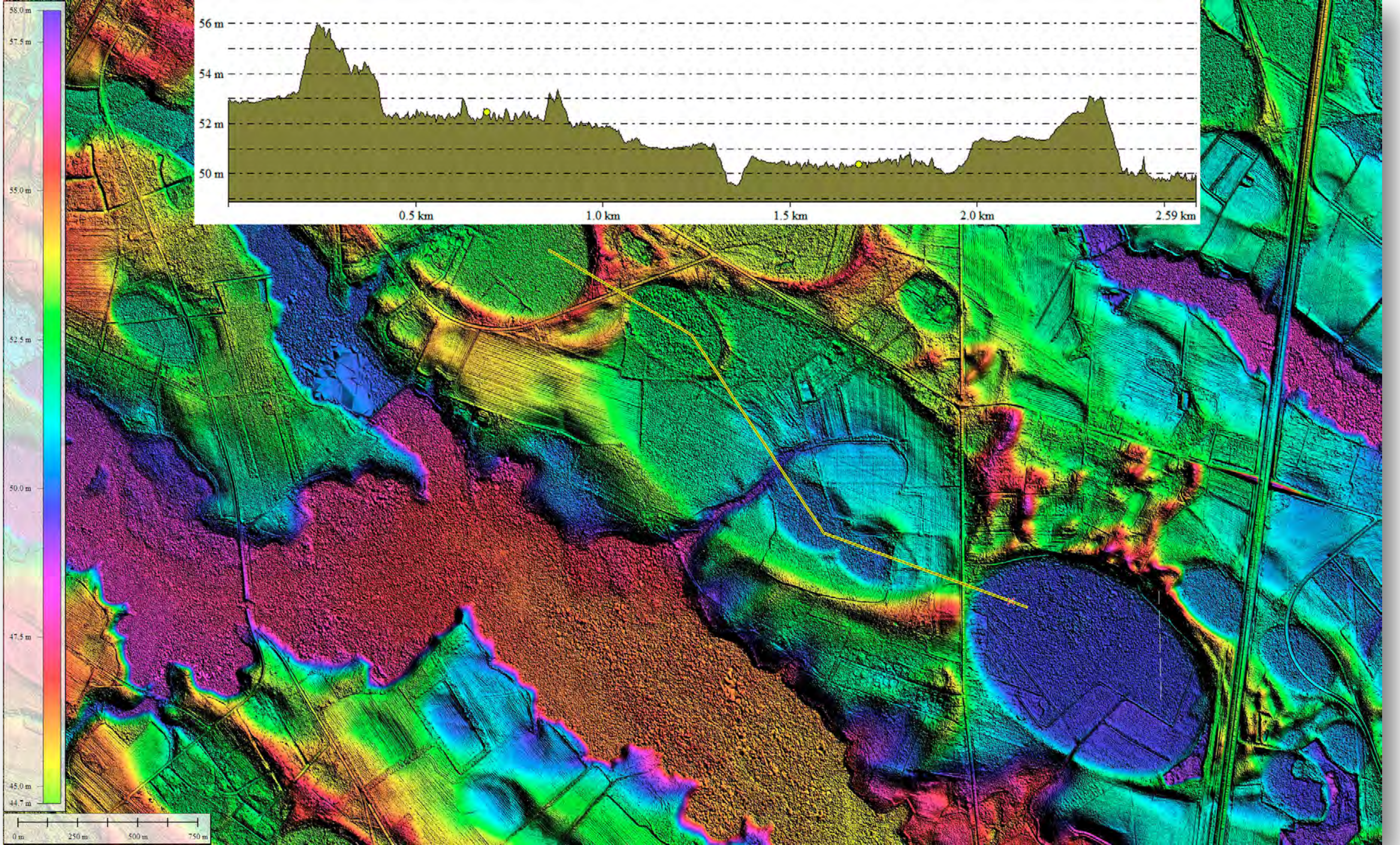
Archetype shape varies only by eccentricity



Clockwise Rotation of ~75º from NJ through Alabama



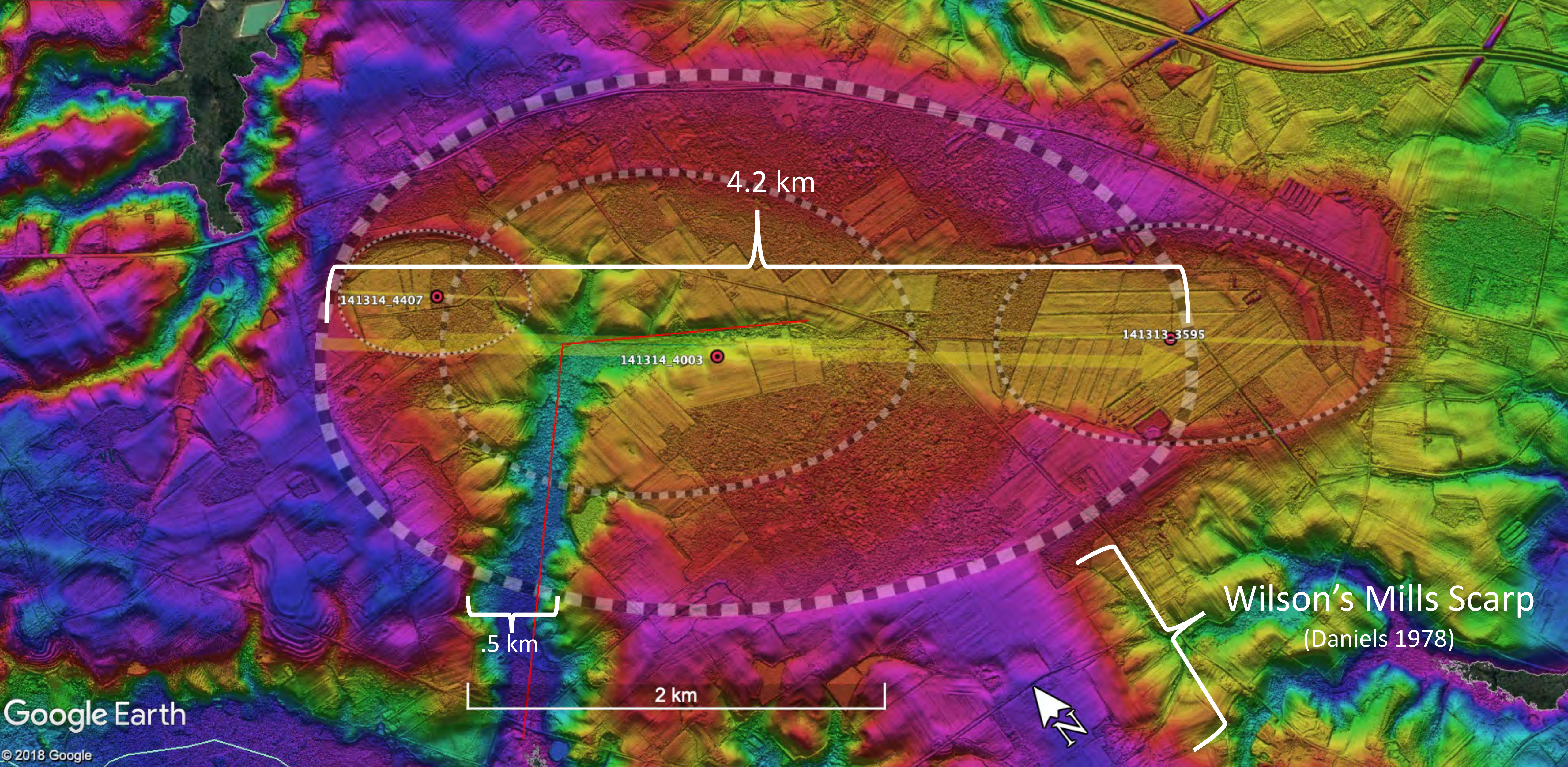
Inverse Distance Weighted interpolation using a 0.2 decimal degree search radius, minimum 3 points, and output grid size of 0.2 decimal degrees.

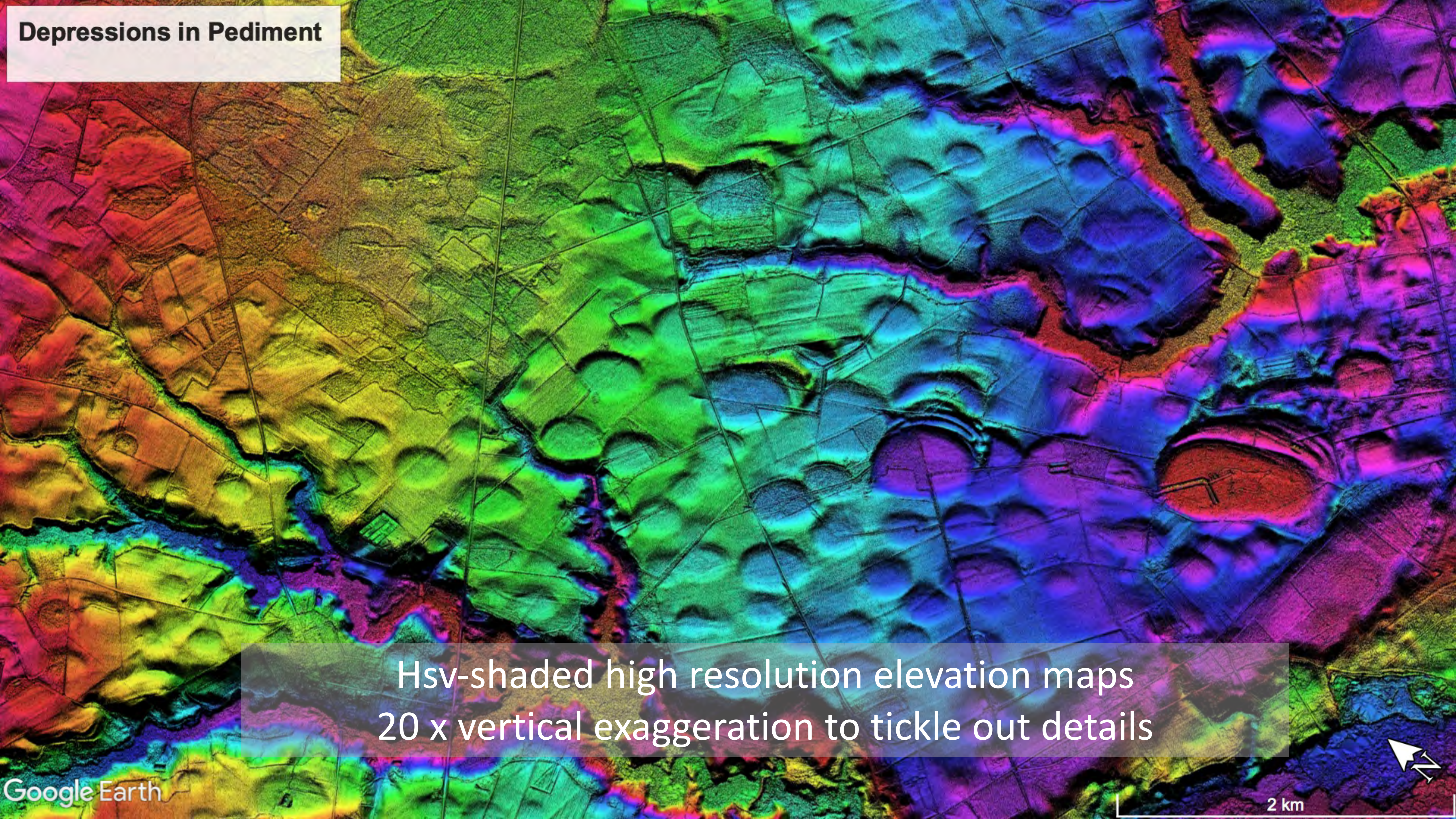


56 m
54 m
52 m
50 m
0.5 km
1.0 km
1.5 km
2.0 km
2.59 km
58.0 m
57.5 m
55.0 m
52.5 m
50.0 m
47.5 m
45.0 m
44.7 m
0 m
250 m
500 m
750 m

Benson Bays, NC

Primary bay planform is 4.2km long. Headward erosion into bay runs for over 3 km from nearby drainage basin, and is 1/2 km wide at rim breach. >10 km north-south 5 m "terrace toe" mid bay.




Depressions in Pediment
Hsv-shaded high resolution elevation maps
20 x vertical exaggeration to tickle out details
Google Earth
2 km

Genesis of our Carolina bays hypothesis

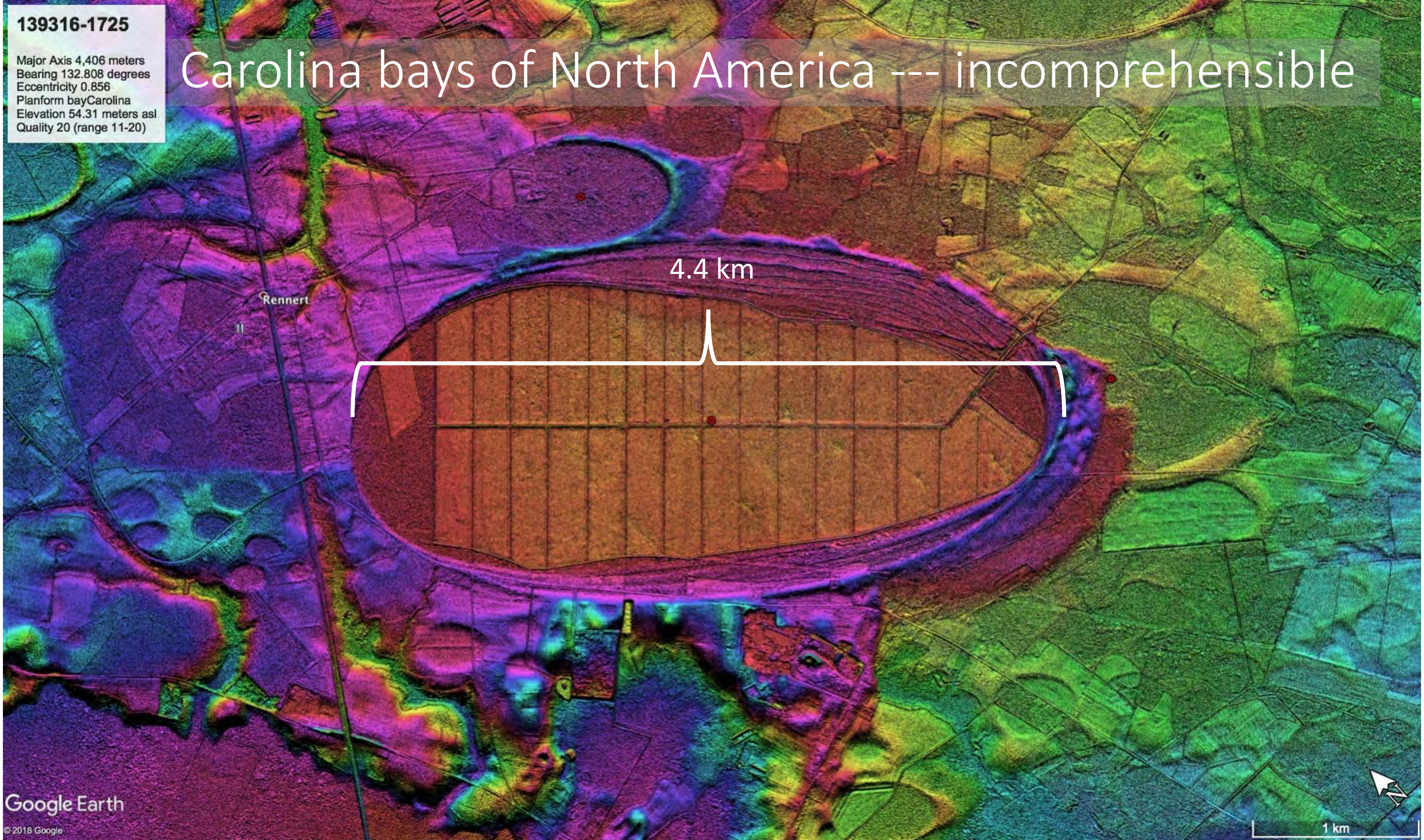
The bays examined in this study and those examined by Bryant (1964) Preston and Brown (1964), and Thom (1970) are clearly surficial features without subsurface expression.

This suggests that the primary depression, regardless of its original shape, was probably formed as a part of the final phase of the *process of deposition of the surficial sediments.*

Gamble, Daniels & Wheeler, 1977

Gamble, Daniels & Wheeler, 1977, Primary And Secondary Rims Of Carolina Bays, Southeastern Geology, V18 No 4

Carolina bays of North America --- incomprehensible

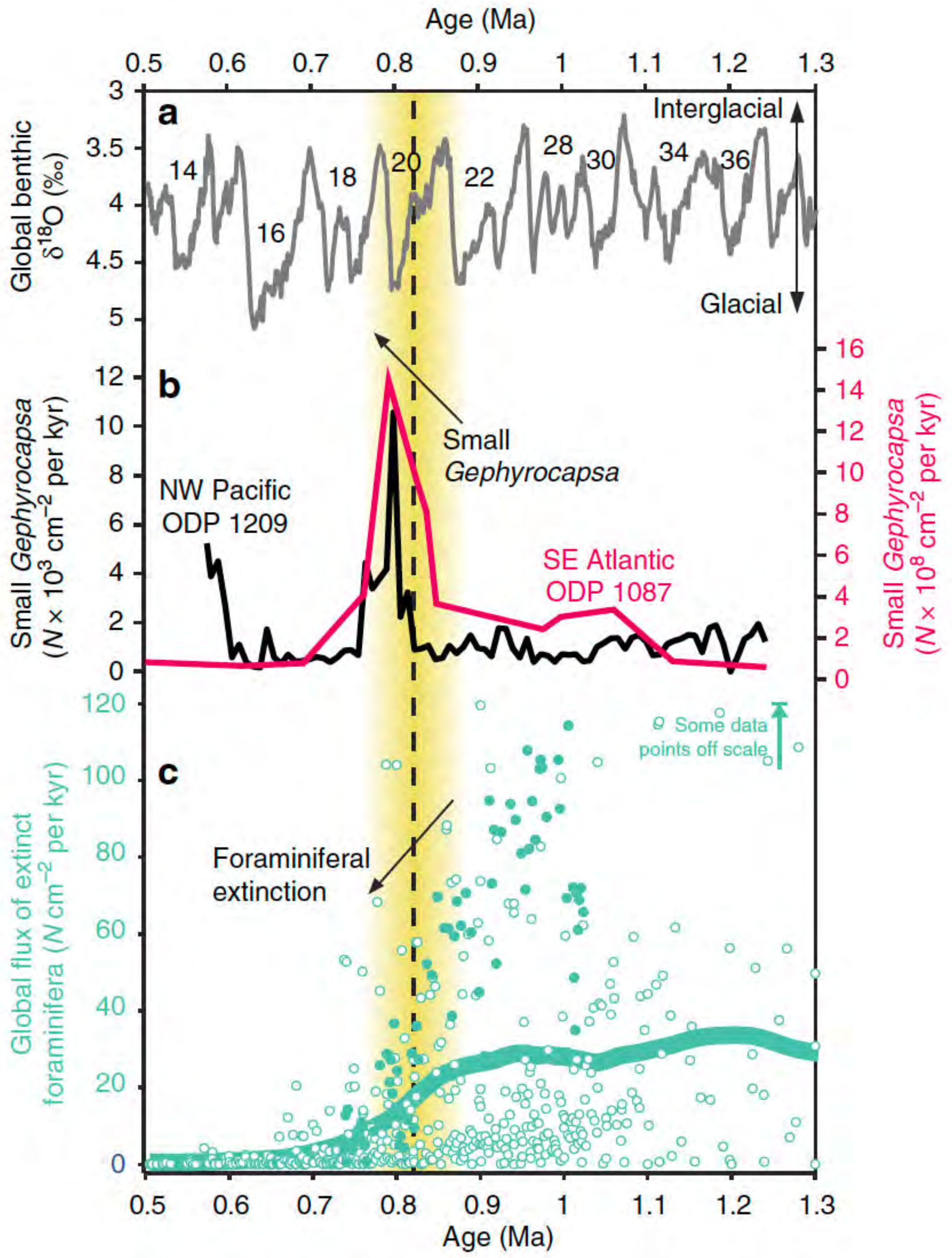


Mid-Pleistocene Transition (MPT)

- Alternatively the *Mid-Pleistocene Revolution*
- Roughly brackets the Matuyama-Brunhes geomagnetic reversal ~ 780 Ka
- Progression from short glacial cycles to the current ~100 Ka
- Java Man disappears from Java's Sangiran Dome fossil deposits

Mid Pleistocene Transition Foraminiferal Mass Extinction

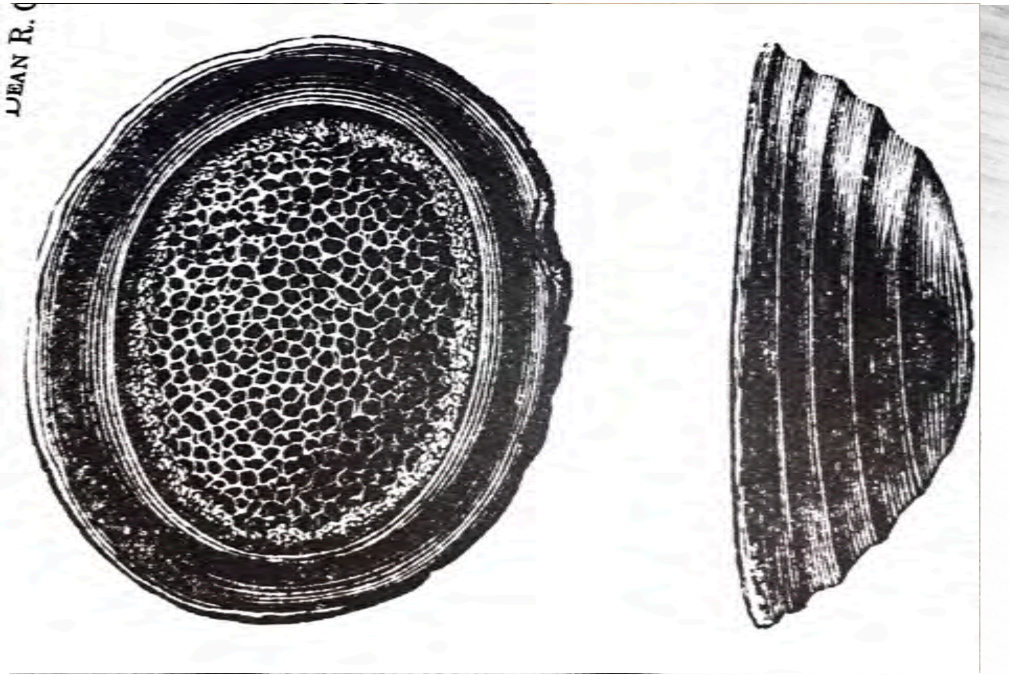
Figure 3 | Nannoplankton assemblages compared with extinct benthic foraminifera over the Mid Pleistocene. (a) Global deep-sea d18O composite52. (b) Accumulation rate of small Gephyrocapsa at Ocean Drilling Program (ODP) Site 1087 (ref. 26) and ODP Site 1209 (ref. 27). (c) Flux (accumulation rate) of extinct foraminifera from 15 global sites compiled by ref. 7 (open symbols), and including new data from this study (solid symbols), with a 0.2-pt LOESS smoothing spline (bold). Some data points are off the scale; smoothed line takes into account all data. Note how the peak in small Gephyrocapsa dominance at B0.8Ma occurs in the NW Pacific and SE Atlantic (and SW Pacific and N Atlantic, Supplementary Fig. 3), and coincides with persistently low abundance of the extinction group thereafter. Vertical yellow and dashed lines as in Fig. 1.

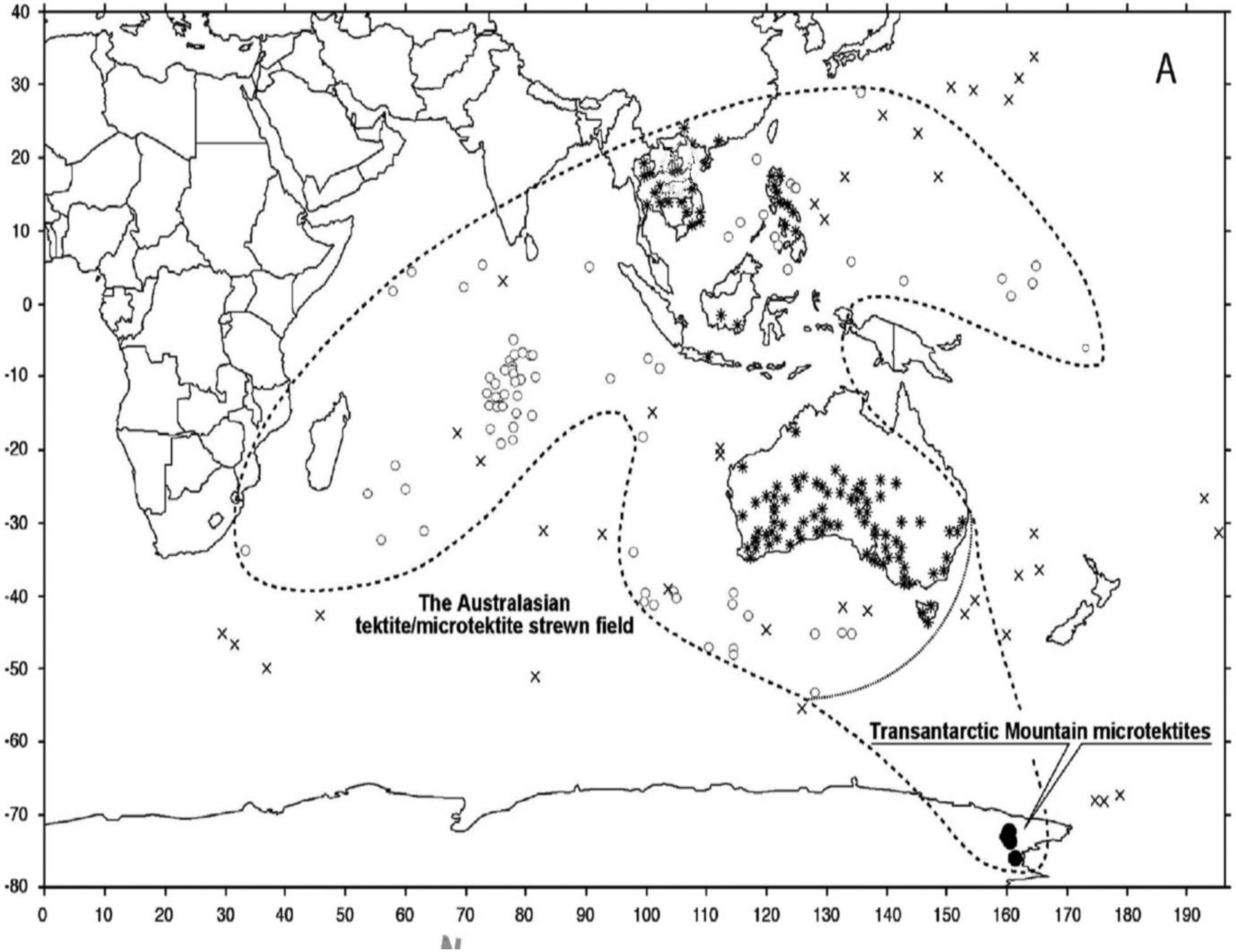


Sev Kender, et al, 2015, Mid Pleistocene foraminiferal mass extinction coupled with phytoplankton evolution, Nature DOI: 10.1038/ncomms11970

MPT Australasian Tektite Strewn Field Enigma

- 50 years have transpired since determining the tektites were created at the MPT
- Distal morphology proposed originally
  - atmospheric ablation
  - devolitized (1,000 x less H_2O than obsidian)
  - high vacuum in bubbles
- Chemistry points to genesis from Average Continental Crust (not marine)





Map from L. Folco, et al, 2016, *Stretching out the Australasian microtektite strewn field in Victoria Land Transantarctic Mountains, Polar Science 10*

Incomprehensible Bounty of Data

Over the past 30 years immense progress has been made in understanding tektites but rather than providing elucidation, the large amount of research on the Australasian tektite Strewn Field seems to have multiplied the constraints to be surmounted.

Joe McCall, 2001, *Tektites in the Geological Record*

Seminal Paper Locating AA Crater in SE Asia

Peter H. Stauffer, 1978, *Anatomy Of The Australasian Tektite Strewnfield And The Probable Site Of Its Source Crater*

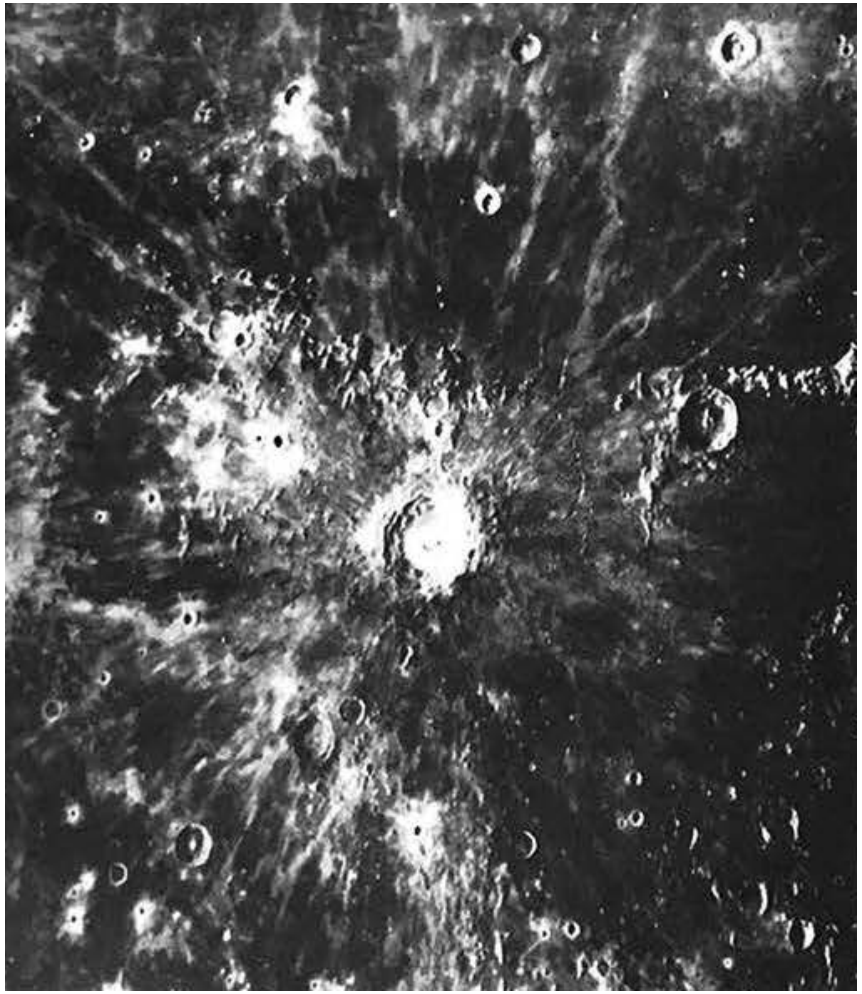
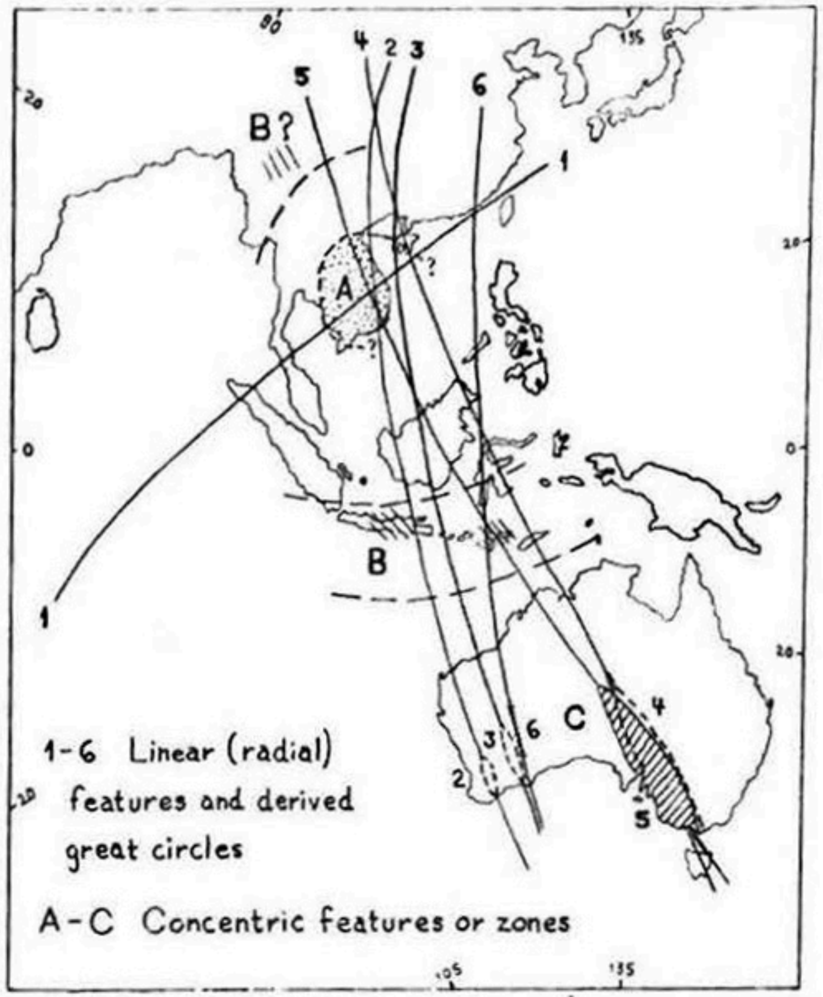


Figure 2. Photograph of the lunar crater Copernicus showing the pattern of ejecta.



Figure• 3. Radial and concentric structural elements of the Australasian tektite strewn field. Radial elements (linear features) and the great circles derived from them:...

Conference Paper: Geology and Mineral Resources of Southeast Asia, Bangkok, November 14-18, 1978, Peter H. Stauffer, Department of Geology, University of Malaya

a priori

[ey prahy-**awr**-ahy, -**ohr**-ahy, ey pree-**awr**-ee, -**ohr**-ee, ah pree-**awr**-ee, -**ohr**-ee]

SHOW IPA

EXAMPLES | WORD ORIGIN

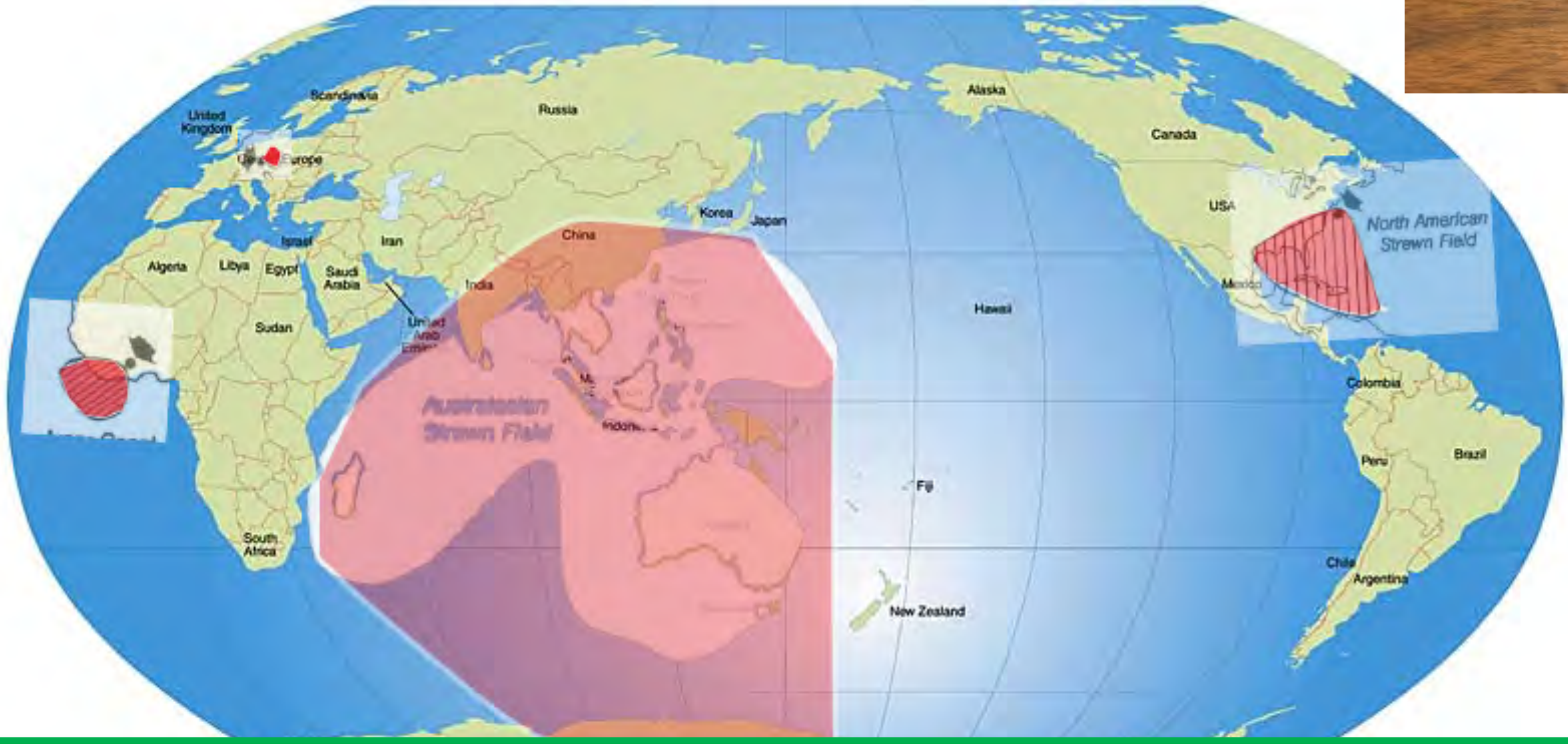
adjective

1. from a general law to a particular instance; valid independently of observation.: Compare a posteriori**(def 1)**.
2. existing in the mind prior to and independent of experience, as a faculty or character trait.: Compare a posteriori**(def 2)**.
3. not based on prior study or examination; nonanalytic:
   an a priori judgment.


I THOUGHT YOU LOST YOUR CAR KEYS OVER THERE?
I DID... BUT IT'S LIGHT OVER HERE.
© Oxford Creativity 2010

Tektite Strewn Fields

- ~180 Impact structures are confirmed on Earth
- Only 3 are evidenced by extensive macro tektite strewn fields
- These are very special events, suggesting special class of cosmic impacts



As youngest of these strewn fields, the lack of an identified impact structure suggests the MPT impact is easily the most enigmatic impact known but not confirmed.

Ivory Coast Crater Tektite Distribution

- 1.07 Ma age, 11 km diameter
- Tektites 400 km from crater
- Asymmetrical Distribution ~10º arc

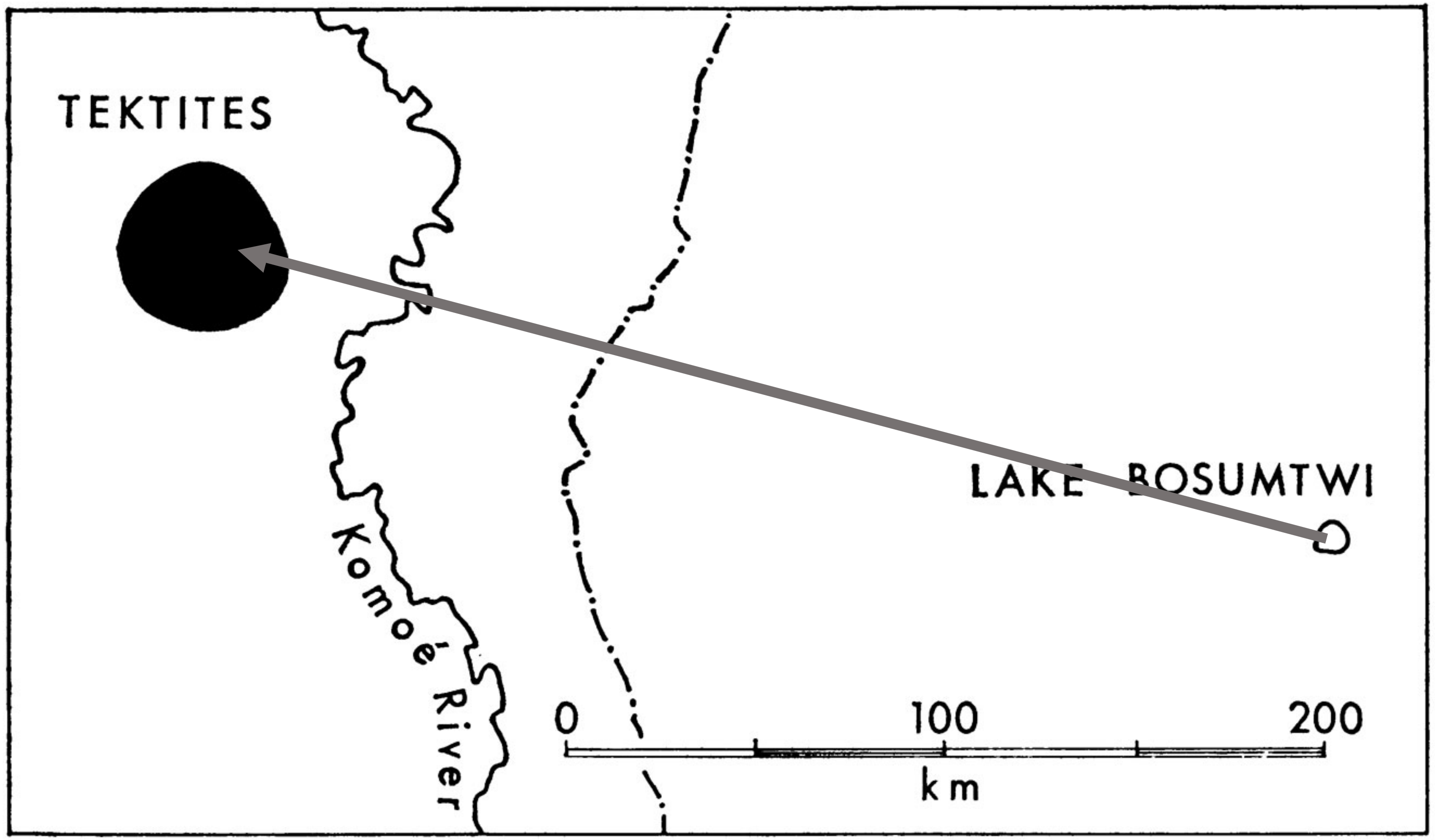


Fig. 1. The Bosumtwi crater in Ghana and (solid area) the approximate area where the Ivory Coast tektites are found.

Fig 1, Henry Faul, 1966, *Tektites Are Terrestrial*, Science Vol 152, Issue 3727

Ries Crater
Tektite Distribution

- 15 Ma age, 15 km diameter
- Asymmetrical Distribution 57º arc
- No tektites within 300 km of crater
- Juxtaposition of Ries and smaller Steinhelm suggests shallow angle of impact

Numerical modeling of tektite origin in oblique impacts: Implication to Ries-Moldavites strewn field

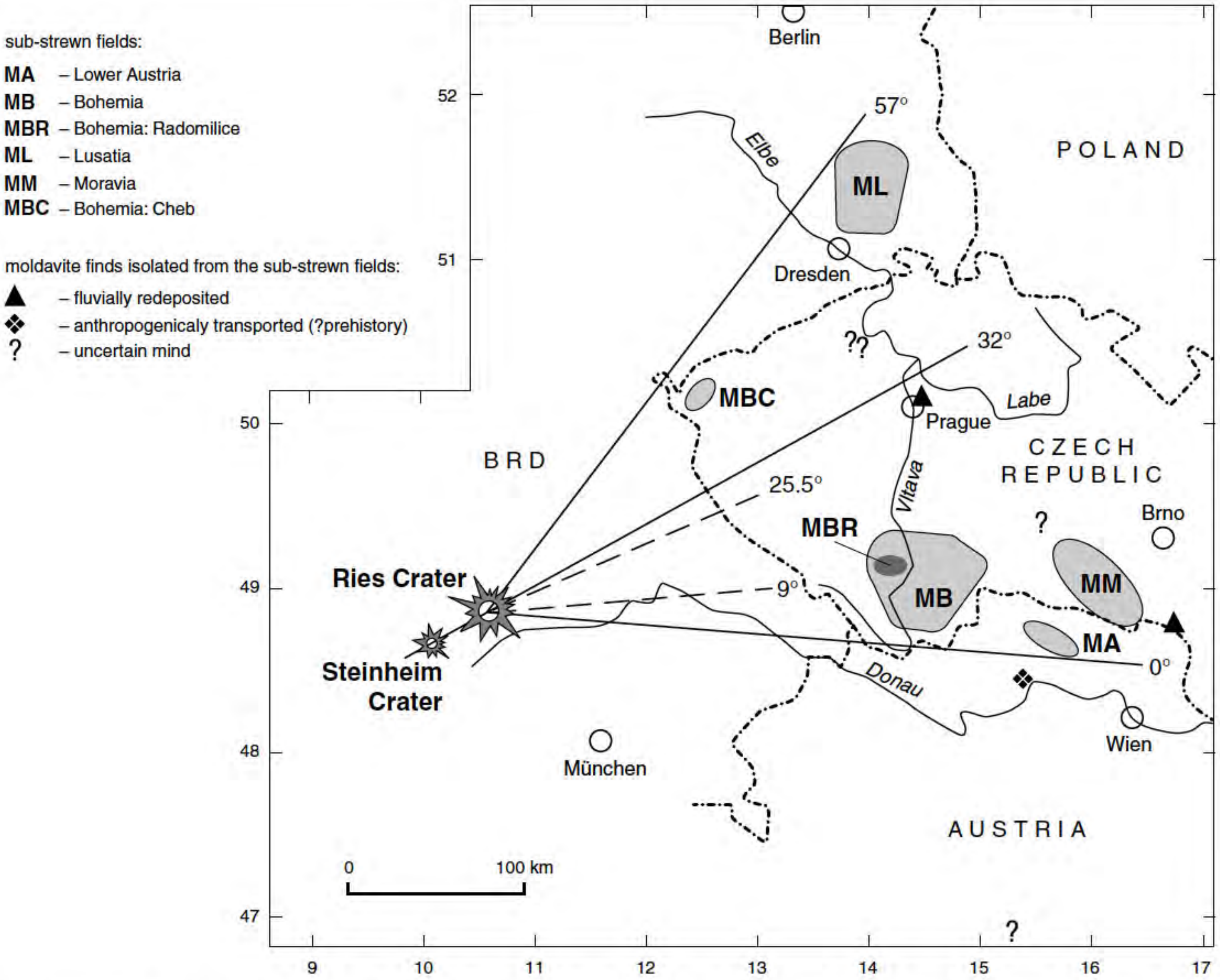


Figure 1. Map of Central Europe showing the Ries and Steinheim craters and the Moldavite strewn field (modified after LANGE, 1996); the sub-strewn-fields are hatched and explained in the legend; dashed lines (9° to 25.5°) define the fan within which coherent melt lumps are observed on the inner slope of the Ries crater rim.

Fig 1, Artemieva, et al , 2002, Numerical modeling of tektite origin in oblique impacts…Bulletin of the Czech Geological Survey, Vol. 77, No. 4,

North American Tektite Distribution

- Correlated with Chesapeake Bay Impact
- 80 km diameter, 35 Ma
- Asymmetrical Distribution ~30º arc
- No tektites within 900 km of crater
- Offset scales with impact energy

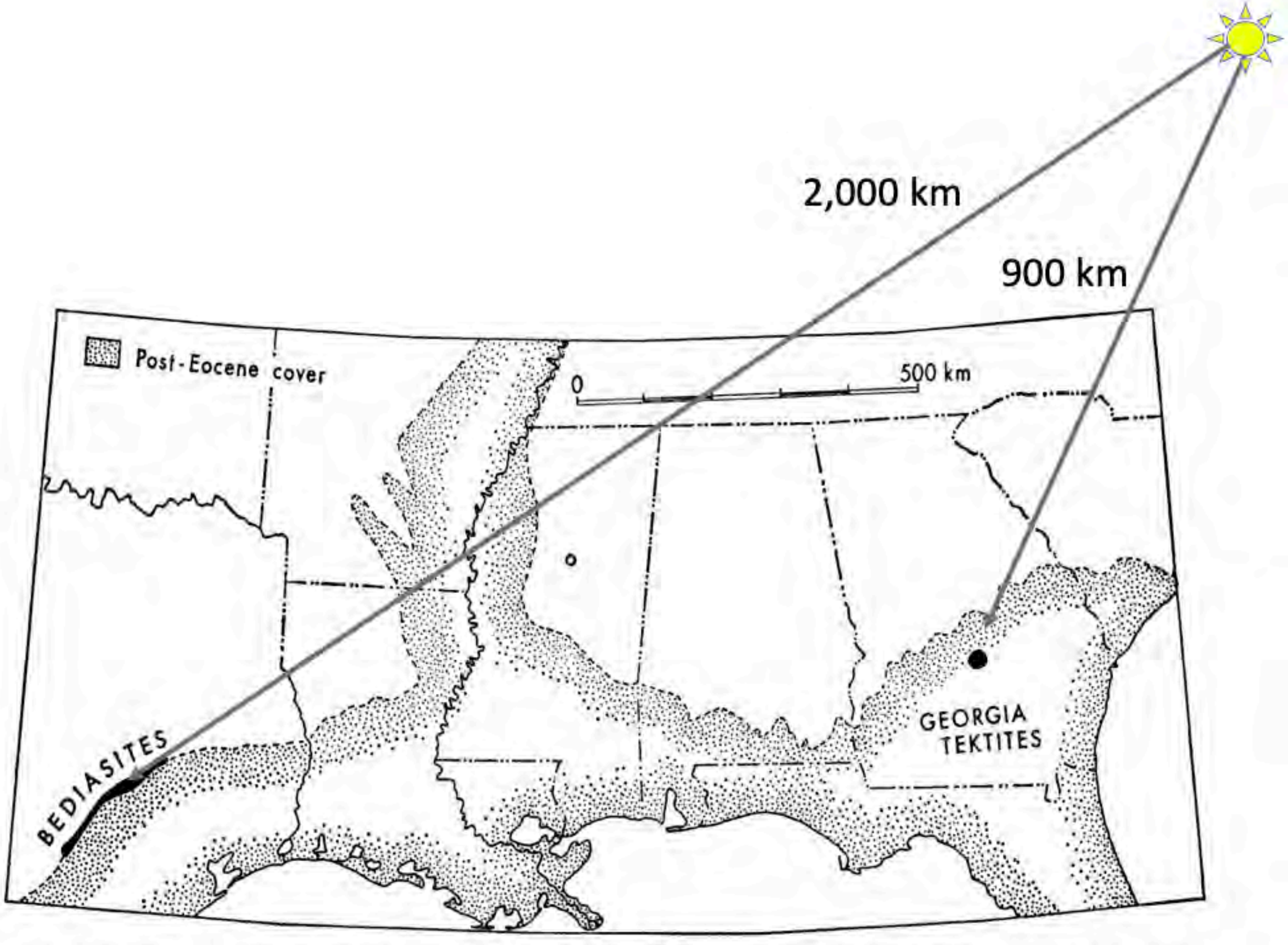


Fig. 3. (Solid areas) Regions where tektites are found in Texas and in Georgia. (Stippled areas) Regions covered by sediments deposited after the tektites fell. (Open circle) The Kilmichael crater in Mississippi.

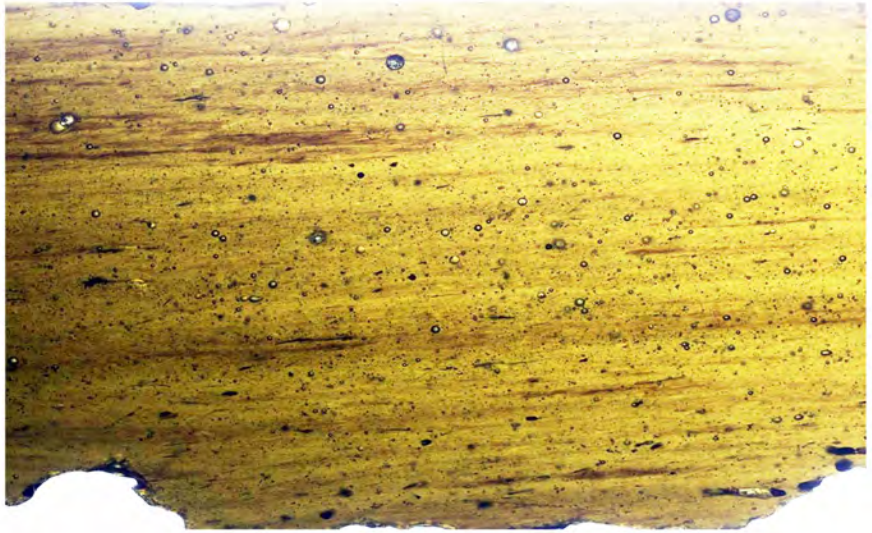
Fig 1, Henry Faul, 1966, *Tektites Are Terrestrial*, Science Vol 152, Issue 3727

Observational Science of Tektite Distribution

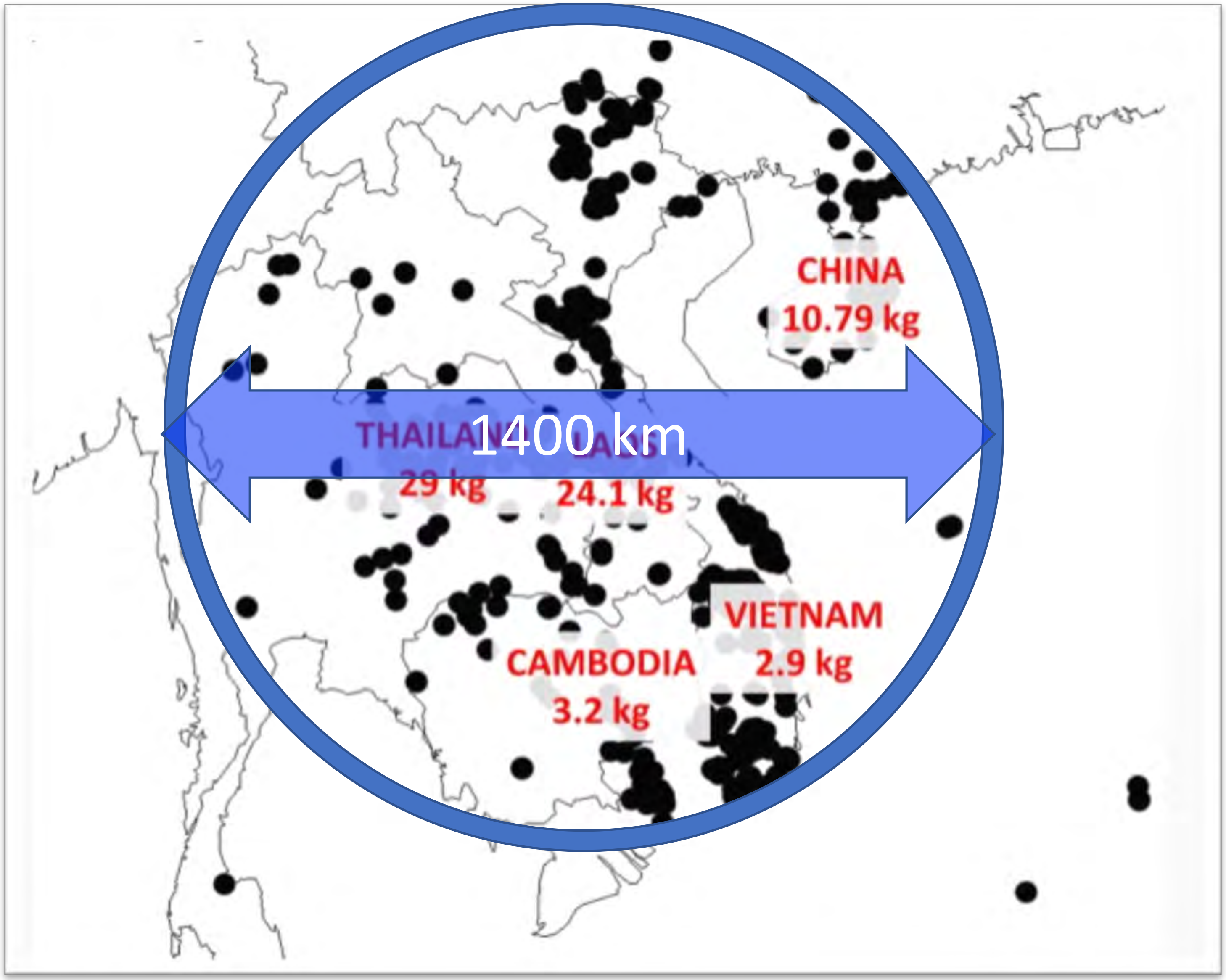
- Three corelated strewn fields and impact structures are accepted
  - No tektites found proximal to those three impact structures
  - Those strewn fields display highly asymmetric distribution of tektites
  - Those strewn fields are offset from impact, increasing with crater diameter
  - Australasian strewn field is orders of magnitude larger, spatially and mass ejected

Impact specialists dismiss the corelated evidence as artifacts of “serendipity”

Muong Nong Layered Tektites



- Current consensus puts the layered tektites into the ”Proximal” impact ejecta category
- Considered to have been melted “less” due to less homogeneity of chemistry
- Splash form tektites (distal) are found throughout this entire region
- A weight distribution “center” is 700 to 1000 km from other Muong Nongs



Weight distribution of largest Muong Nong tektites – credit: A. Whymark

Irreconcilable Nature of being a Te

Muong Nong are low H_2O true Tektites

- All four strewn fields have low H_2O
- Muong Nong have more H_2O than other AA
- Muong Nong have same H_2O as Chesapeake Bay tektites
- MPT strewn field is more variable
- MPT Strewn Field estimated to have 10^5 more mass than Moldavites

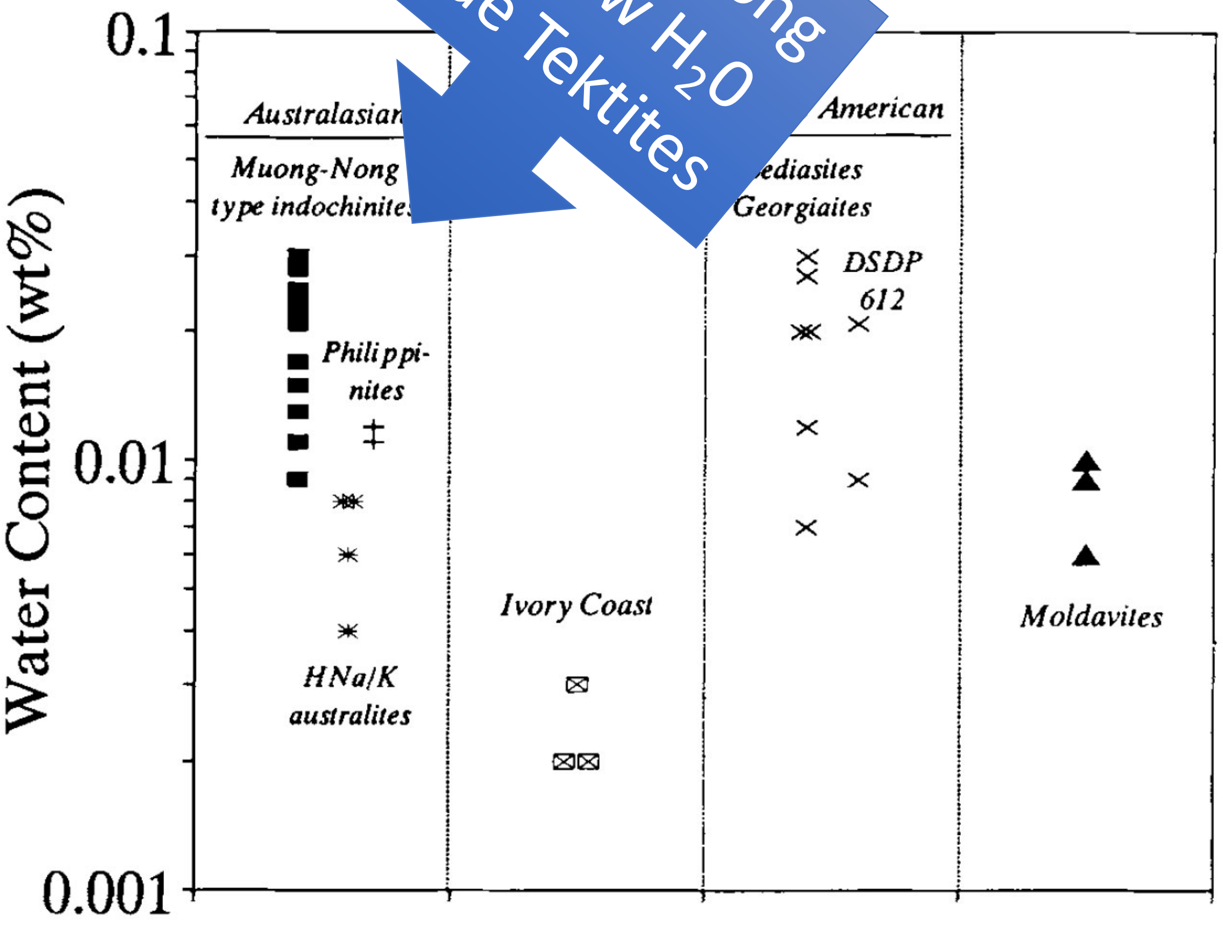


FIG. 1. Water content of tektite samples from all four Cenozoic strewn fields.

A. Beran & Christian Koeberl, Meteoritics & Planetary Science 32.21 1-216 (1997)

distal *adjective*

dis·tal | \ ˈdi-stᵊl \

Definition of *distal*

1 *anatomy* : situated away from the point of attachment or origin or a central point especially of the body

— compare PROXIMAL

// the *distal* ends of the tibia and fibula

2 *dentistry* : of, relating to, or being the surface of a tooth that is next to the tooth behind it or that is farthest from the middle of the front of the jaw

— compare MESIAL sense 2

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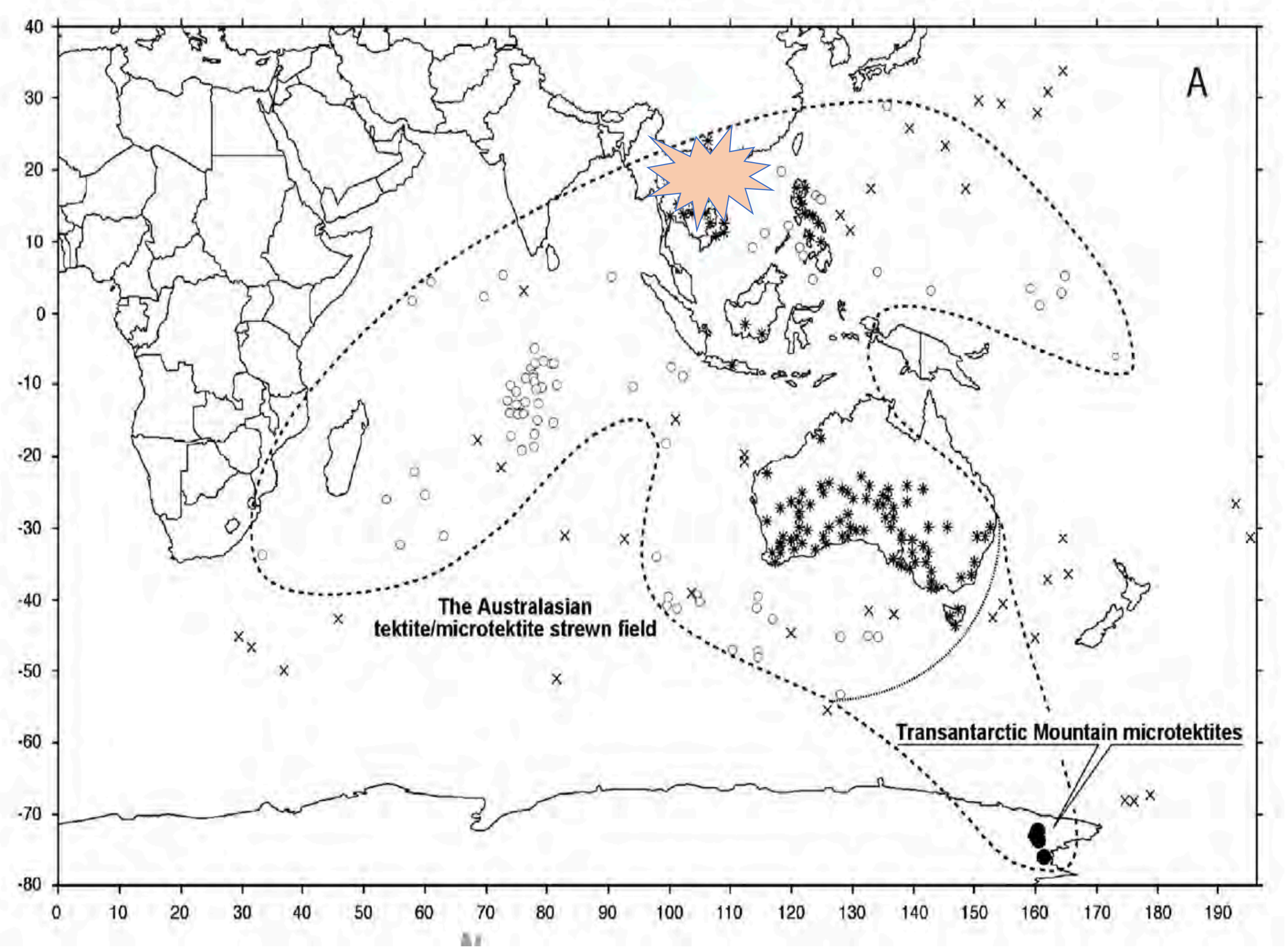
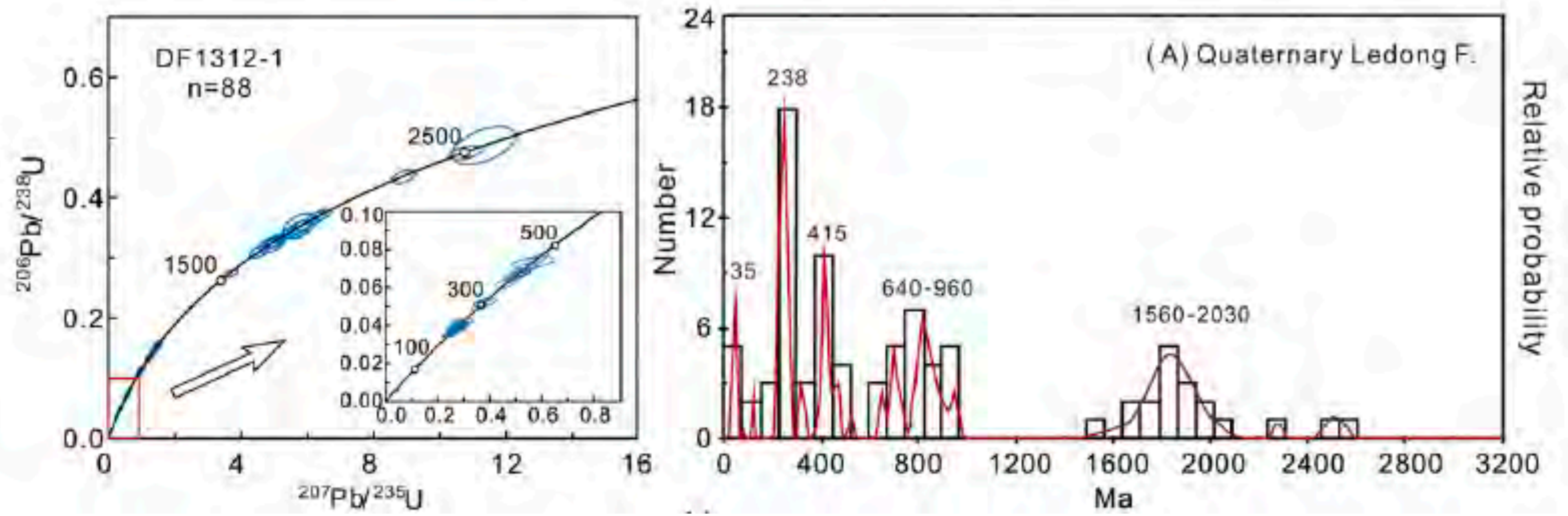


Map from L. Folco, et al, 2016, *Stretching out the Australasian microtektite strewn field in Victoria Land Transantarctic Mountains, Polar Science 10*

Australasian Tektite Strewn Field Crater

- Search has moved to South China Sea shelf that was exposed at MIS20
- Marine cores in the literature are not supportive
  - Only littoral depositional environments identified in 1250 m of Quaternary sediments
  - Source cratons' ages identified by Ce Wang et al, do not corelate with tektites' ages

C. Wang et al. / Marine Geology 355 (2014) 202–217



Provenance of Upper Miocene to Quaternary sediments in the Yinggehai-Song Hong Basin, South China Sea: Evidence from detrital zircon U–Pb ages


I know there's a pony in here somewhere!

Impact sites outside of Indochina

- Vladimir Vand suggested the Wilkes land Crater
- E.C. Chao suggested "*Scandinavia*"
- Bill Glass Suggested the Zhamanshin Crater
- Robert S. Dietz suggested the 18 km Siberian *Elgygytgyn* crater
- Jiri Mizera has proposed the loess sediments of Lingtai, 2,000 km North

Advice Offered

Lin offered:

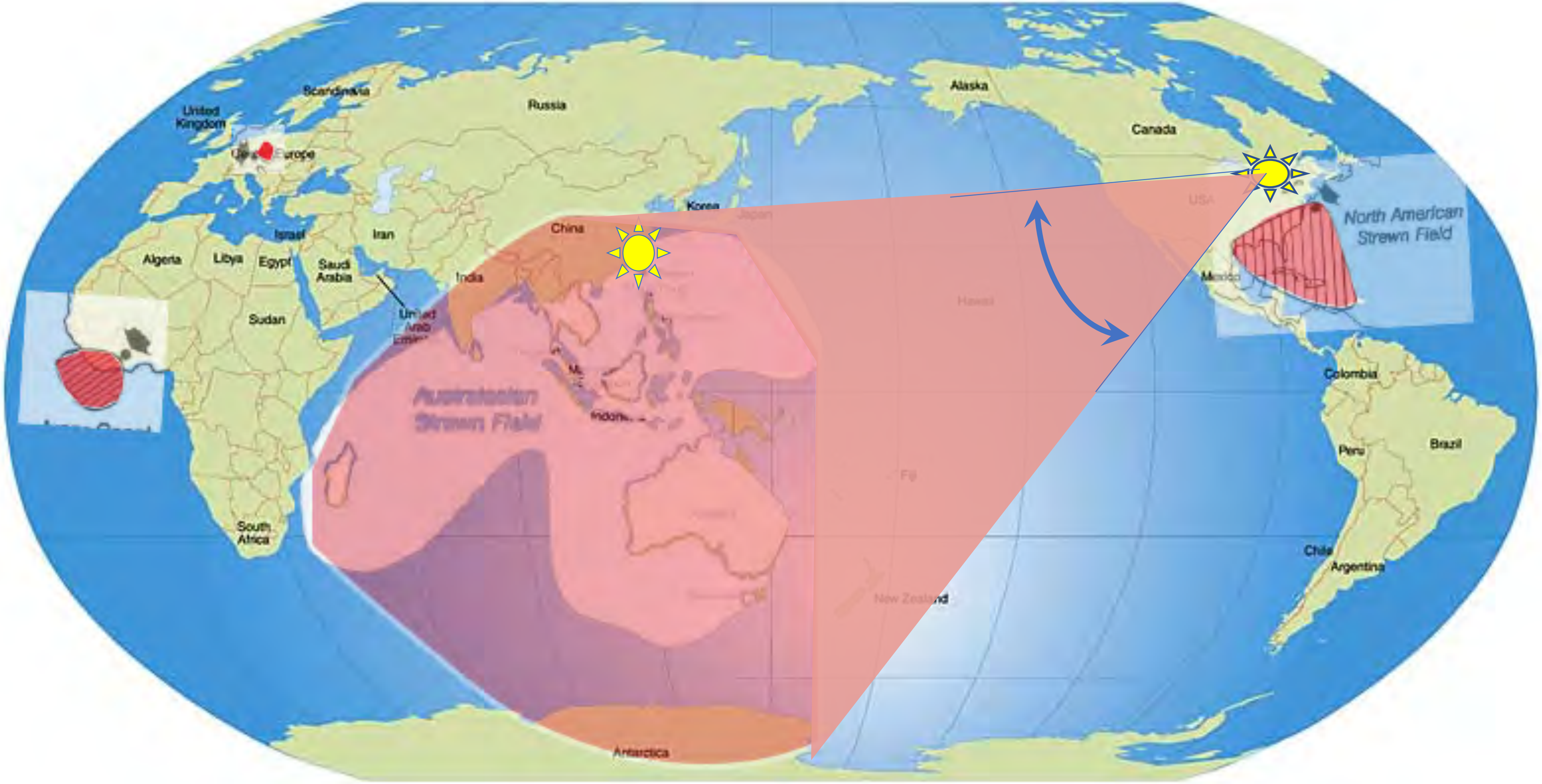
If the explosive comet-impact model is applied to the explanation of Australasian tektites [Chapman, 1964],one may postulate ***a point of impact far removed from the Australasian region****. The evidence of* ***impact crater must then be sought on other continents****."*

Urey suggested:

"The residual crater may be very difficult to identify;

but it might well be looked for while ***keeping some flexible ideas*** *as to what its properties may be."*

We suggest the Great Lakes area of North America



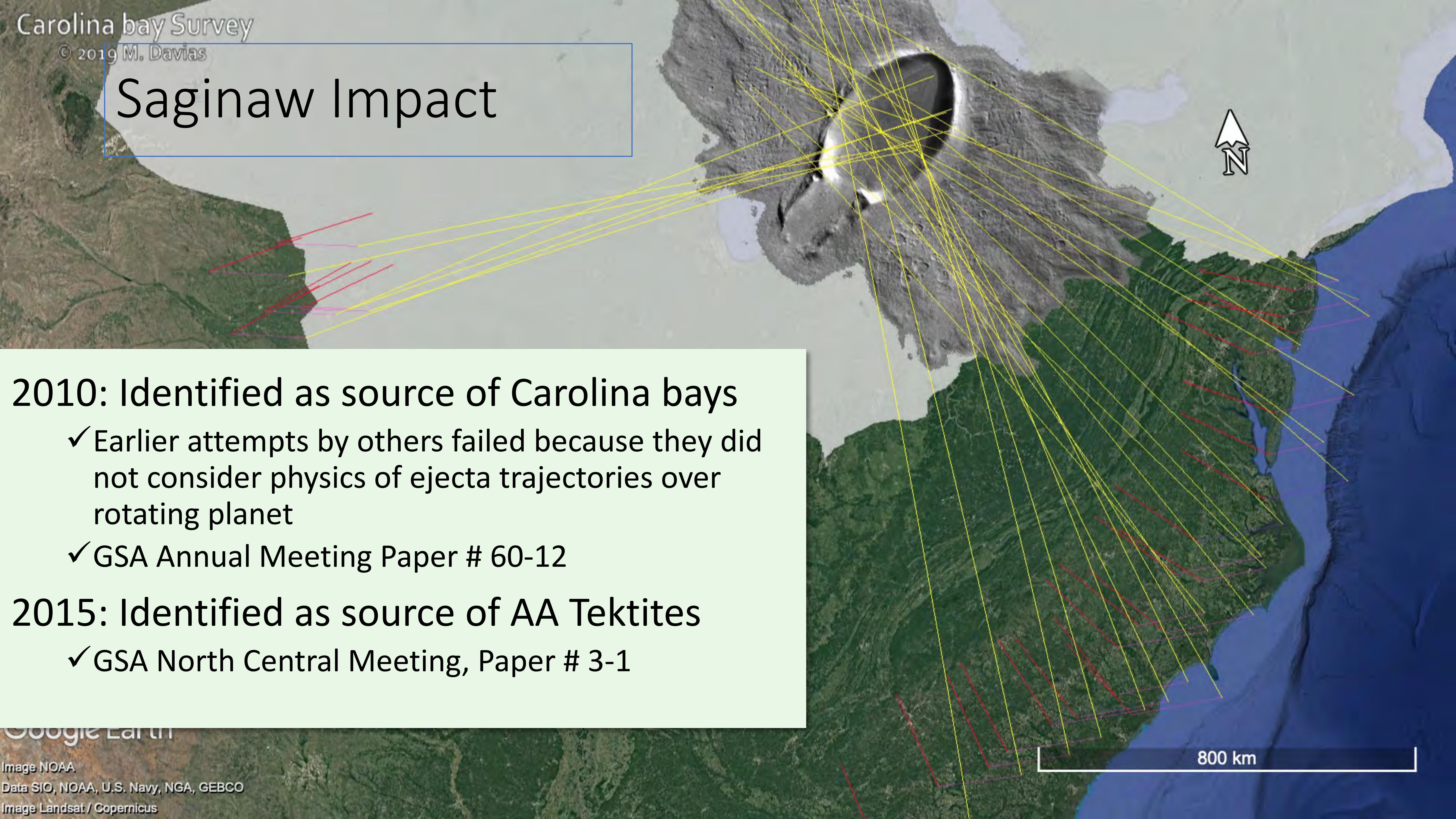
Saginaw Impact

2010: Identified as source of Carolina bays

- ✓Earlier attempts by others failed because they did not consider physics of ejecta trajectories over rotating planet
- ✓GSA Annual Meeting Paper # 60-12

2015: Identified as source of AA Tektites

- ✓GSA North Central Meeting, Paper # 3-1



The Great Lakes Area with θi gravity aspects

No definitive evidence of impact, *"But combed strike angles … disclose a trace of high pressure to the SE/S/SW of the Bay and may be due to an impacting body."*

Klokočník, et al, Journal of Great Lakes Research 45 (2019) 12–20

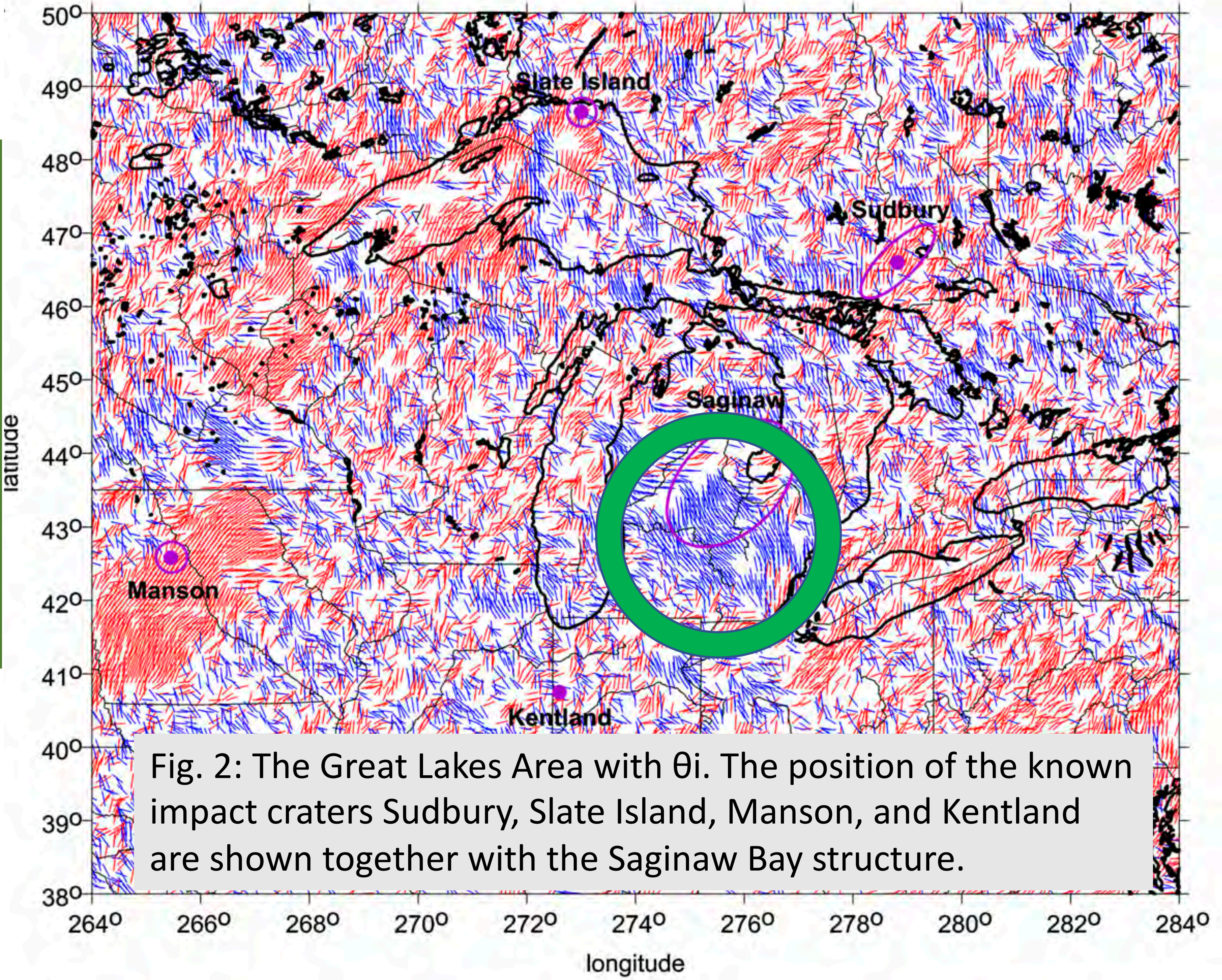
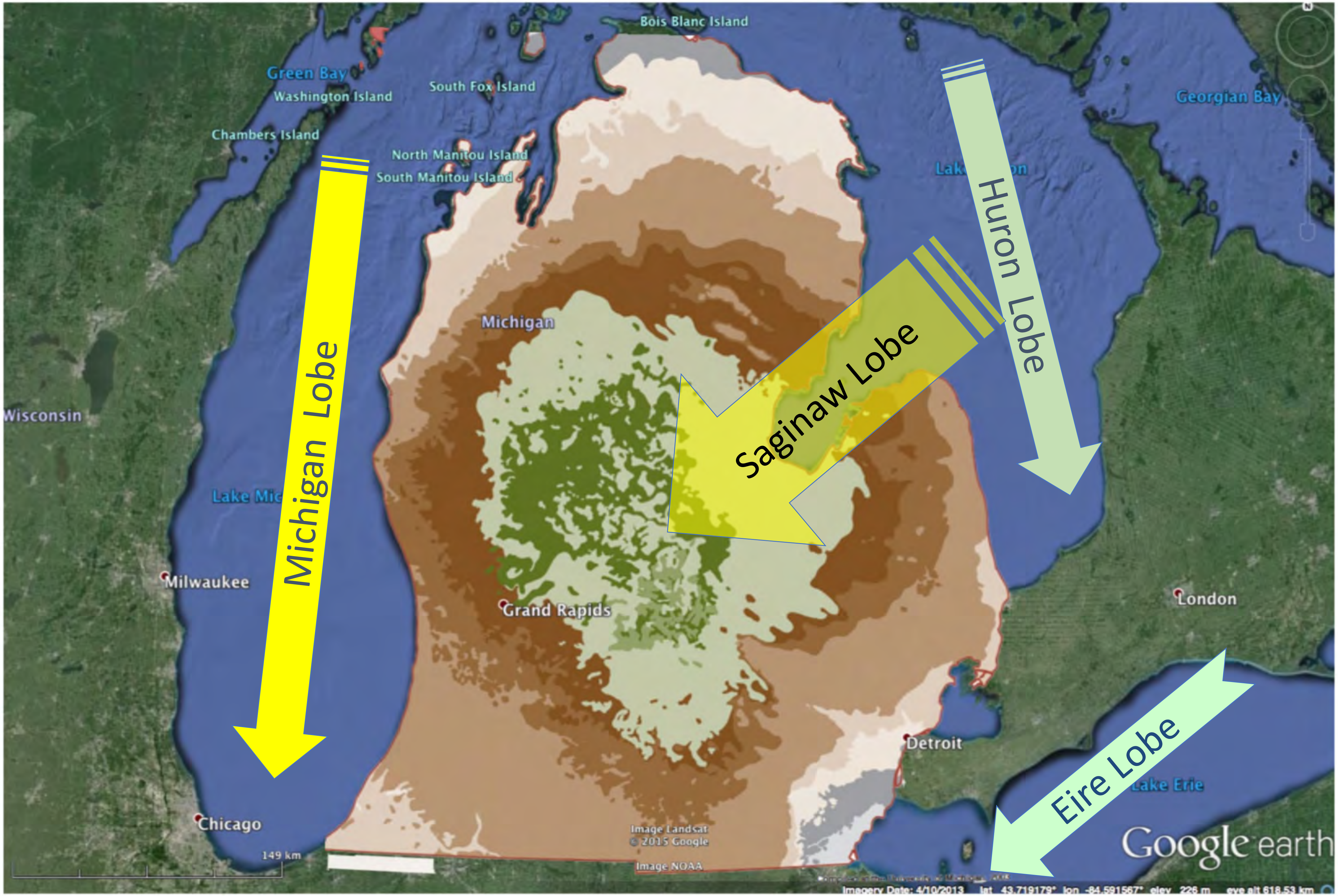
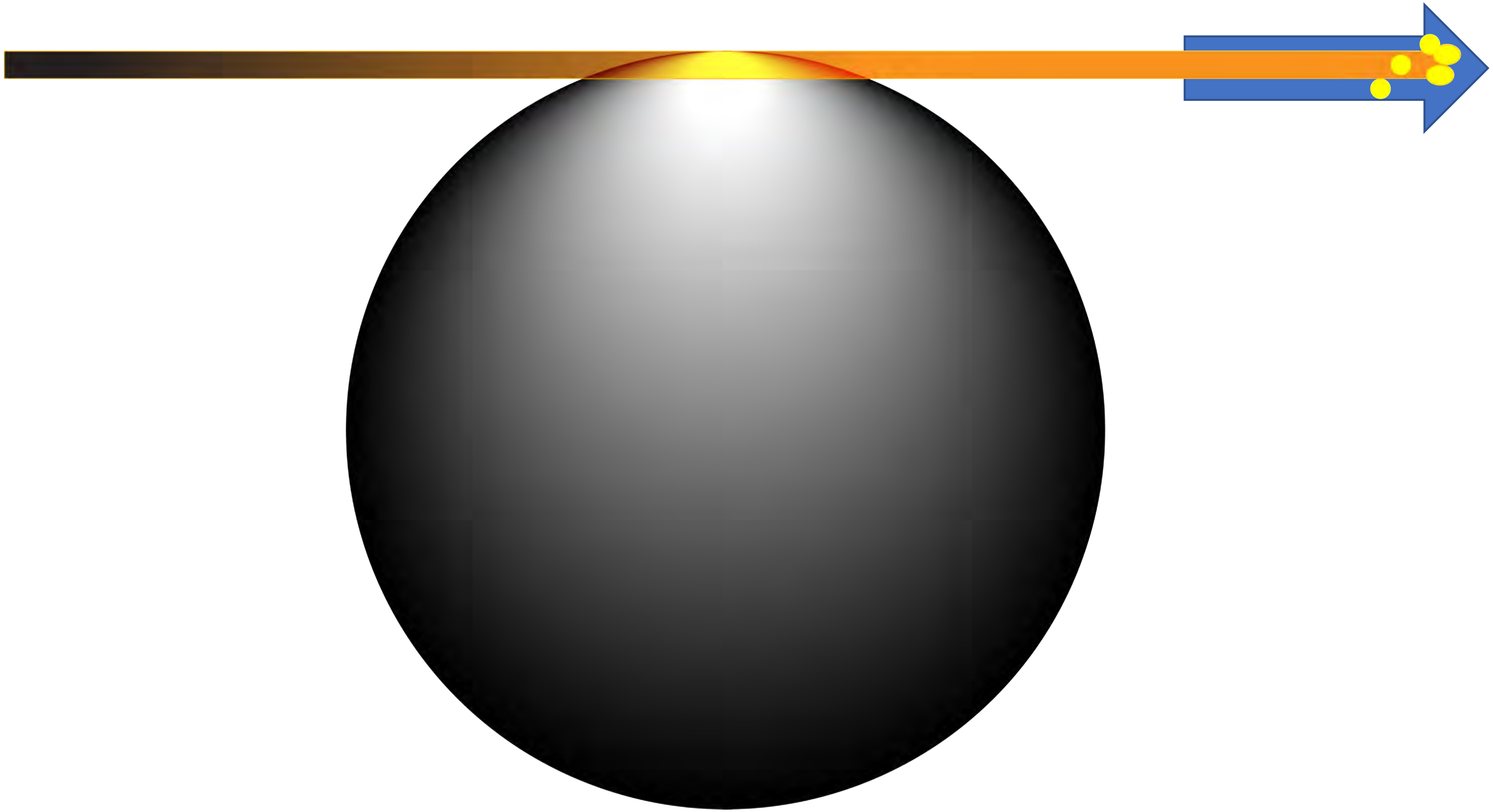


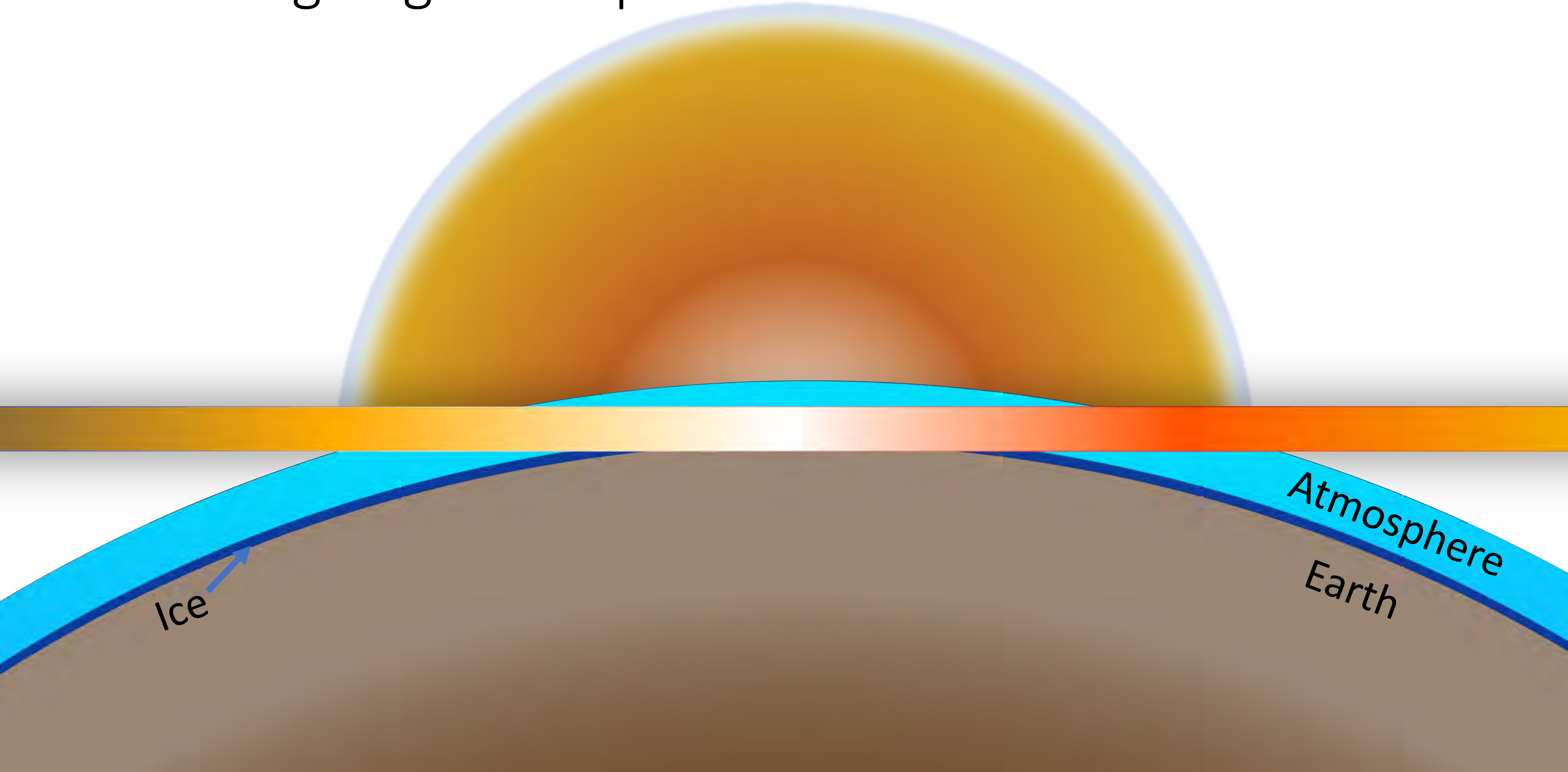
Fig. 2: The Great Lakes Area with θi. The position of the known impact craters Sudbury, Slate Island, Manson, and Kentland are shown together with the Saginaw Bay structure.


Bois Blanc Island
Green Bay
Washington Island
South Fox Island
Georgian Bay
Chambers Island
North Manitou Island
South Manitou Island
Michigan Lobe
Huron Lobe
Saginaw Lobe
Michigan
Wisconsin
Lake Mic
Milwaukee
Grand Rapids
London
Detroit
Eire Lobe
Lake Erie
Chicago
149 km
Image Landsat
© 2015 Google
Image NOAA
Google earth

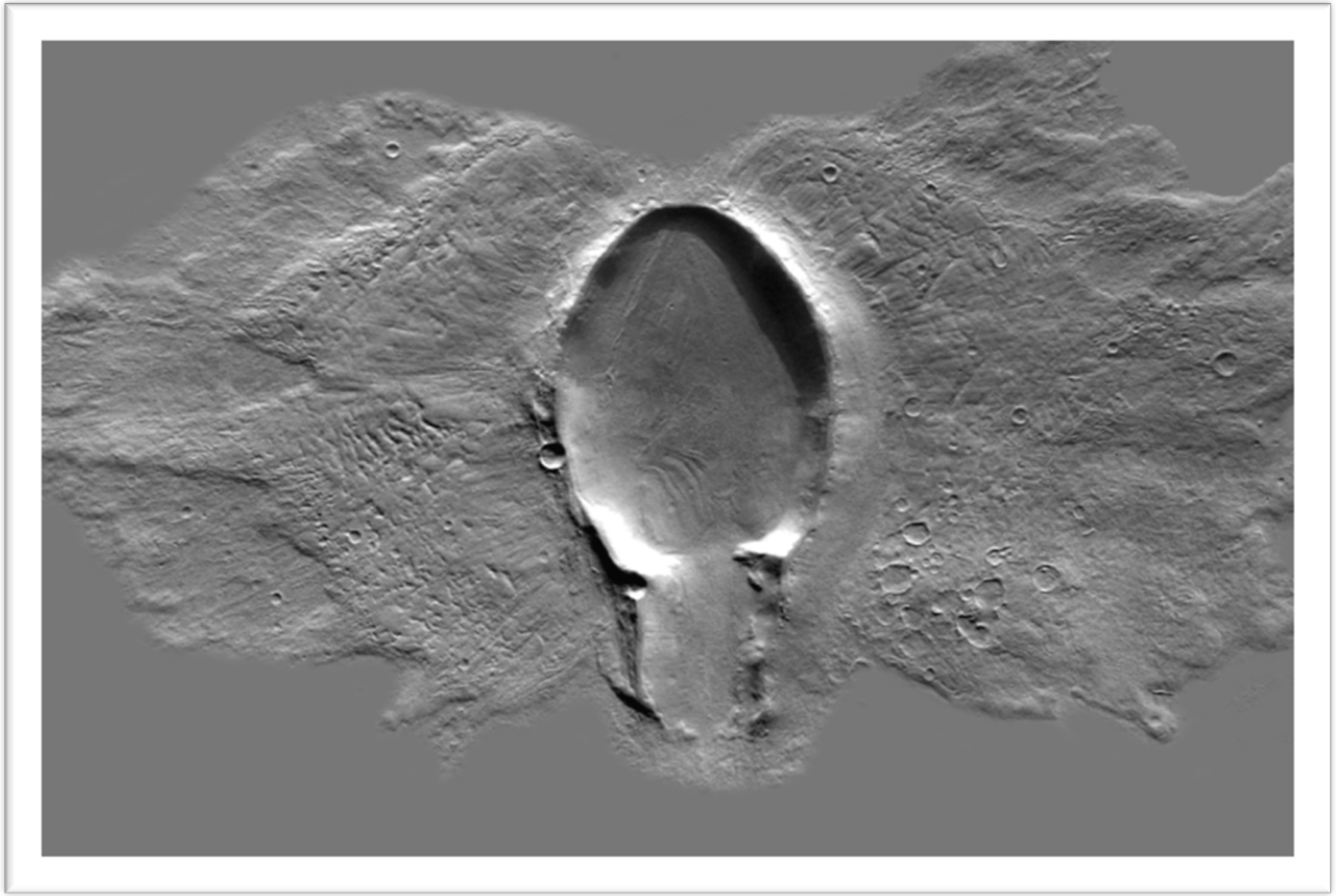
Grazing Regime Impact

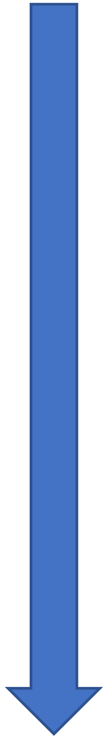


Grazing Regime Impact



Mars Grazing Regime Examples



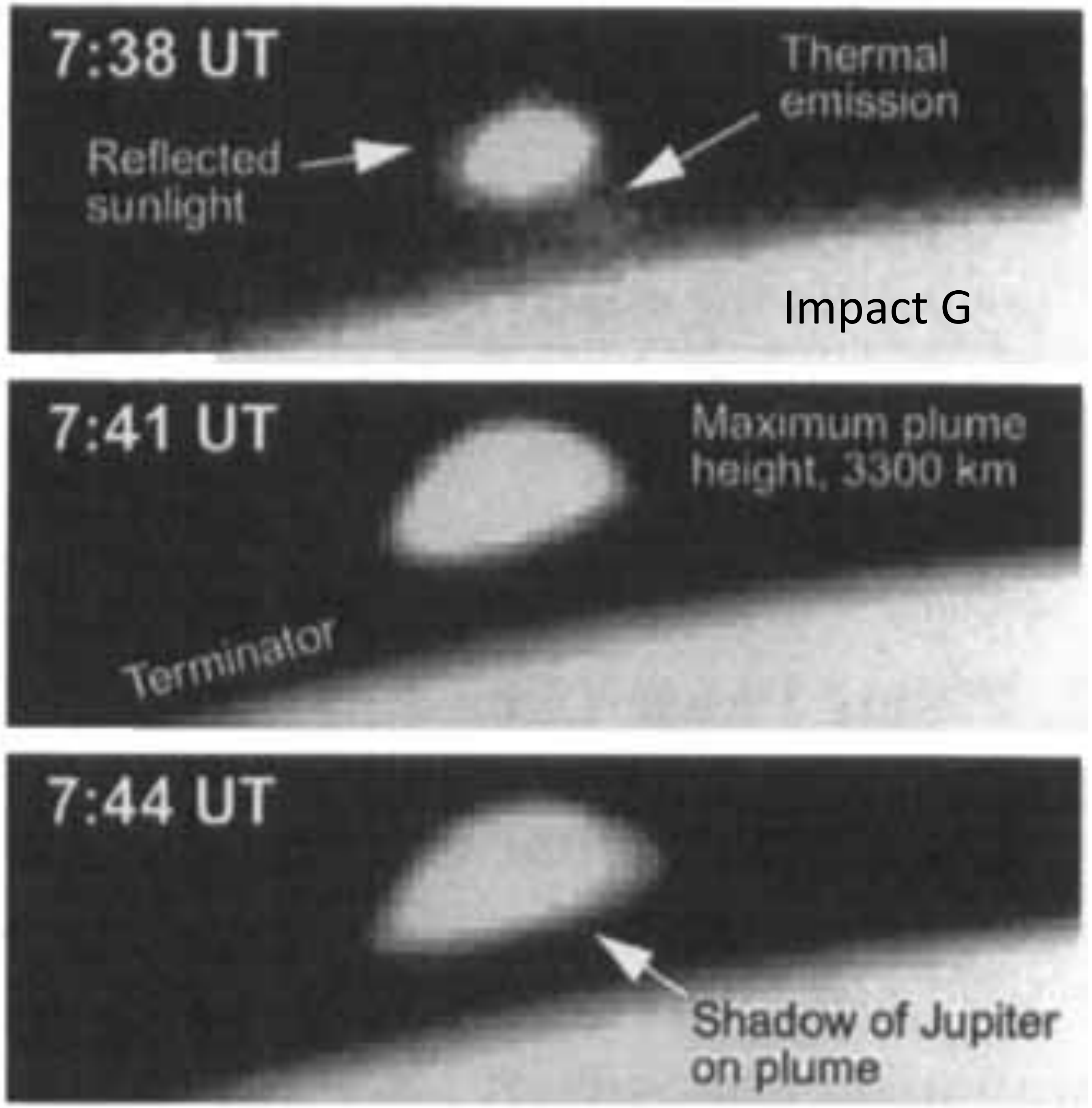


Incomprehensible: SL-9

"Astronomers indeed observed the fireballs and plumes predicted by the models…

The actual event, however, produced a much richer array of consequences than anyone had anticipated."

- Boslough & Crawford



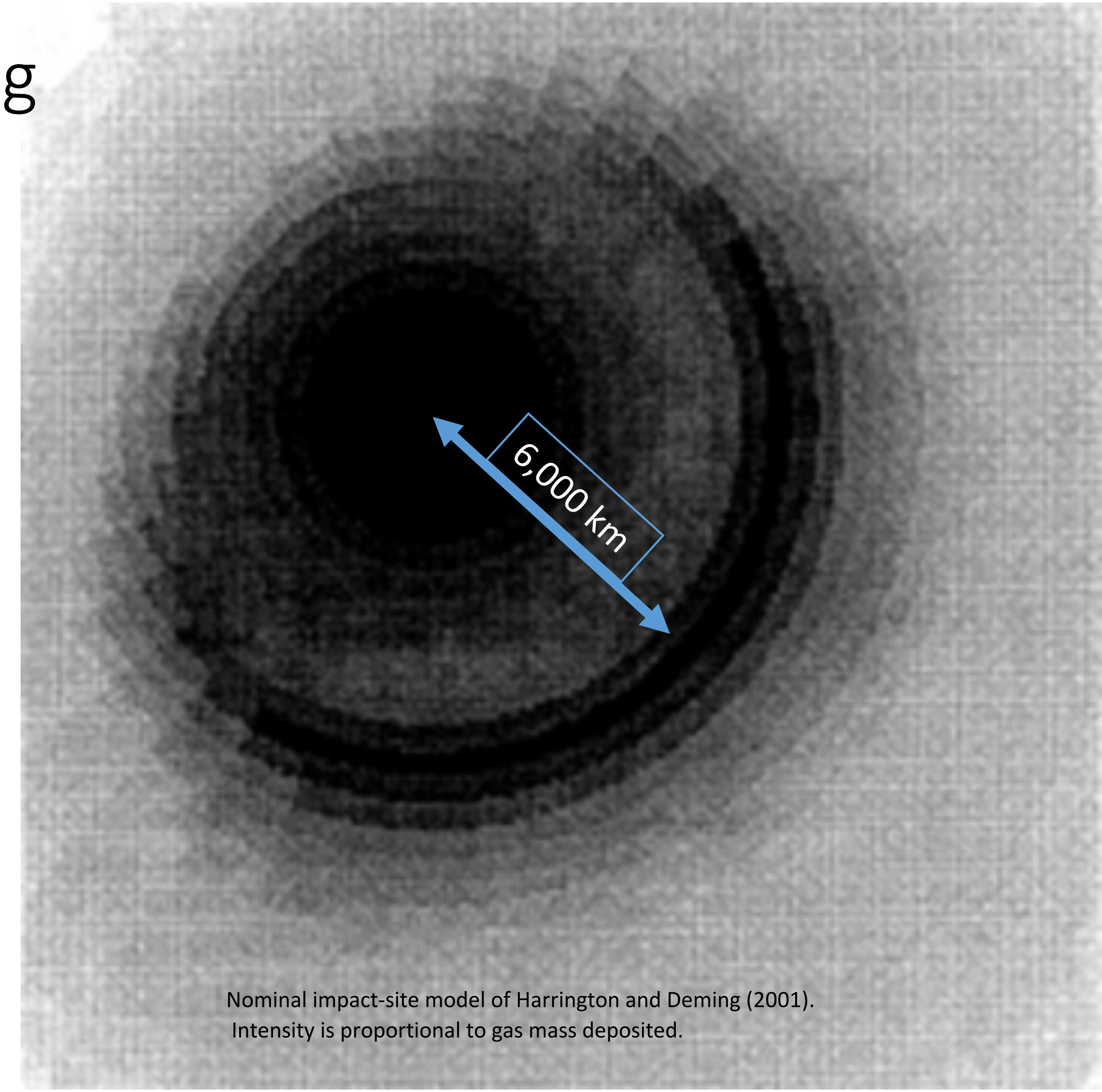
Incomprehensible Skidding

A ring of ejecta debris expanded for hours, while slowly rotating due to Coriolis forces.

The inner crescent edge has slid 6,000 km from the impact site.

The interpretation is that the debris was *skidding* across the top of a super heated atmospheric layer.

The same dynamic has been applied to explain the transport of unshocked minerals from the K-P impact all the way to New Zealand.



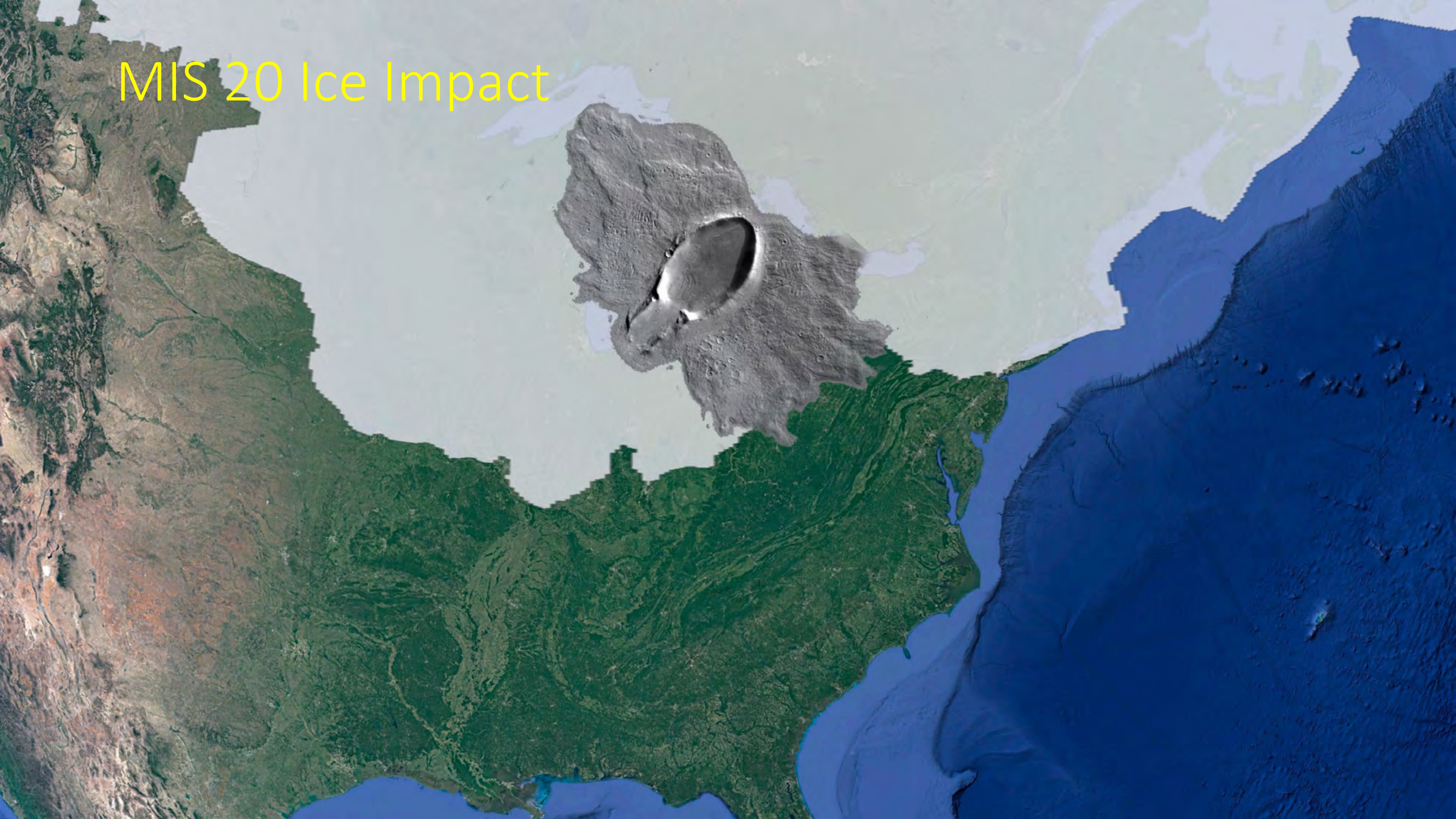
Nominal impact-site model of Harrington and Deming (2001).
Intensity is proportional to gas mass deposited.

Michigan Basin Sandstone a Hydrous Target

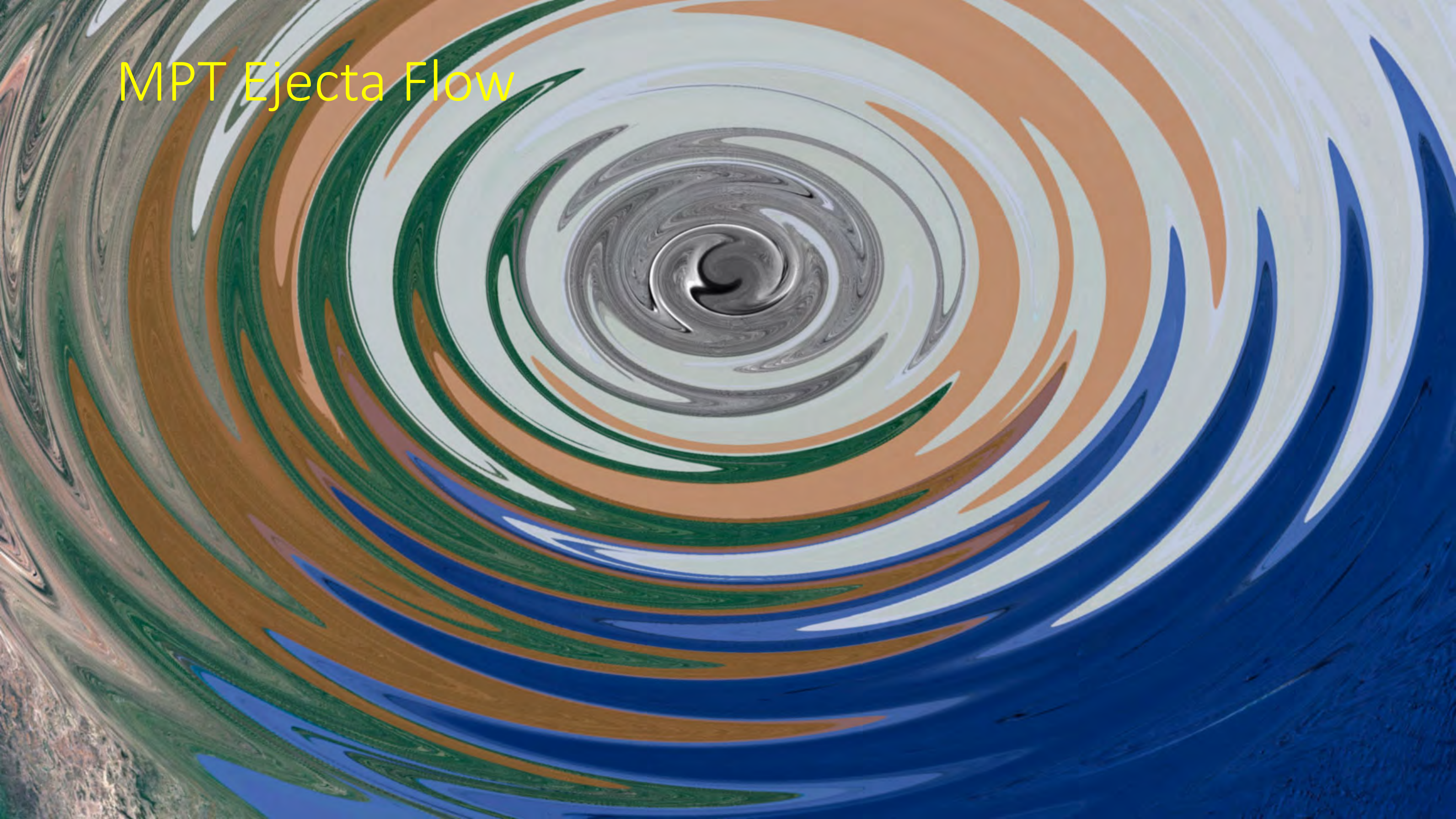
"We suggest that in addition to strength-weakening due to the presence of fluids, vaporization of water upon pressure release provides an additional ***explosive potential that superimposes the impact-induced flow field."***

"Cratering efficiency, ejection velocities, and spall volume are enhanced if the pore space of the sandstone is filled with water. In addition, the crater morphologies differ substantially from wet to dry targets, i.e., ***craters in wet targets are larger, but shallower****."*

Thomas KENKMANN, et al, 2011, *Impact cratering in sandstone: The MEMIN pilot study on the effect of pore water, Meteoritics & Planetary Science 46, Nr 6,*


MIS 20 Ice Impact

MPT Ejecta Flow




MPT Debris Ring


Saginaw Scrubbed

Forensic Evidence From AA Tektites

- Barnes 1990, regarding the Origin of Australasian Tektites

  All of the tektites analyzed have rare-earth-element compositions that exactly match, within the limits of error, the rare-earth-element values in the North American Shale Composite.

- Blum, 1992, *Rb/Sr Dating*

  A correlation of Rb/Sr fractionation with Sr model ages indicates that the last major Rb/Sr fractionation event experienced by the target materials occurred 175 ± 15 Ma ago. We interpret this age as the time of deposition of sedimentary target rocks and consider the compositional layering observed in Muong Nong-type tektites to ***reflect compositional variability inherited from Jurassic sediments****. Depleted mantle Nd model ages fall within the narrow range of* ***1490-1620 Ma,*** *indicating that the source material was derived dominantly from a* ***Proterozoic crustal terrene***

Barnes, 1990, *Tektite research 1936-1990 (*Barringer Award paper), Meteoritics Vol 25

Joel D. Blum, 1992, *Neodymium and strontium isotopic study of Australasian tektites: New constraints on the provenance and age of target materials*

Michigan Basin Mesozoic Sandstone Zircon Ages

Dickinson, et al, *Detrital zircons from fluvial Jurassic strata of the Michigan basin: Implications for the transcontinental Jurassic paleoriver hypothesis*, Geology 2010;38;499-502

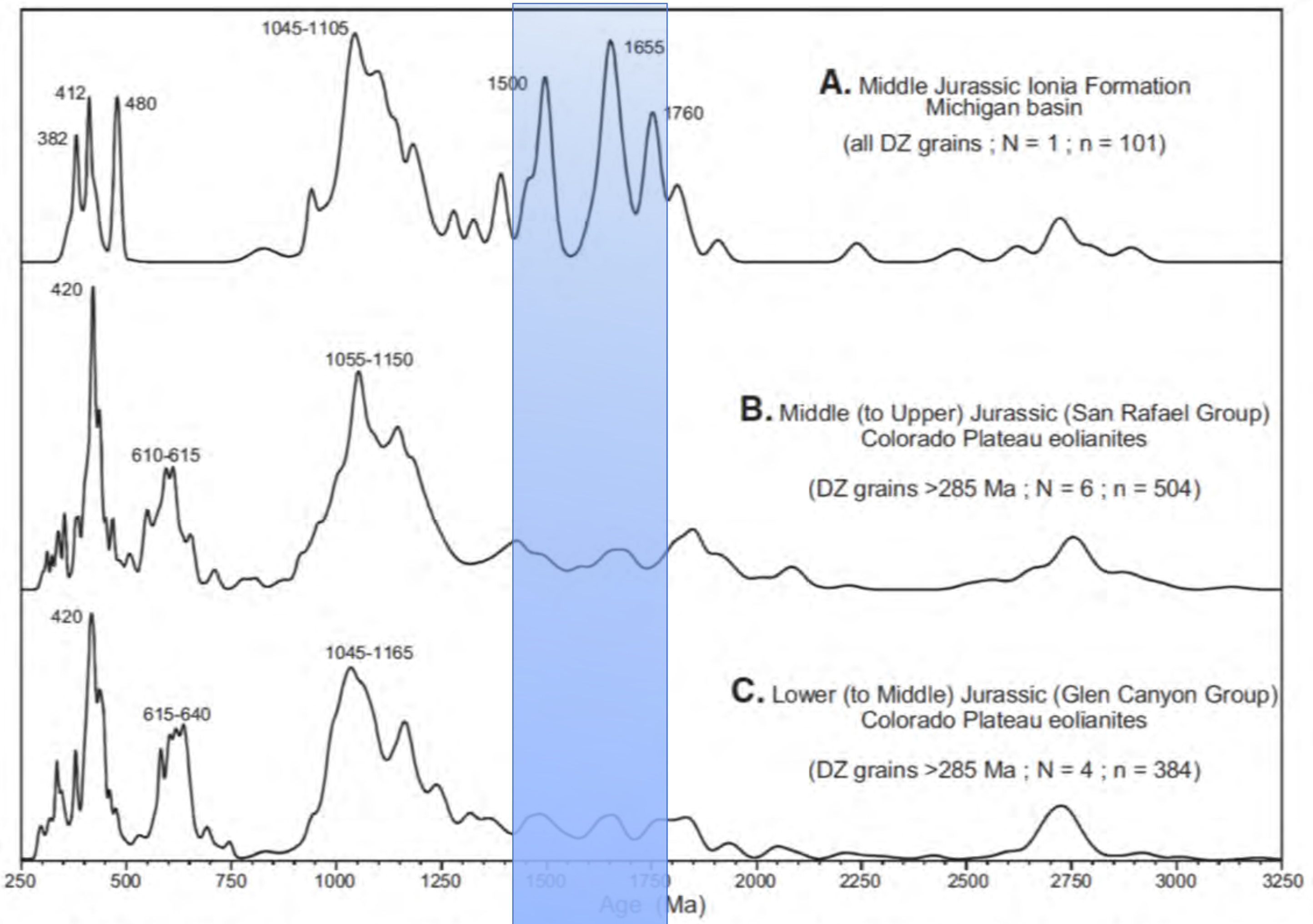
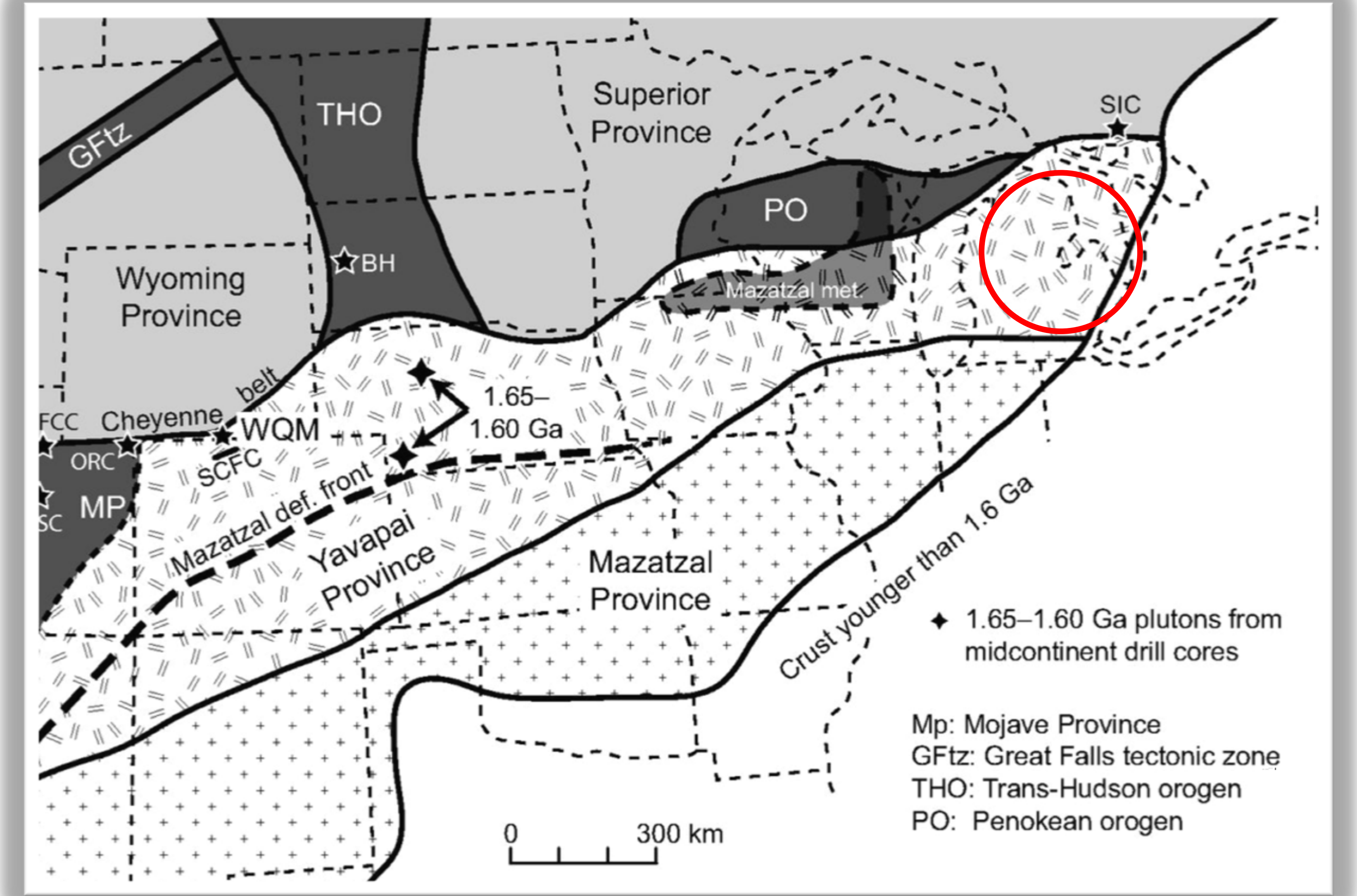
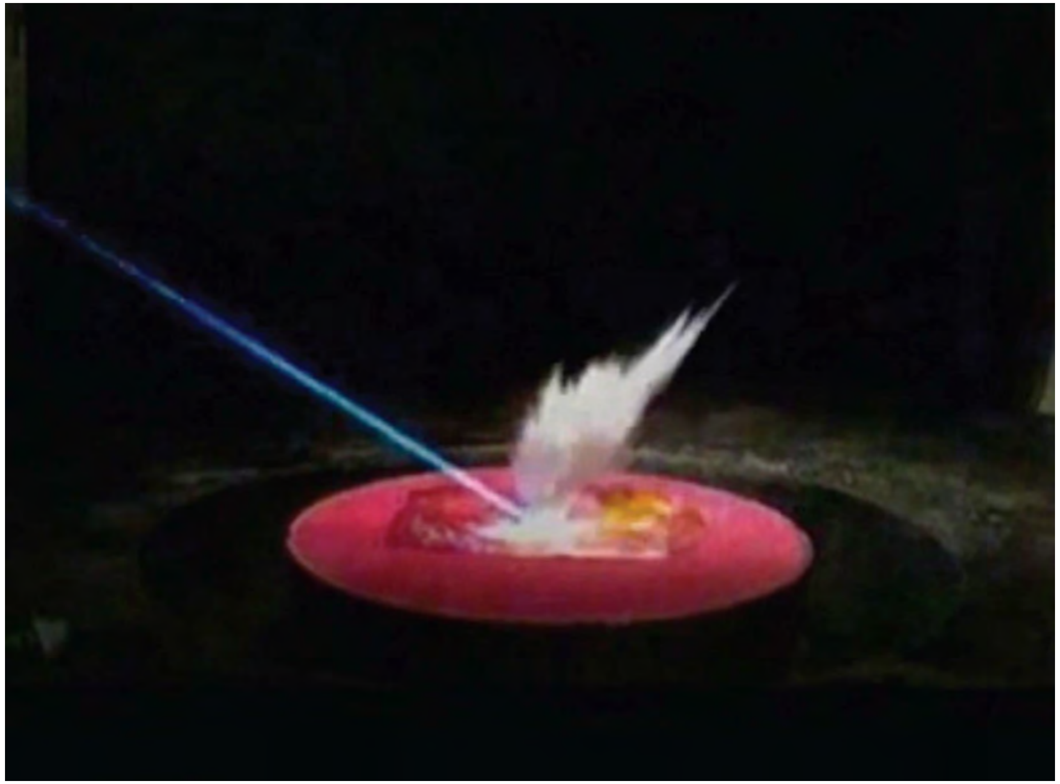


Figure 2. Age-distribution curves (normative age-probability plots) of U-Pb ages. A: Detrital zircon (DZ) grains in Ionia Formation of the Michigan basin. B, C: Detrital zircon grains older than 285 Ma in Colorado Plateau eolianites of Jurassic age. N—number of samples; n—number of grain ages.

Michigan Basin Jurassic Sandstone Zircon Ages

Jones, et al, 2012, *Reactivation of the Archean-Proterozoic suture along the southern margin of Laurentia during the Mazatzal orogeny: Petrogenesis and tectonic implications of ca. 1.63 Ga granite in southeastern Wyoming, GSA Bulletin V. 125 no. 1-2*






Enigmatic Button Flange

- First entered literature though Charles Darwin’s voyage on the Beagle
- Thought to be volcanic bomb
- Found across south eastern Australia
- One found in a grab core in the Central Indian Ocean, 7,000 km east of the Australian finds

Fig. 1. First illustration known of a tektite [from *Darwin*, 1844], thought by Charles Darwin to be a volcanic bomb.

Button-Flange AA Tektites Ring Waves

In 1964, Dean Chapman and a team at NASA Ames demonstrated how these ringlets and flanges were created during aerodynamic ablation of a fully solidified spherical tektite, requiring velocities close to Earth Escape

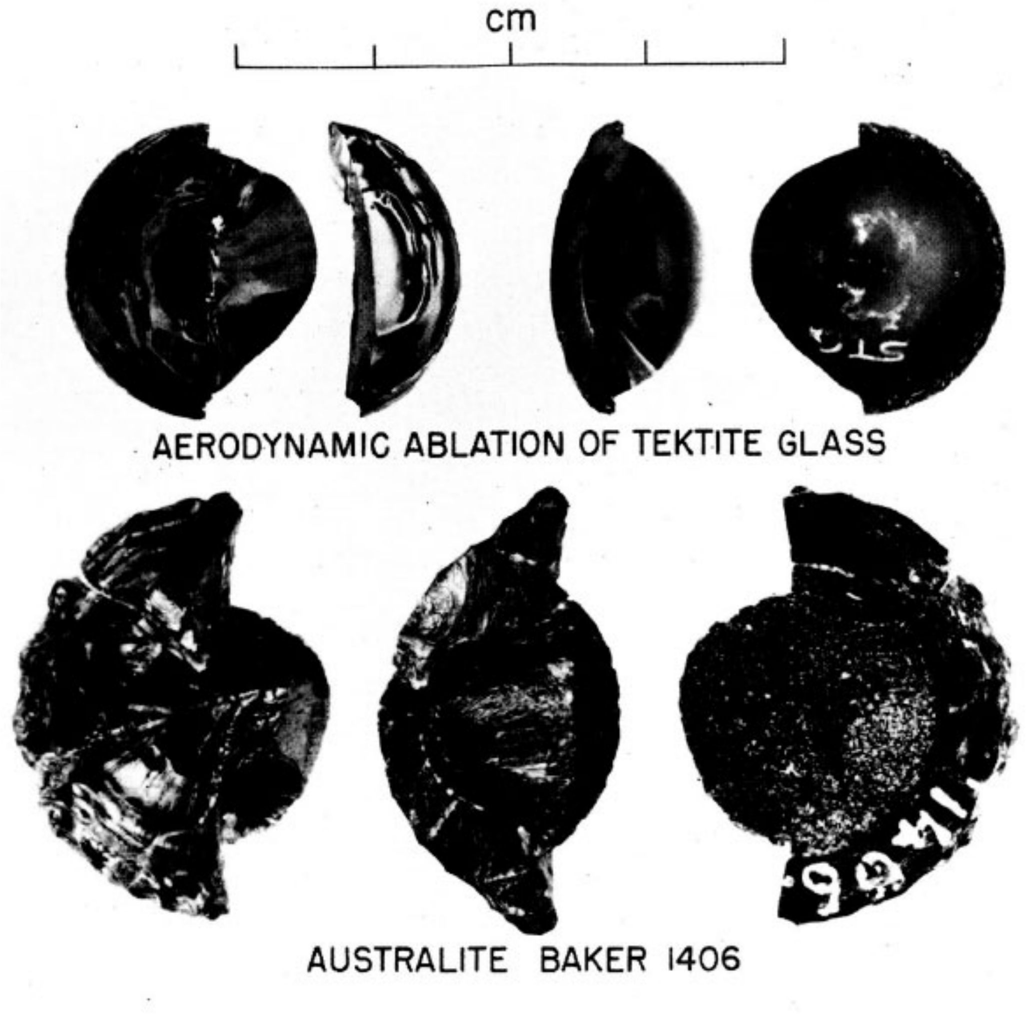


Fig. 4. Half spallation of aerothermal stress shell.

Chapman, *On the unity and origin of the Australasian tektites, Geochimica et Cosmochimica Acta* 1964, Vol. 2

Central Indian Ocean Button-Flange AA Tektite

A well-preserved examples was recovered from the central Indian Ocean floor 7,000 km west of the main button-flange strewn field, suggestion the Indian Ocean was paved with tektites

A lack of ring waves suggests it reentered at a lower velocity than those in Australia

A 1.5mm diameter impact pit on anterior face suggests mid-air collision after solidification

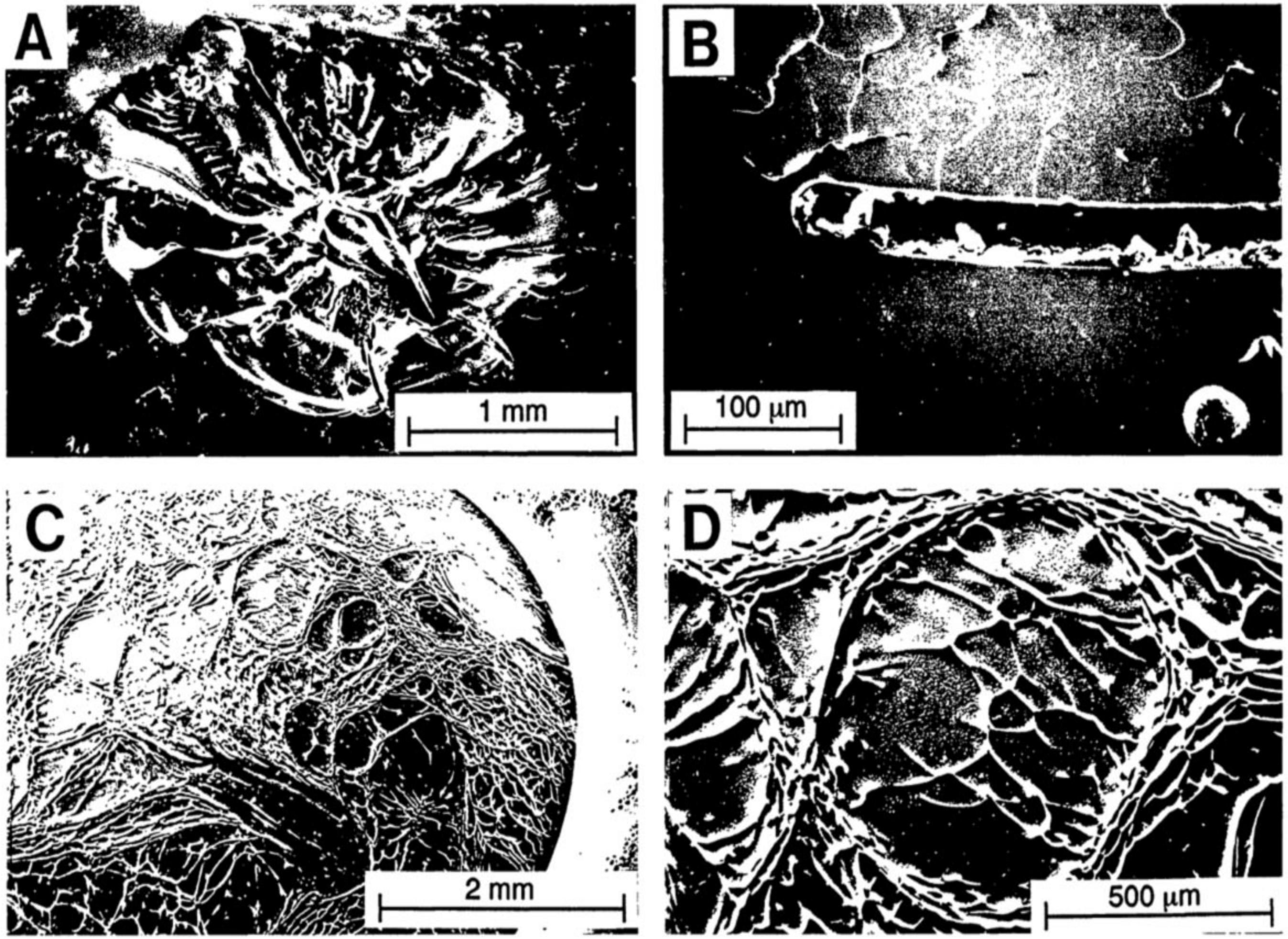
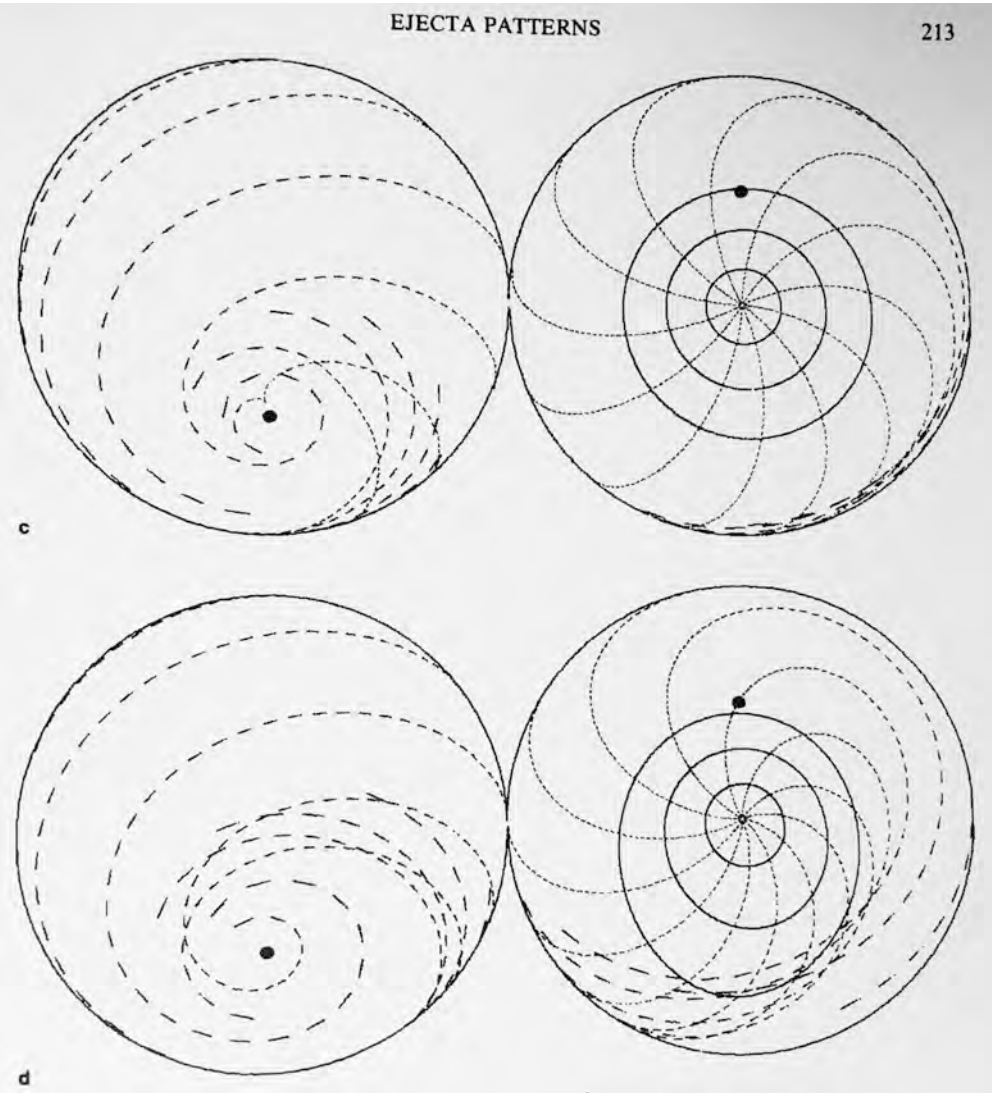


FIG. 3. Scanning electron microscope photomicrographs of surface features on the central Indian Ocean tektite. (a) Impact pit on anterior surface (see Fig. 2a). (b) Crack on anterior surface (32 μm wide). (c) Part of posterior surface and a portion of the flange (note vesicular area in upper right). (d) High-magnification view of sculpturing on the posterior surface.

Glass, Chapman & Prasad, 1996, Ablated tektite from the central Indian Ocean, Meteoritics & Planetary Science #31

Distal Ejecta – Tektites Trajectories

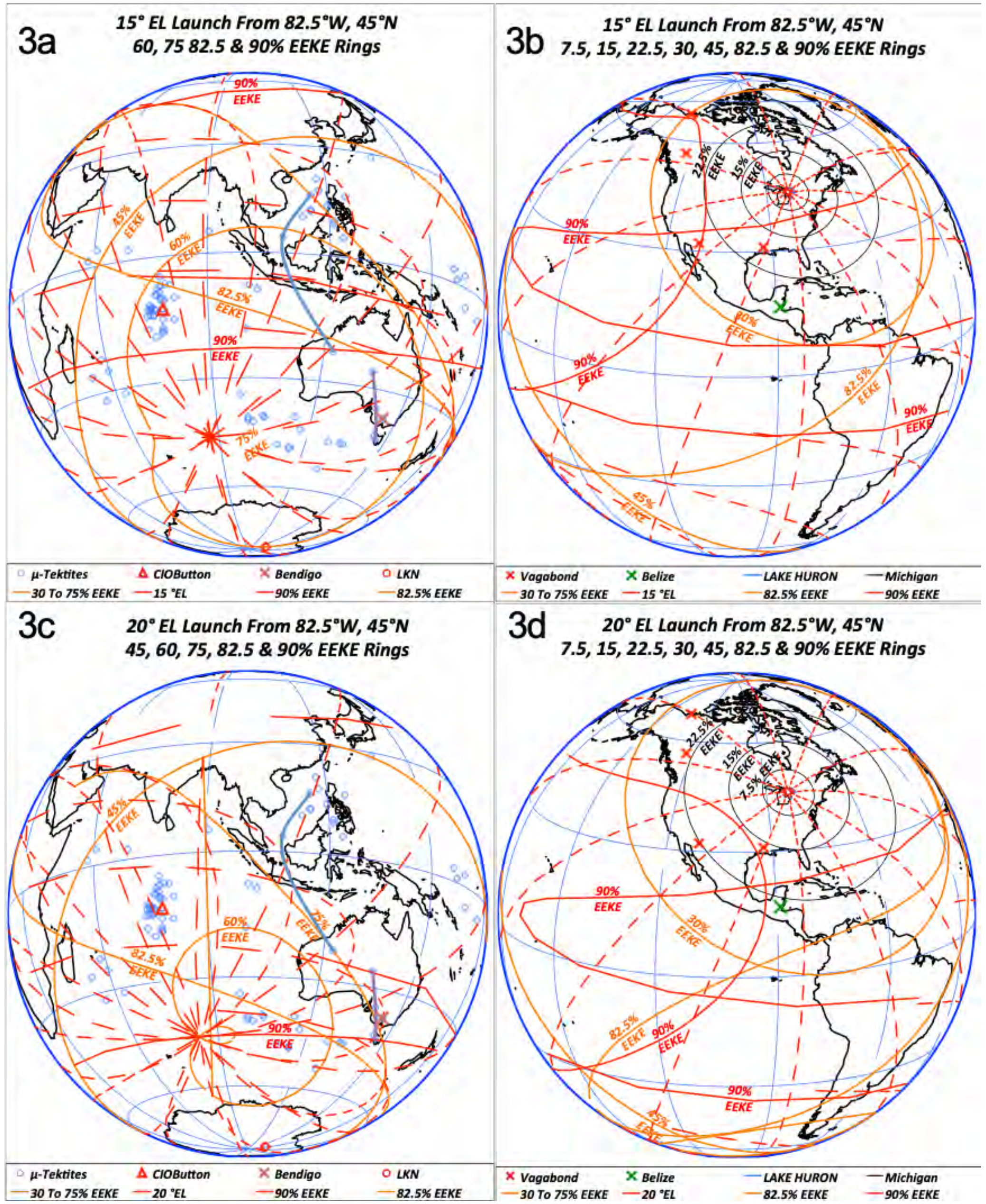
- Computation engine built to derive and plot trajectories for distal ejecta
- Engine uses Dobrovolskis' process
- Computations performed for launches from extensive range of latitudes
- Simple transposition yields plots on globe from launch longitudes
- Plots for viable range of launch azimuths and kinetic energy
- Efforts to publish our processes and findings are meeting with strong resistance due to entrenched consensus that demands Indochina impact

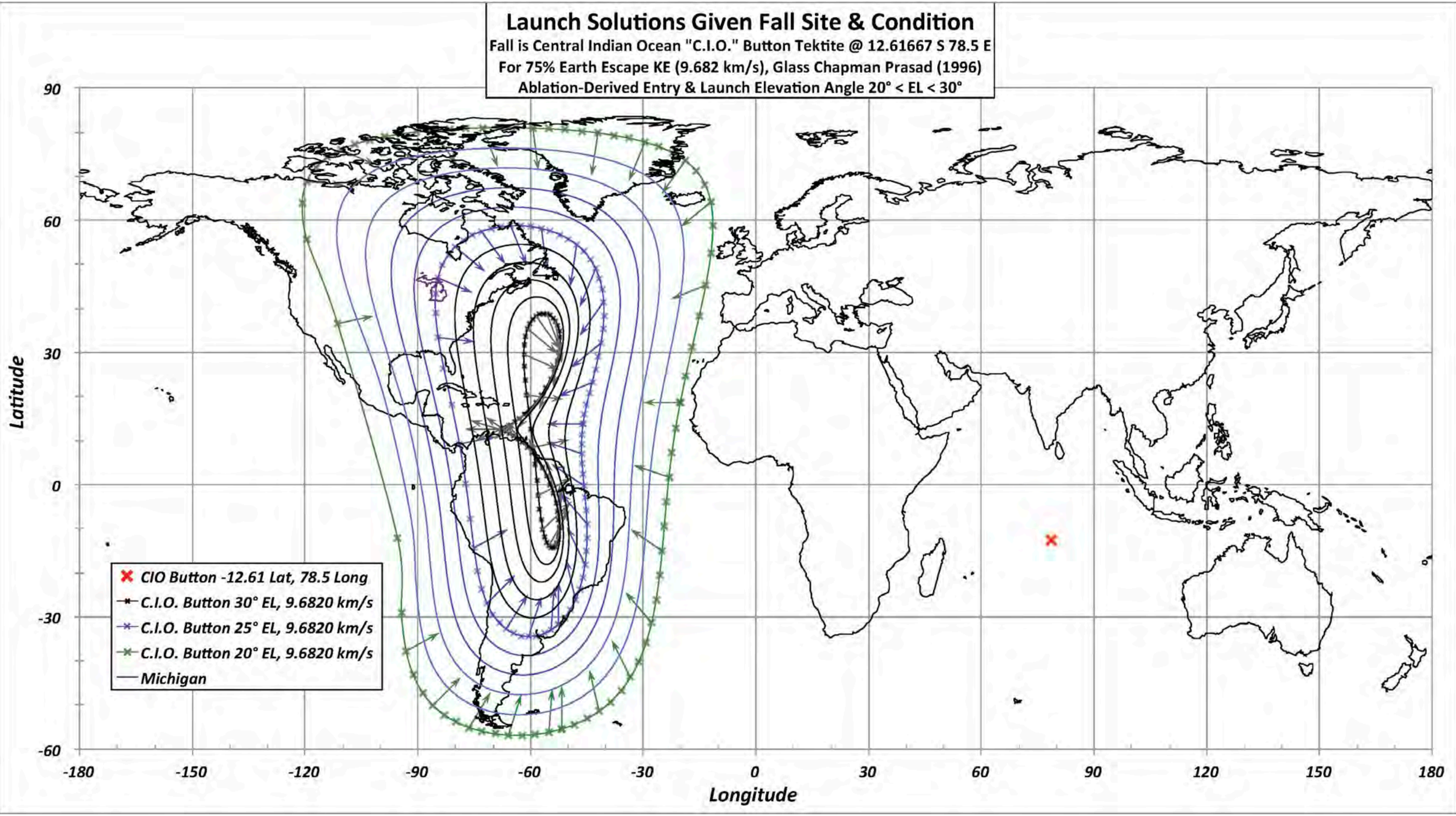


A. Dobrovolskis, 1981, *Ejecta Patterns Diagnostic of Planetary Rotations*, Icarus #47 pp203-219

Distal Ejecta – Tektites Trajectories From Saginaw

- Tektites launched at high EEKE from Saginaw will focus on Indian Ocean antipode
- Many viable velocities and azimuths to reach Australia

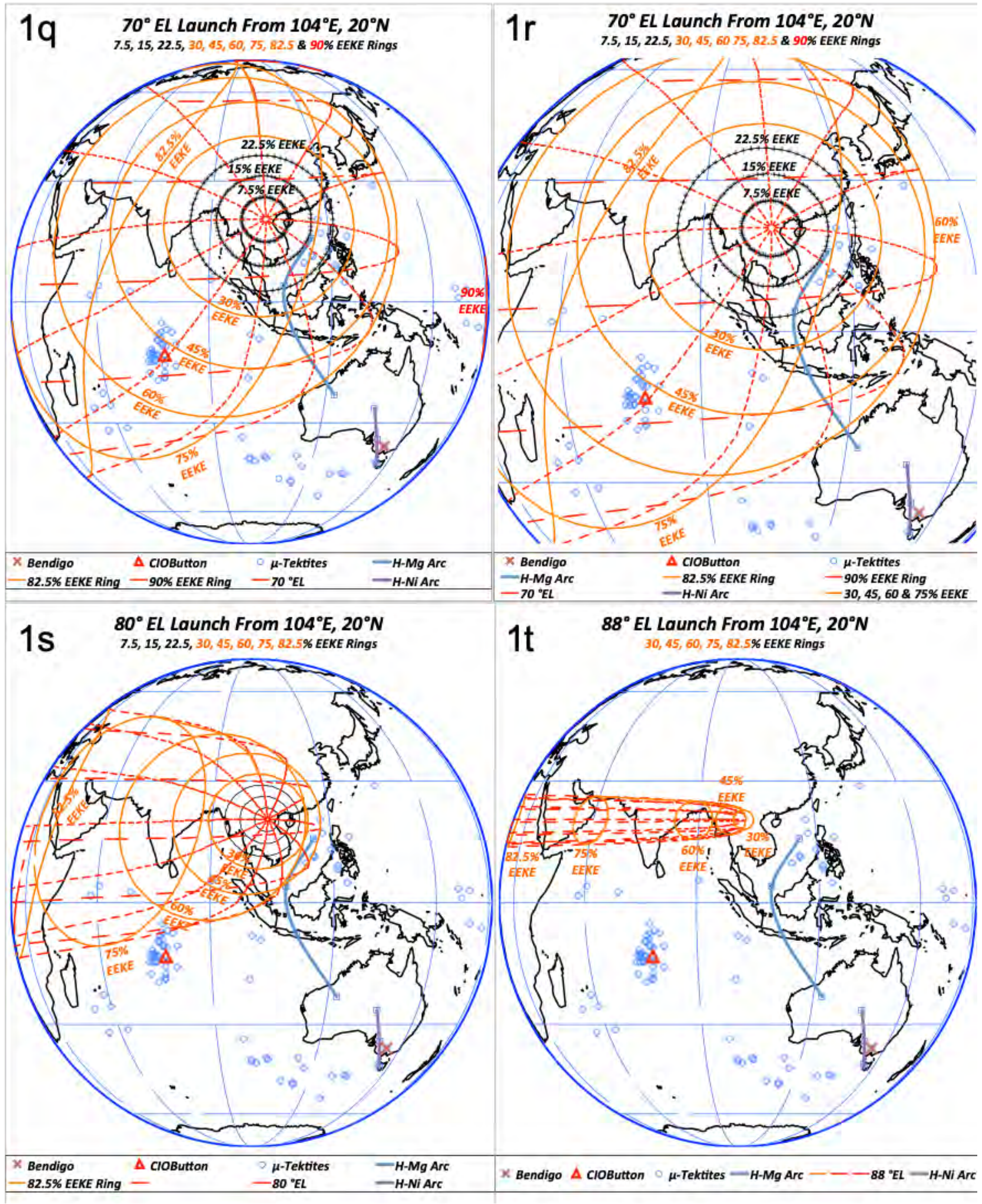




Launch Solutions Given Fall Site & Condition
Fall is Central Indian Ocean "C.I.O." Button Tektite @ 12.61667 S 78.5 E
For 75% Earth Escape KE (9.682 km/s), Glass Chapman Prasad (1996)
Ablation-Derived Entry & Launch Elevation Angle 20° < EL < 30°
CIO Button -12.61 Lat, 78.5 Long
C.I.O. Button 30° EL, 9.6820 km/s
C.I.O. Button 25° EL, 9.6820 km/s
C.I.O. Button 20° EL, 9.6820 km/s
Michigan
Latitude
Longitude
90
60
30
0
-30
-60
-180
-150
-120
-90
-60
-30
0
30
60
90
120
150
180

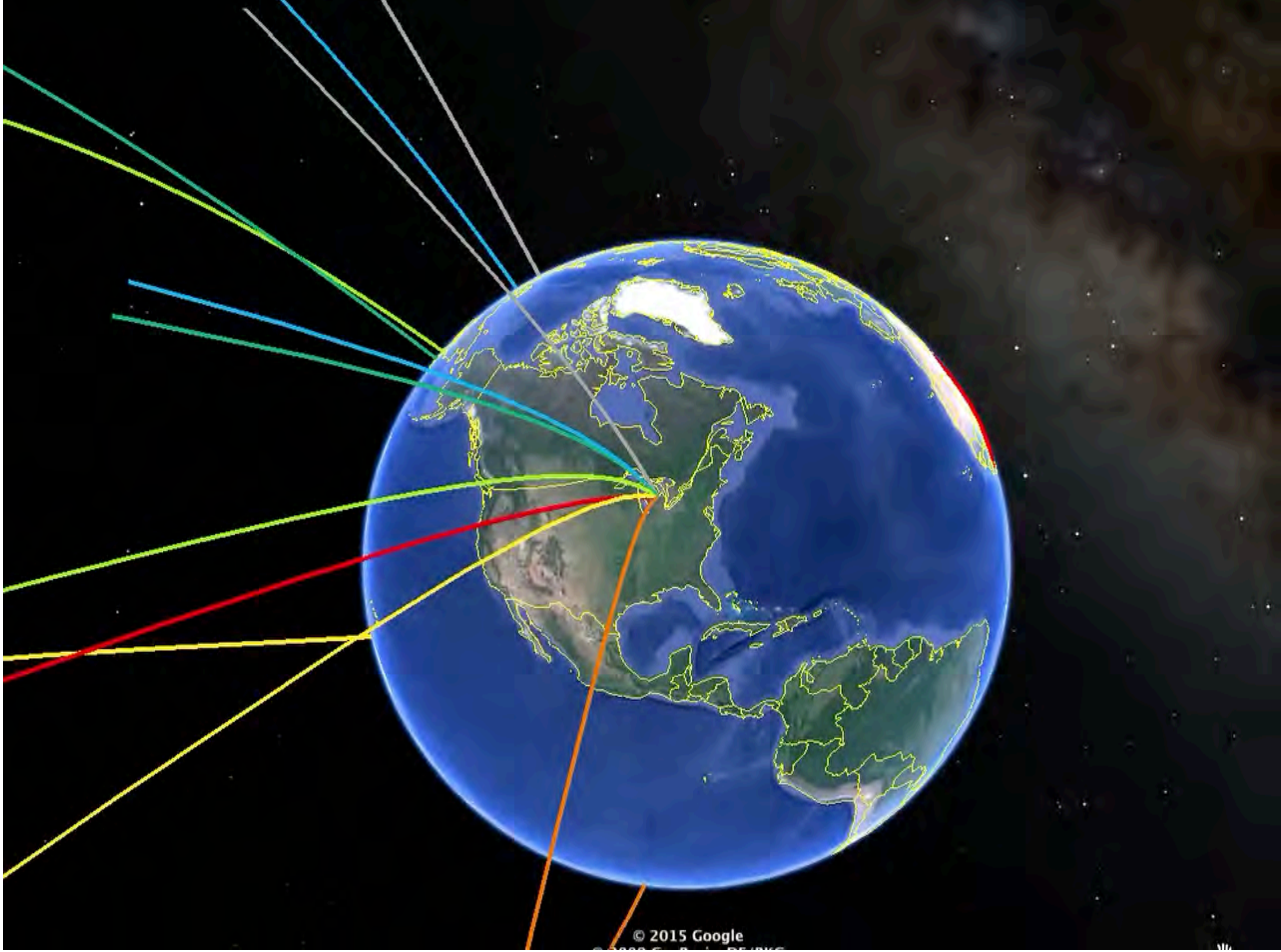
Distal Ejecta – Tektites Trajectories From Indochina

- Tektites launched at 70º elevation
  - fall mostly to the west due to planetary rotation
  - Most EEKE % can reach CIO Button
  - Can't land in Australia
- Tektites launched at >80º elevation
  - can't reach Bendigo, Australia
  - nor the Central Indian Ocean Button location



MPT Impact

Must account for Earth's rotation, a critically important step for the very high-speed Australasian tektites and their associated long loft duration

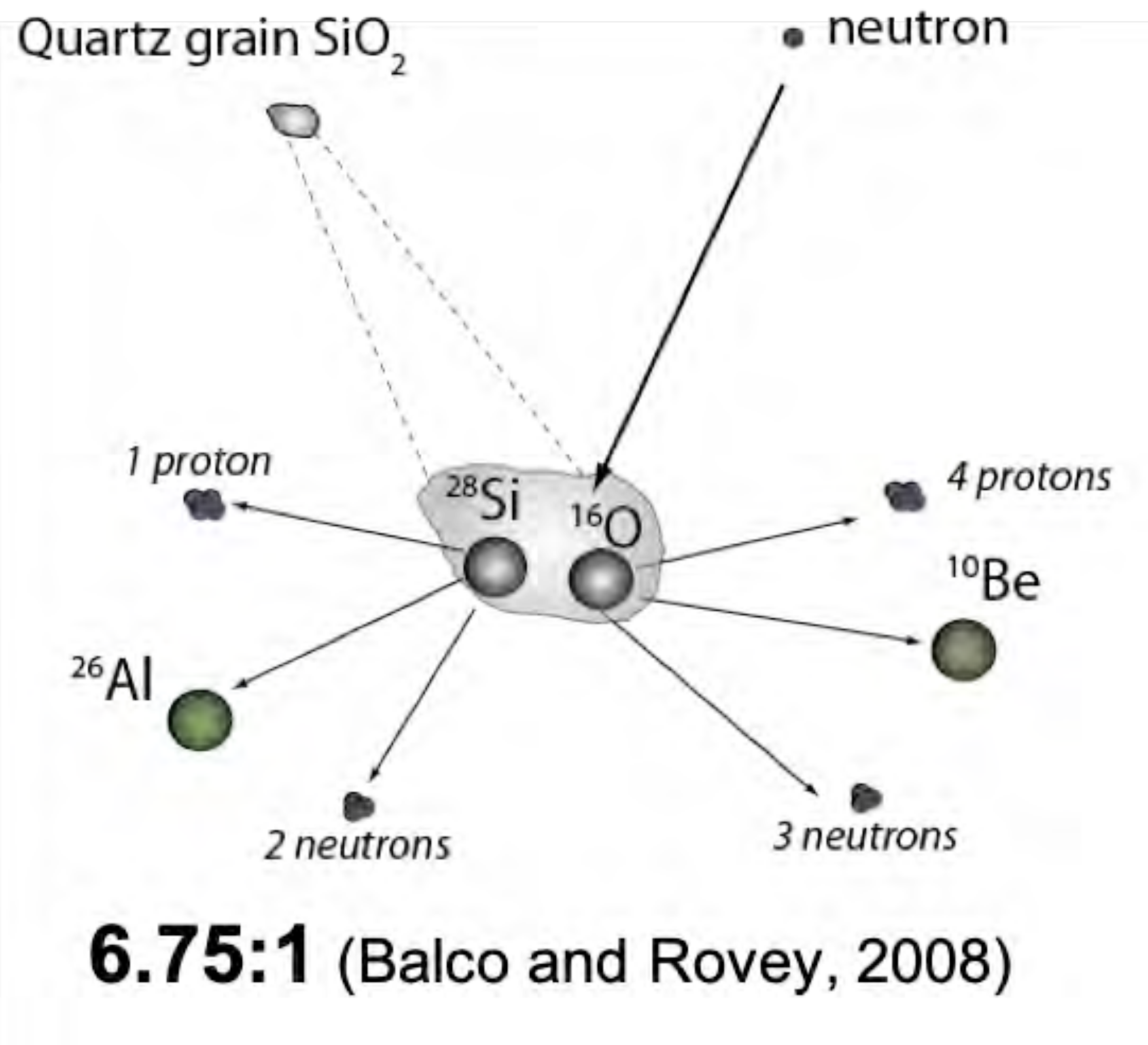


Falsification

- This hypothesis is falsified if inspection of Central and Eastern areas of the United States do not show a significant pulse of surficial sediment aggregation circa 800 ka
- Such as an assessment can only be accomplished with cosmic isotope burial dating
- We note that the falsification has been dismissed as irrelevant, since the climate changed at MPT, so might have sedimentation regimens

Cosmic Ray Splitting Quartz Grain

- Each grain of quartz split yields Beryllium and Aluminum isotopes in a know ratio
- Be^{10} & Al^{26} have differing half lives
- Be^{10} – Al^{26} analysis can identify burial dates back 5 million years
- Range is required to accurately identify surficial sediment deposition across the MPT
- C^{14} good only to ~50 ka
- OSL good only to ~140 ka



Dating the Regolith Impulse using Be^{10}/Al^{26}

- Balco[1] noted anomalous regolith loading in glacial tills deposited at ~**800** ka
- Anthony[2] Noted a widespread, singular, Appalachian drainage basin aggradation signal at ~ **800** ka
- Del Vecchio[3] Identified a sudden onset of regolith circa **750** ka in a Central Appalachia bog trap basin previously only accumulating saprolite

1 - Balco, Stone & Jennings, *Fate of the preglacial regolith beneath the Laurentide Ice Sheet,* unpublished

2 - Darlene M. Anthony And Darryl E. Granger, 2006, *Five million years of Appalachian landscape evolution preserved in cave sediments*, Geological Society of America, Special Paper 404

3 – Joanmarie Del Vecchio, et al, *Pleistocene Climate-Modulated Erosion: Interpretations From Cosmogenic Nuclide Concentrations Of An 18 M Sediment Core In Central Appalachia,* this meeting Session No. 44 - Booth# 301

Summary

- Impact at Mid Pleistocene Transition 788 ka
  - Highly oblique
  - Strikes deep MIS 20 continental ice sheet, providing for “missing impact”.
- Saginaw Bay, Lake Huron excised as impact structure
  - Multiple successive ice sheet transgressions erased shallow impact evidence
- Proximal ejecta created “glacial regolith” on top of ice sheet
  - Swept to south by ice sheet advances
- Medial ejecta created Carolina bays and Rainwater Basins
  - interpreted as artifacts in sheets of geophysical mass flows
  - NOT primary or secondary impact scars
- Created Australasian Tektite Strewn Field as Distal Ejecta.
- Incomprehensible impacts require physics of ejecta transported over a rotating Earth, not a stationary one

Must we banish from our worldview
things that science cannot comprehend?


http://MPTimpact.org
Google Earth
200 m

An Incomprehensible Cosmic Impact at the Mid Pleistocene Transition;

Searching for the Missing Crater Using Australasian Tektite Suborbital Analysis and Carolina Bays' Major Axes Triangulation

Australasian (AA) tektites are distal ejecta of a cosmic impact into terrestrial sediments 788.1 ± 2.8 ka. Protracted explorations within the strewn field, as preferred by consensus opinion, have yielded neither an astrobleme nor a proximal imprint. In 3 lesser strewn fields correlated with progenitor astroblemes, tektites are strewn asymmetrically and their total masses and minimum loft distances scale with projectile kinetic energy (KE) partitioning yield. Pursuing an a priori astrobleme location within the uniquely expansive AA strewn field ignores such findings. Absent identification of proximal ejecta in the strewn field, workers are now inferring that indochinite tektites are proximal, dismissing their known devolatilization, weightless vacuum quench and their carefully derived re-entry speeds, ≥ 80% of Earth escape. A defendable guess 40 years ago, but promoting an a priori astrobleme in Indochina is now impeding progress.

Ironically, a cosmic link to the Carolina bays' genesis is considered soundly falsified by the same absence of a correlated astrobleme. We have measured ~50,000 of these shallow, oriented, ovoid basins, located around an annulus focused on Saginaw Bay, Michigan. We posit the ovoid planforms to be surficial manifestations of cavitation voids within an incomprehensible geophysical mass flow of volatiles and entrained target clastics.

Unifying both missing astroblemes, we propose an incomprehensible cosmic event on a hemisphere diametrically opposed to the AA distal tektite strewn field. We invoke a highly oblique, perhaps tangential, hypervelocity projectile ricocheting off the Earth's limb along an extended footprint. Sub-horizontal shock to thick MIS 20 ice sheet overburden triggered endogenic comminution, as stored pressure potential within the substrate was released by phase change of pore water to steam, provisioning fluidized medial ejecta outflow for Carolina bay emplacement. Shocked ice plume expansion augmented tektite velocities, and dissipated significant partitioned KE, preventing another Chicxulub-style global conflagration. The KE partitioning process conspired with intervening ice age transgressions to dislocate proximal ejecta and obfuscate the cosmic signature.

AA tektite Suborbital Analysis with appropriate dynamical accounting supports a putative antipodal Saginaw impact site, as does a recent EIGEN 6C4 gravity field assessment. The hypothesis would be falsified if 26Al/10Be burial dating of terraces under Carolina bays disallows bay deposition circa 788 ka.