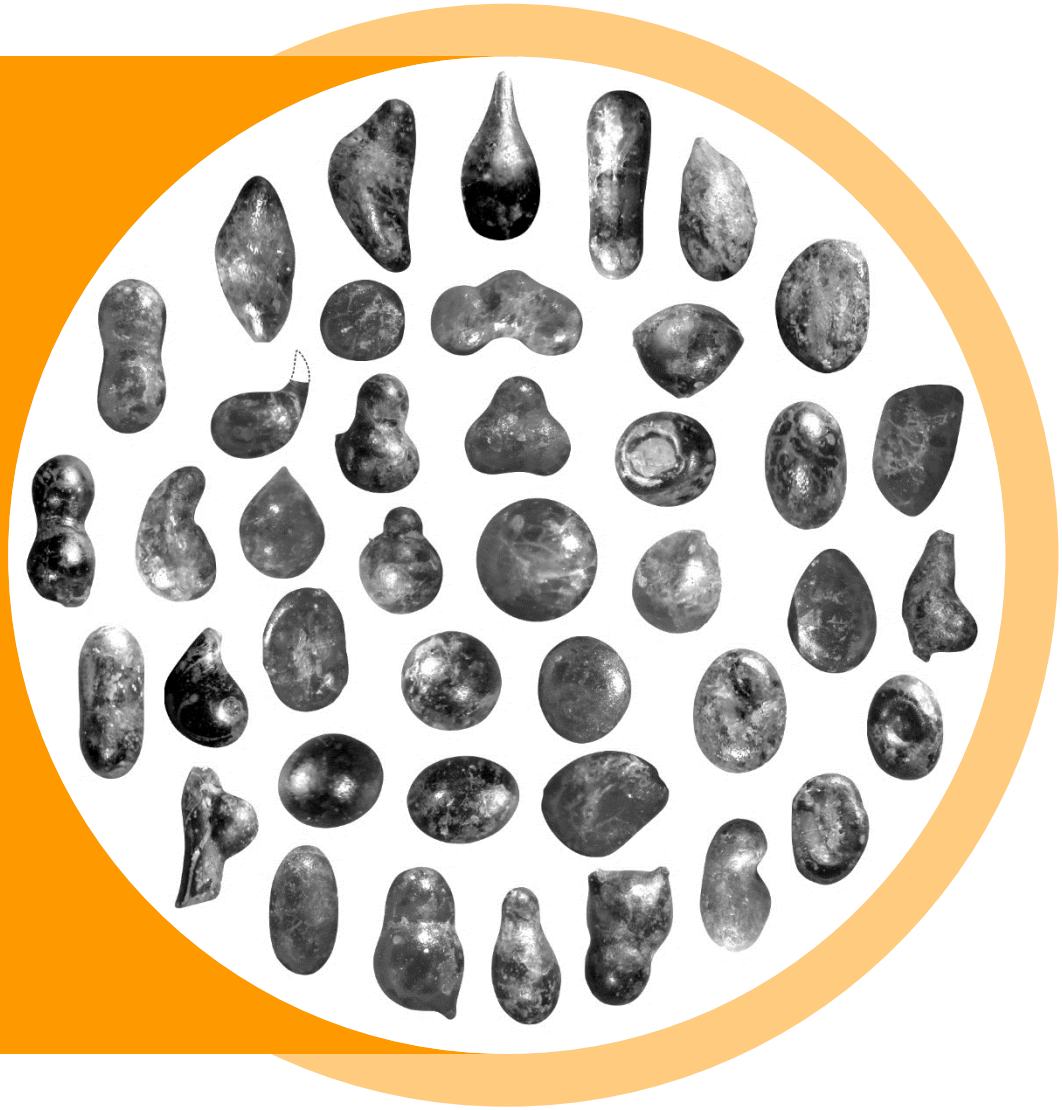
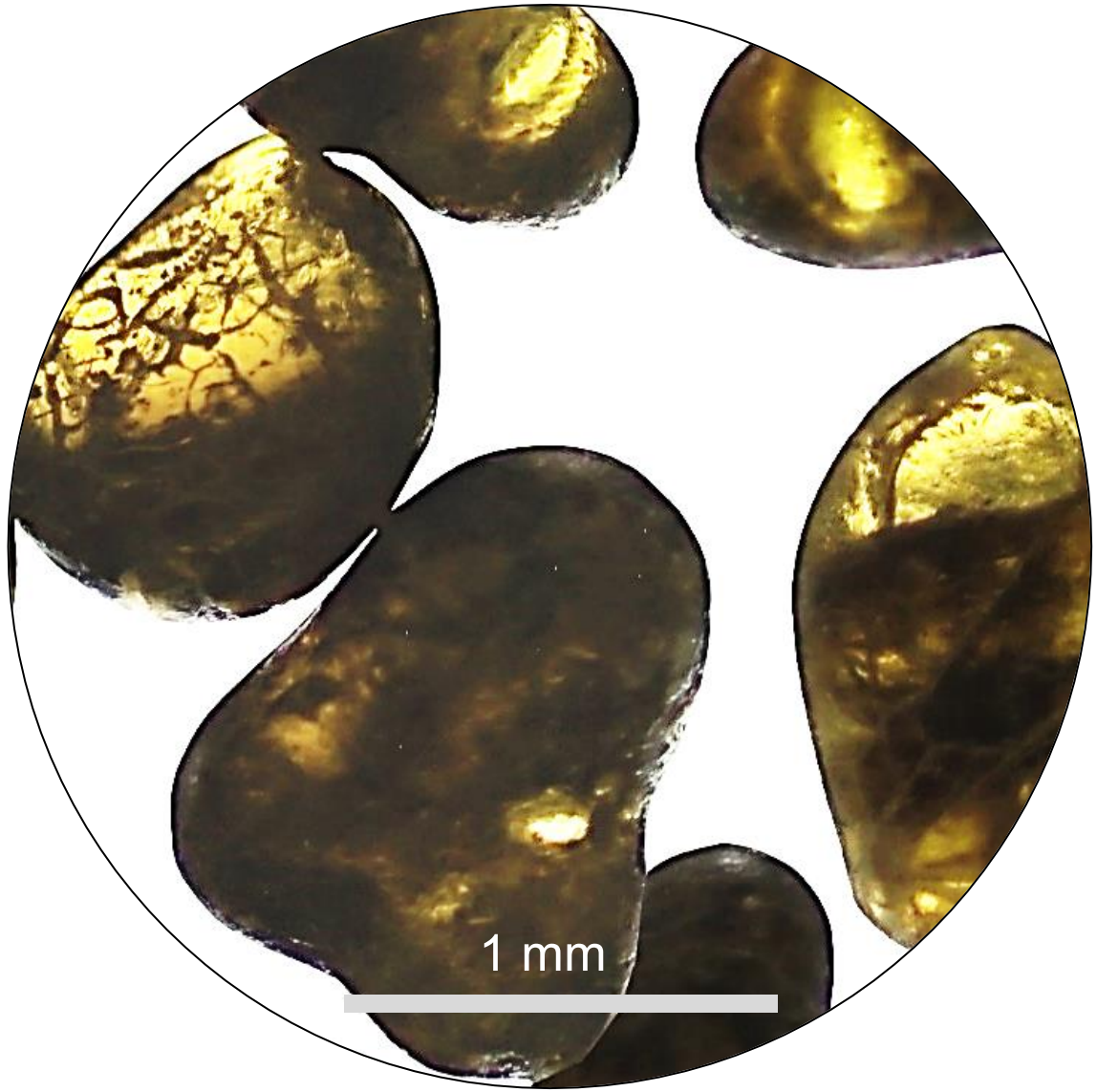


Morphology of impact glass ejecta associated with the Chicxulub asteroid impact: New data from Gorgonilla Island, Colombian Pacific

Hermann D. Bermúdez;

Dr. Joanna Morgan; Maura De Palma & Dr Ying Cui

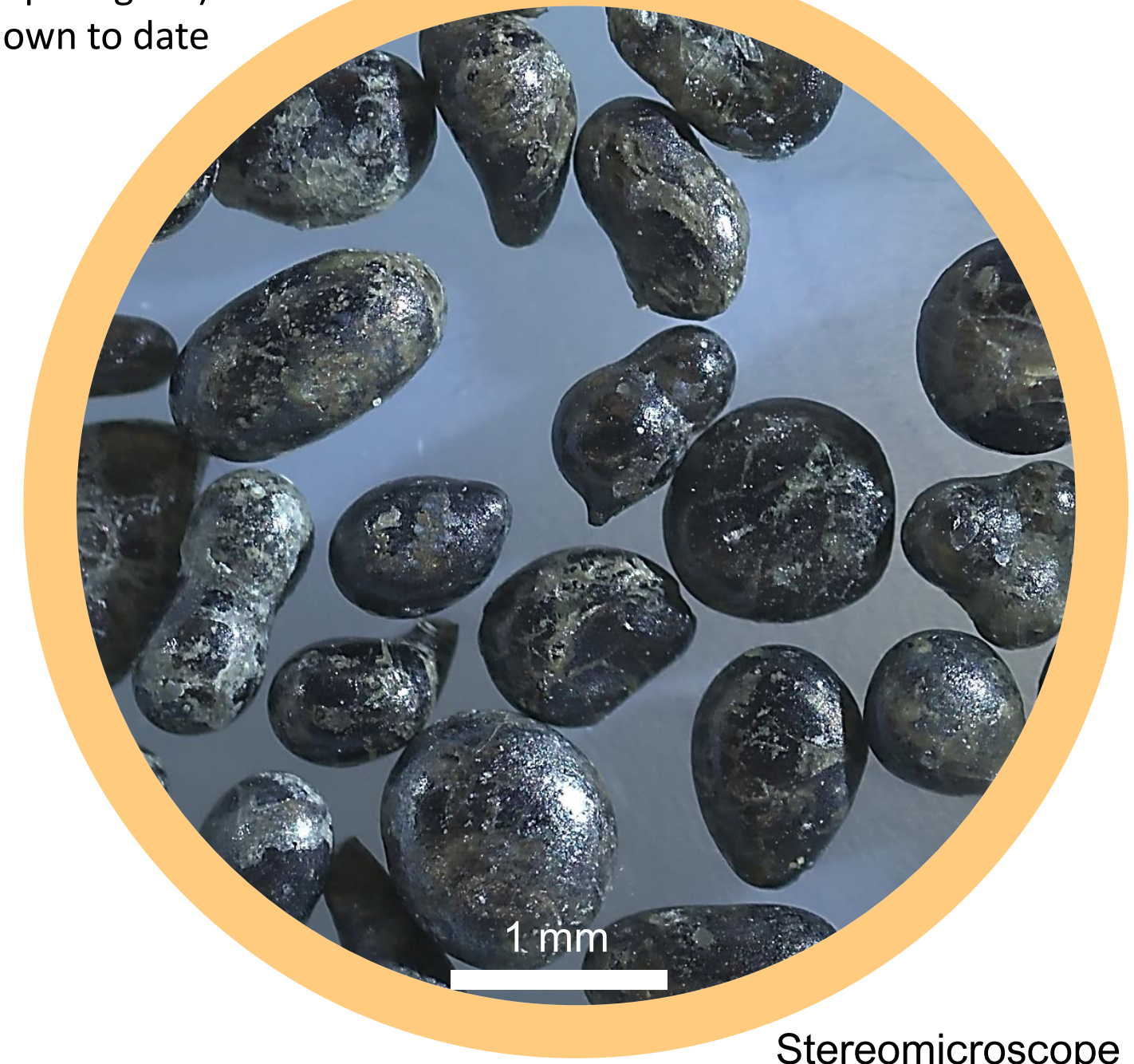
Portland, OR. October 13, 2021



Material is scarce and not always well preserved

Millions of exquisitely preserved microtektites (90% pure glass)
Most pristine K/Pg boundary spherule-rich layer known to date

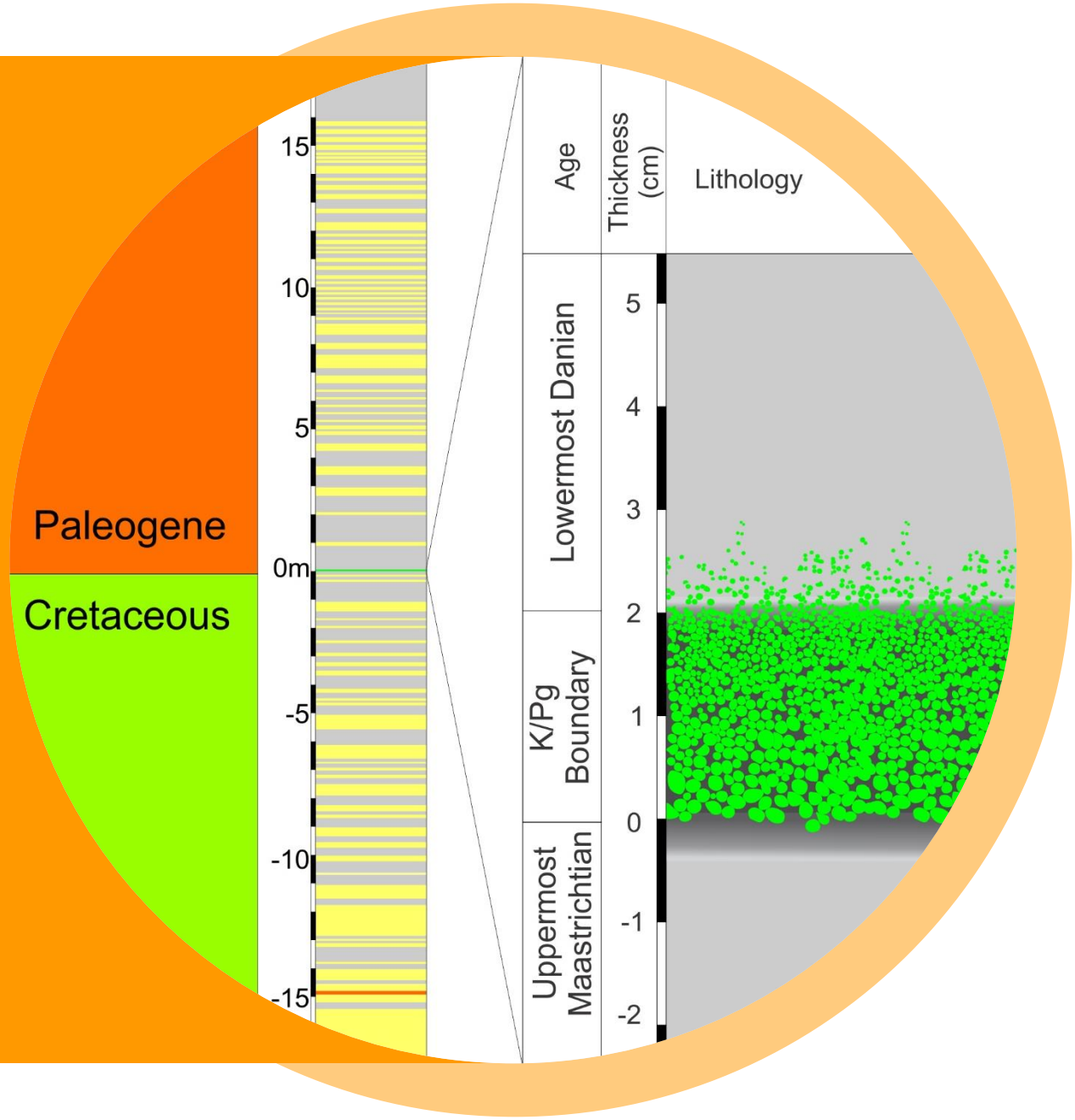
Outcrop



Stereomicroscope

Location

Gorgonilla Island -
Gorgona National Natural Park
~20 miles off the Colombian coast
KPB ~3000 km Chicxulub



Gorgonilla K/Pg section

2-cm-thick spherule-rich bed

KPB interbedded ultramafic lavas and deep-sea marine deposits

$^{40}Ar/^{39}Ar$ dating and planktic foraminiferal - Chicxulub

Age of 66.051 ± 0.031 Ma
Suggested age impact (66.052 ± 0.043 Ma)

Material

Sampling

Selection & counting

1000 spherules

Classification / Interpretation

Material & Methods

Gorgonilla Island K/Pg spherule-rich layer

Manual disgregation

Olympus VT-II Stereo Microscope - Zeiss Stemi 508 with axiocam

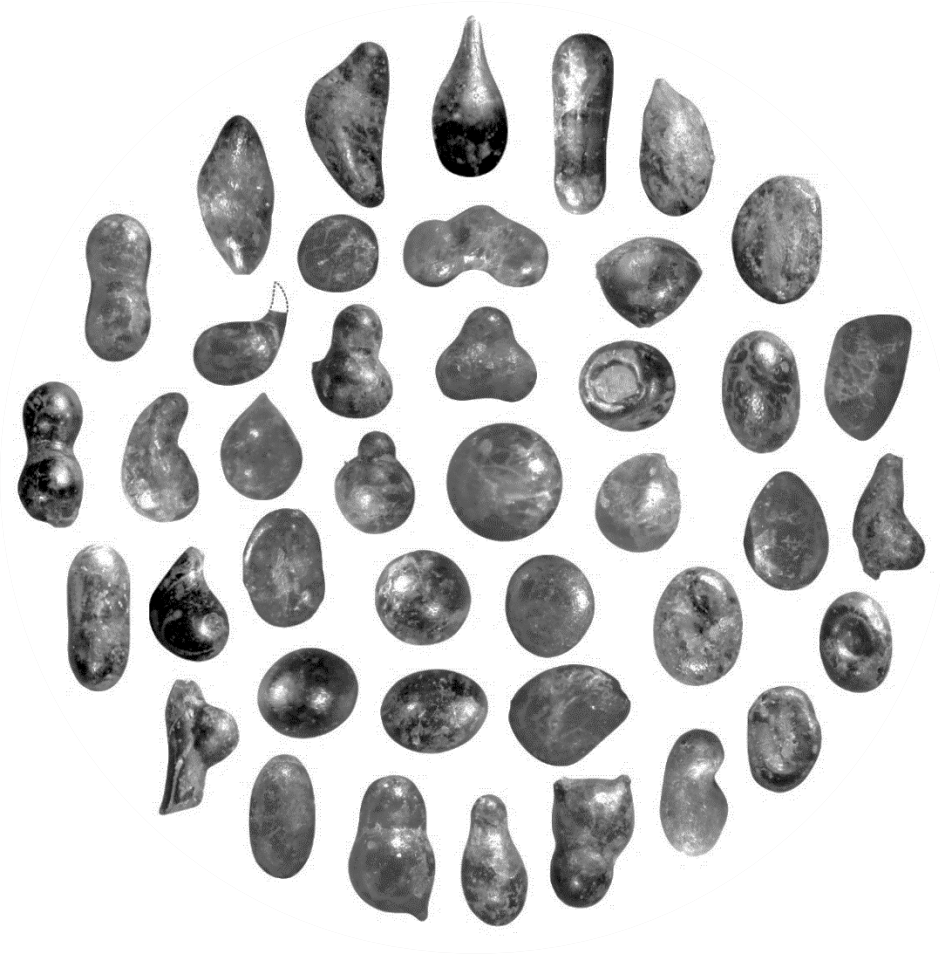
1000 individual spherules (significant quantity -statistically representative)

New model based on Stauffer & Butler, 2010

Tektites - microtektites

GROUP I
Spin or modified spin-induced forms

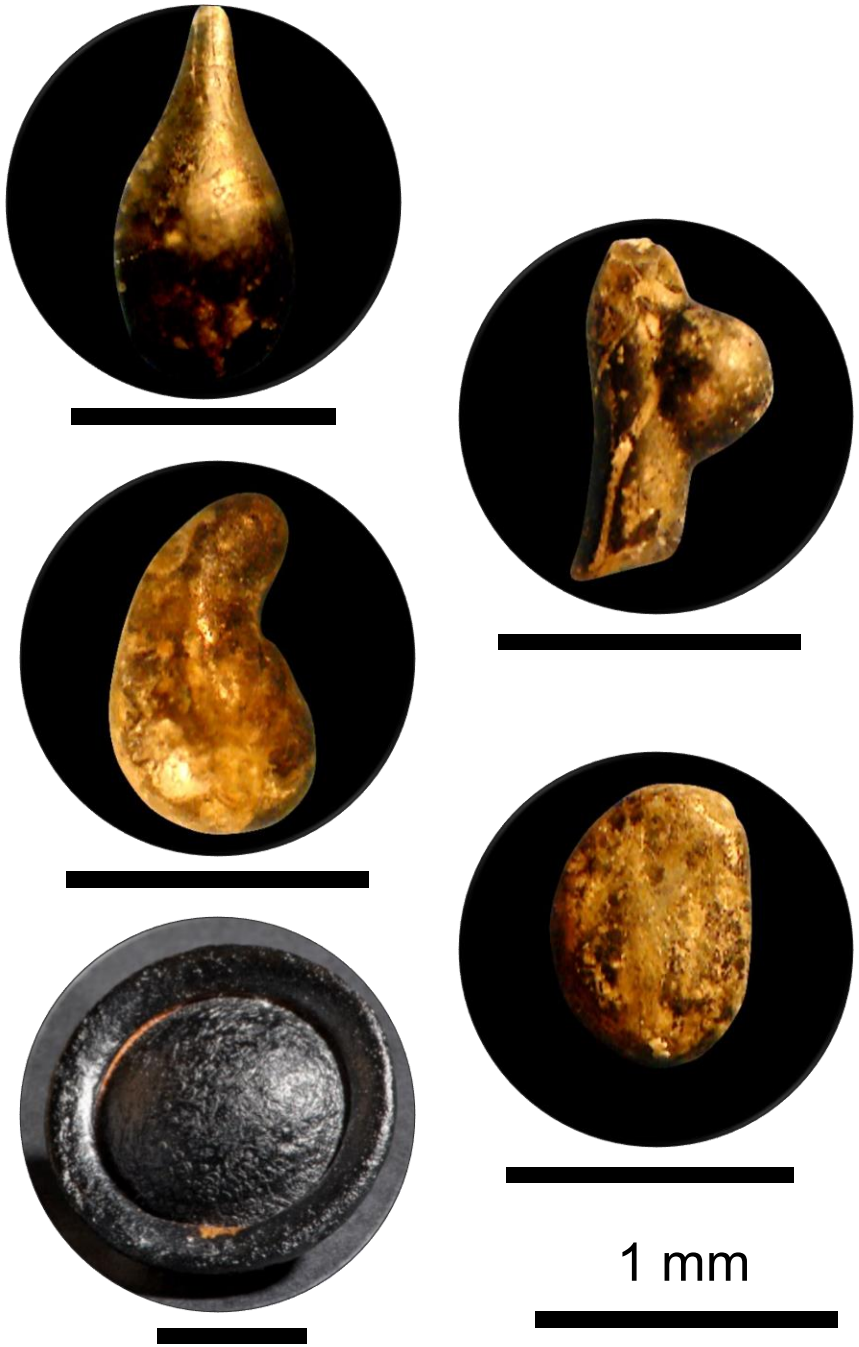
GROUP II
Muong Nong-type tektites (layered tektites)

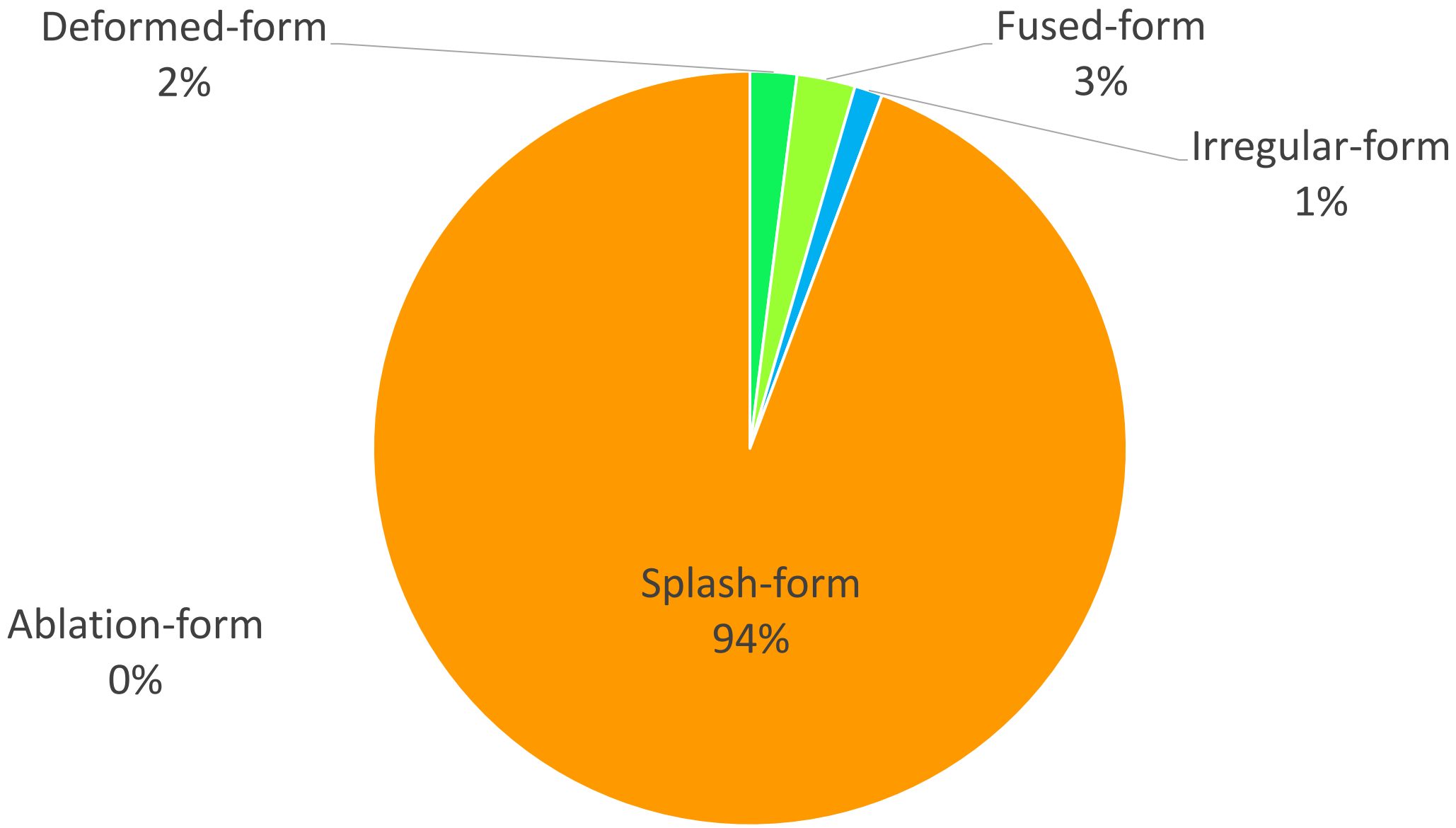


Group I
100%

Group II
0%

GROUP I Spin or modified spin-induced forms		
	Splash-form tektites	Spheres
		Rods
		Ovoids
		Ovoid Disks
		Spherical Disks
		Dumbbells
		Bowties
		Oval Bowls
		Circular Bowls
		Tear Drops
		Teardrop Bars
		Ovoid Teardrops
		Teardrop Disks
	Fused-form tektites	Any combination of 2 or more splash-form tektites
	Deformed tektites	Any splash-form tektite with evidence of deformation (by rotation or impact)
	Irregular tektites	Undefined morphologies including impact effects
	Ablation-form tektites	Not present




Deformed-form
2%
Fused-form
3%
Irregular-form
1%
Splash-form
94%
Ablation-form
0%

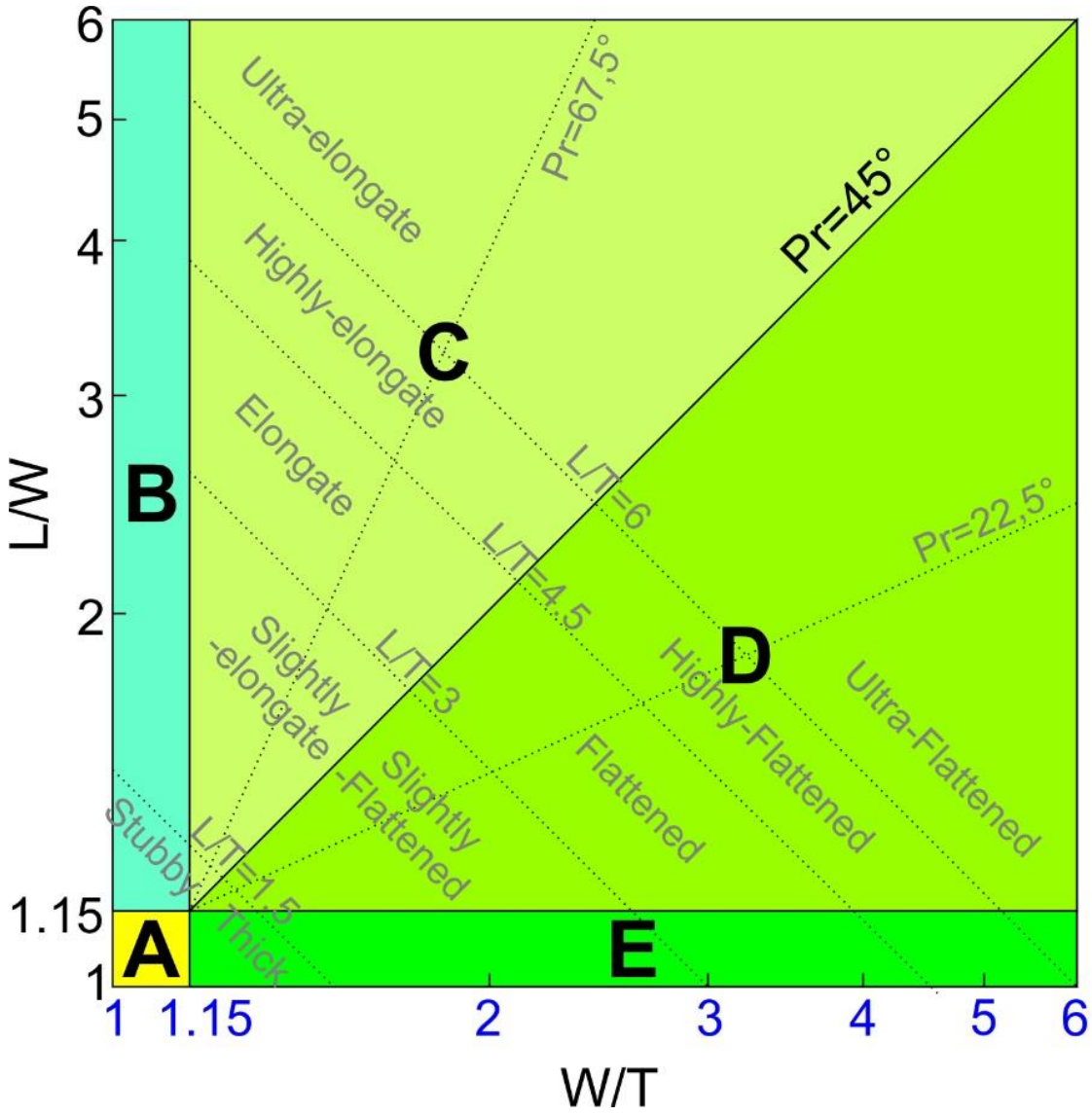
Analysis

Splash forms, other morphologies variations or combinations of splash forms

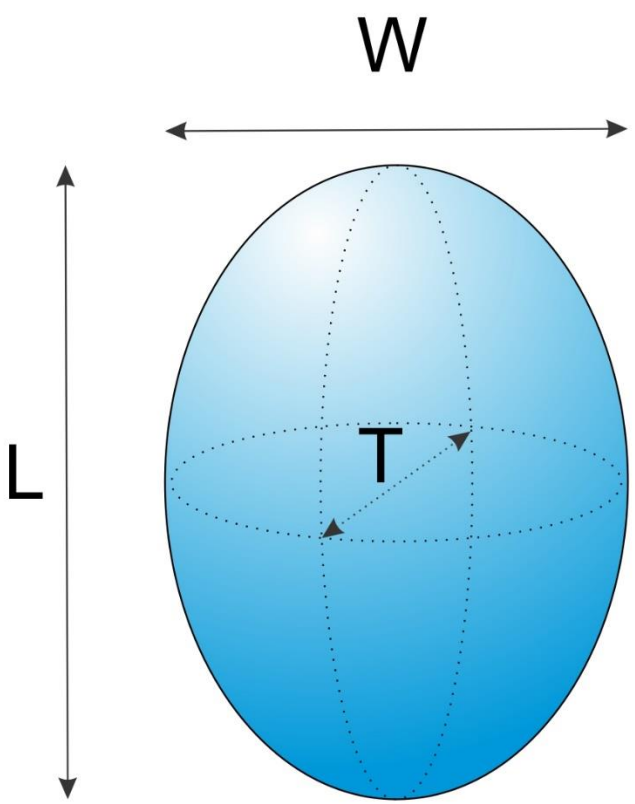
Modified version Stauffer and Buttler (2010)

Provides us quantitative way to study the shapes of splash-form tektites

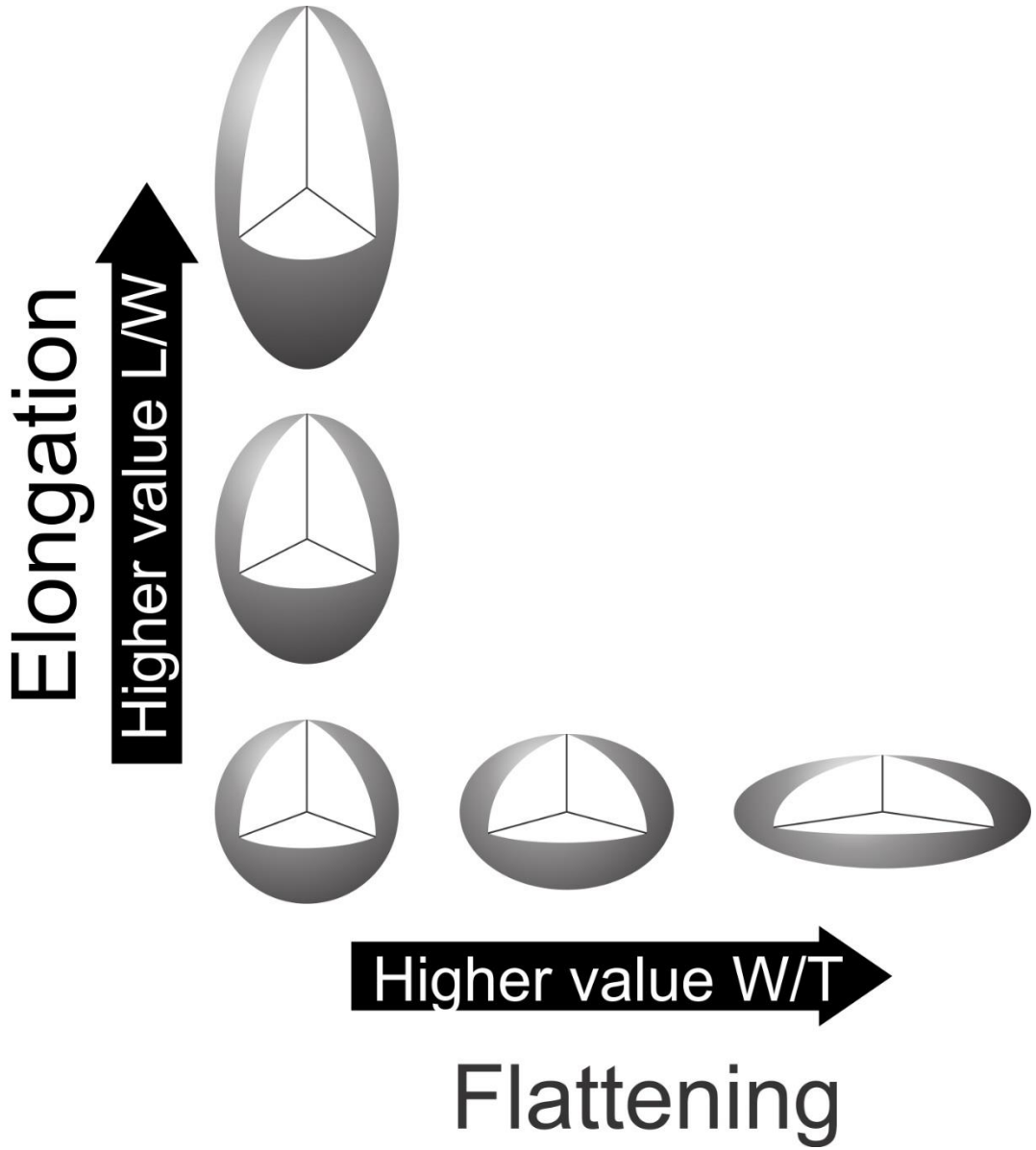
Using these diagnostics, we can give quantitative definitions and try to understand the origin of this shapes based on basic physics

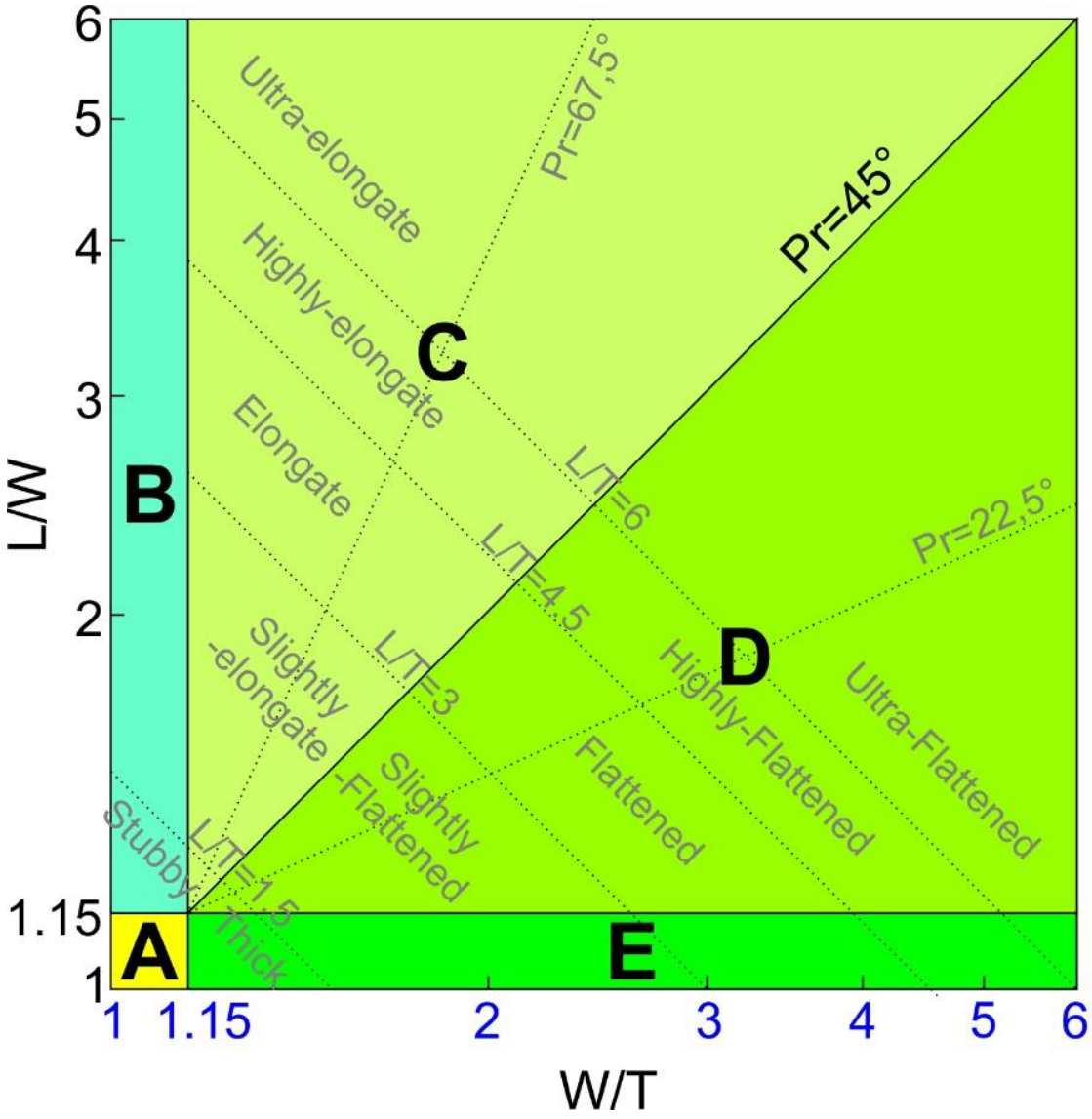


Parameters



Major axis is the length (L)
Intermediate axis is the width (W)
Minor axis is the thickness (T)



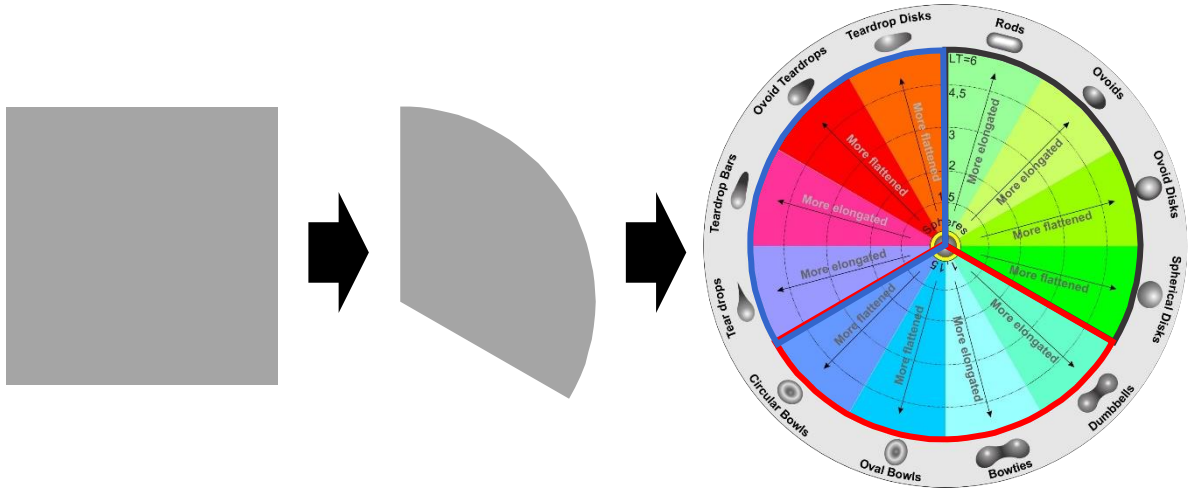


A: Sphere
B: Ovoids / Dumbbells
C: Bars / Bow Ties
D: Oval Disks / Oval Bowls
E: Round Disks (Bowls)

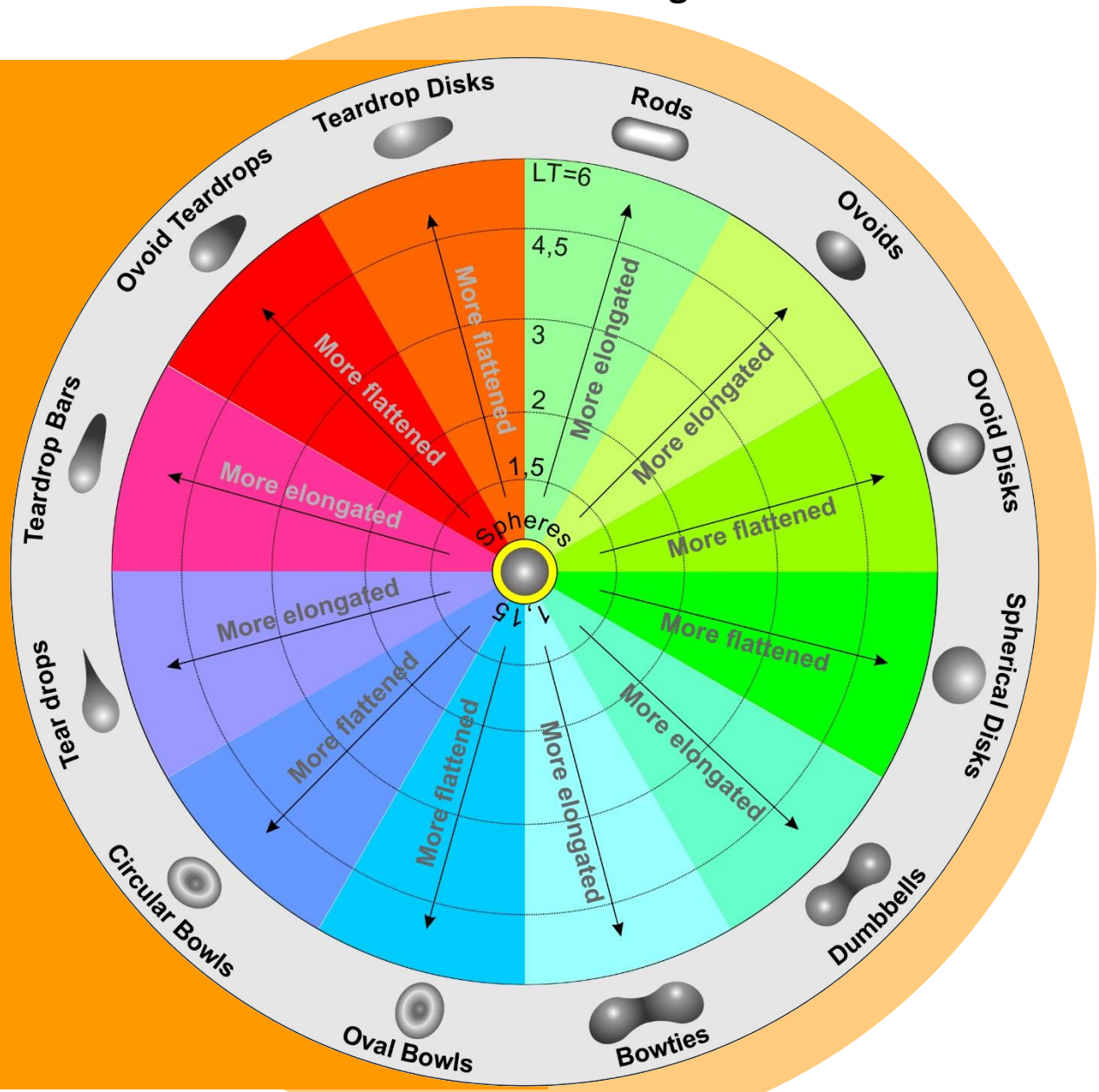
Modified from Stauffer and Butler, 2010

Using these values, we can define different shapes and different degrees of flattening and elongation.

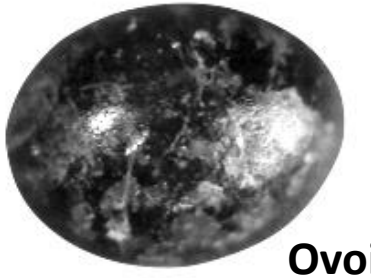
Quadrangles have been modified to radial quadrangles and integrated into a single classification scheme.



New classification diagram

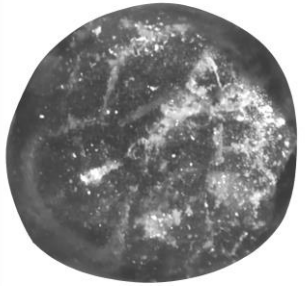


Sphere

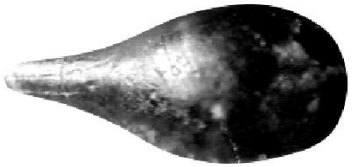


Ovoid

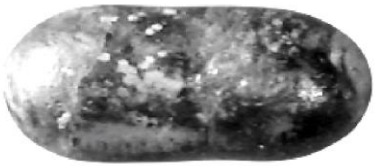
Slightly elongated Rod



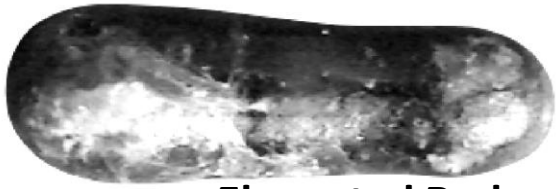
Spherical disk



Teardrop



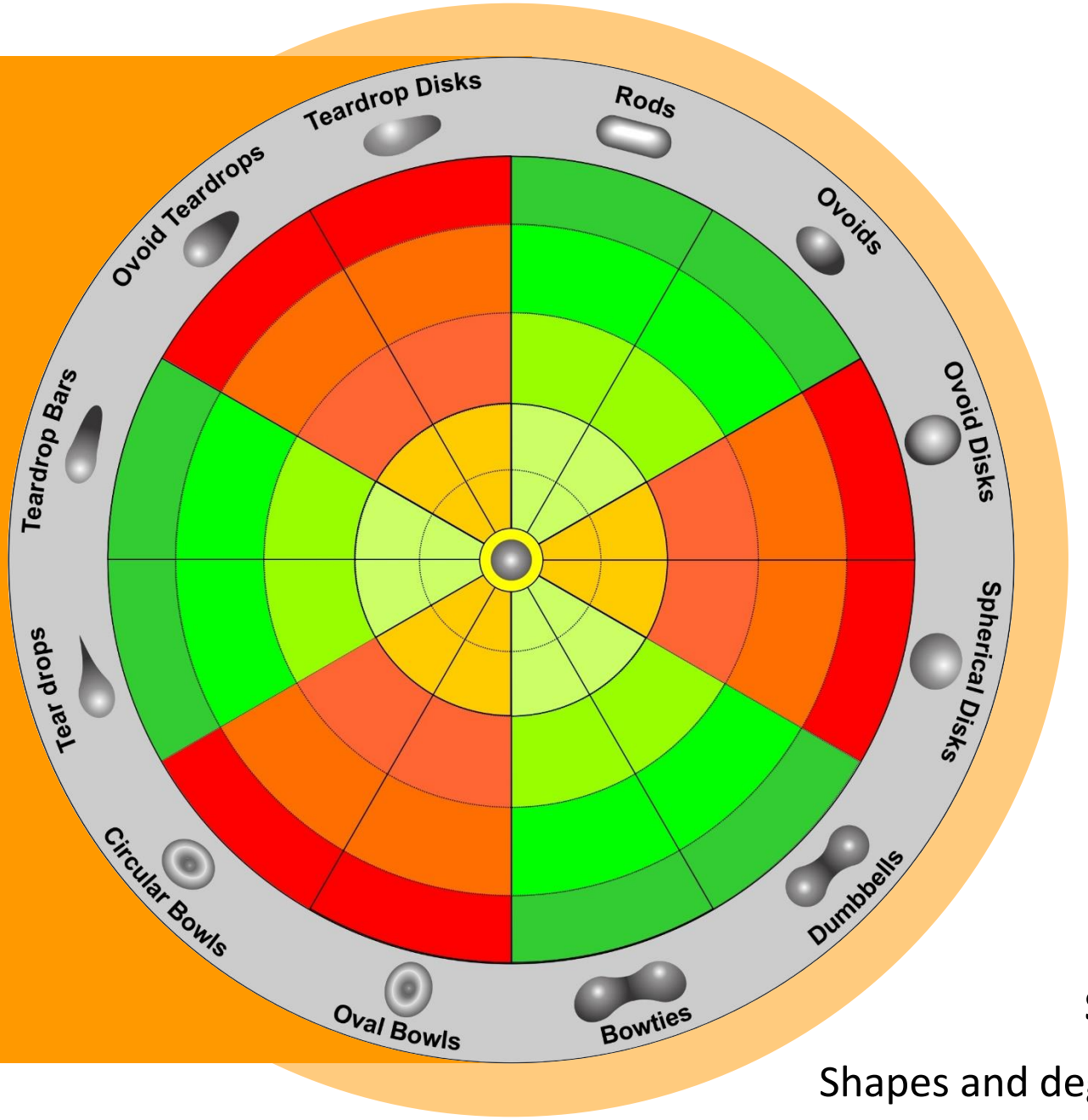
Rod



Elongated Rod

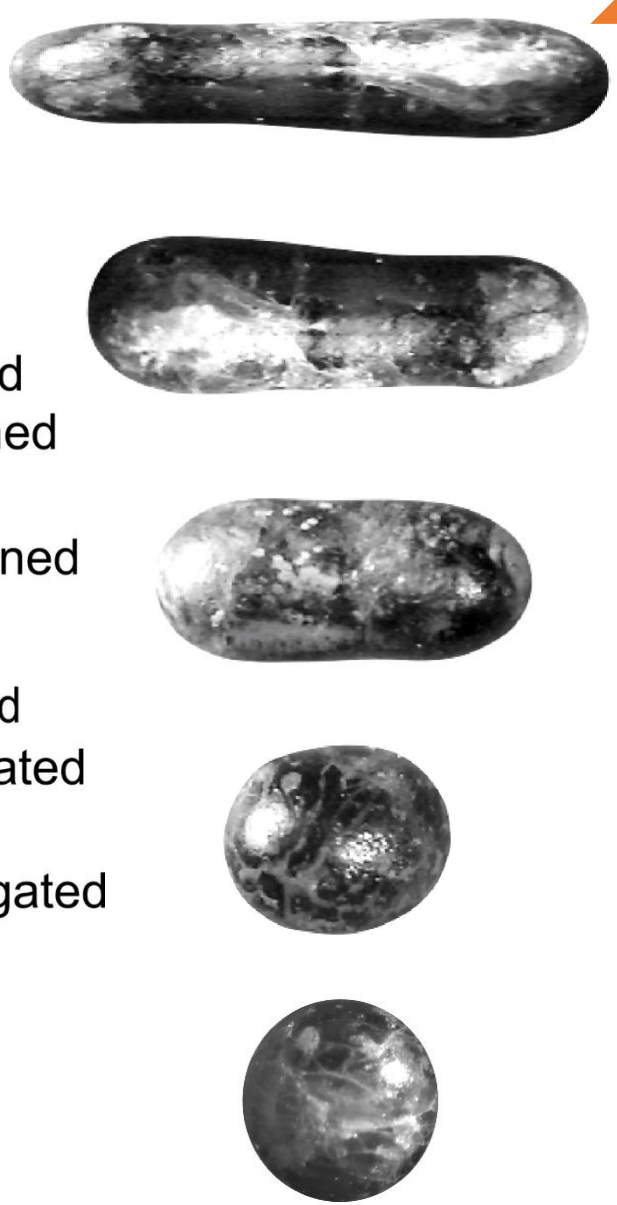
Dumbbell

Different morphologies that result from deforming at different rates an original sphere.
Progressive deformation, depending on the shape, results in different degrees of flattening or elongation.



Ultra flattened
Highly flattened
Flattened
Slightly flattened

Ultra elongated
Highly elongated
Elongated
Slightly elongated

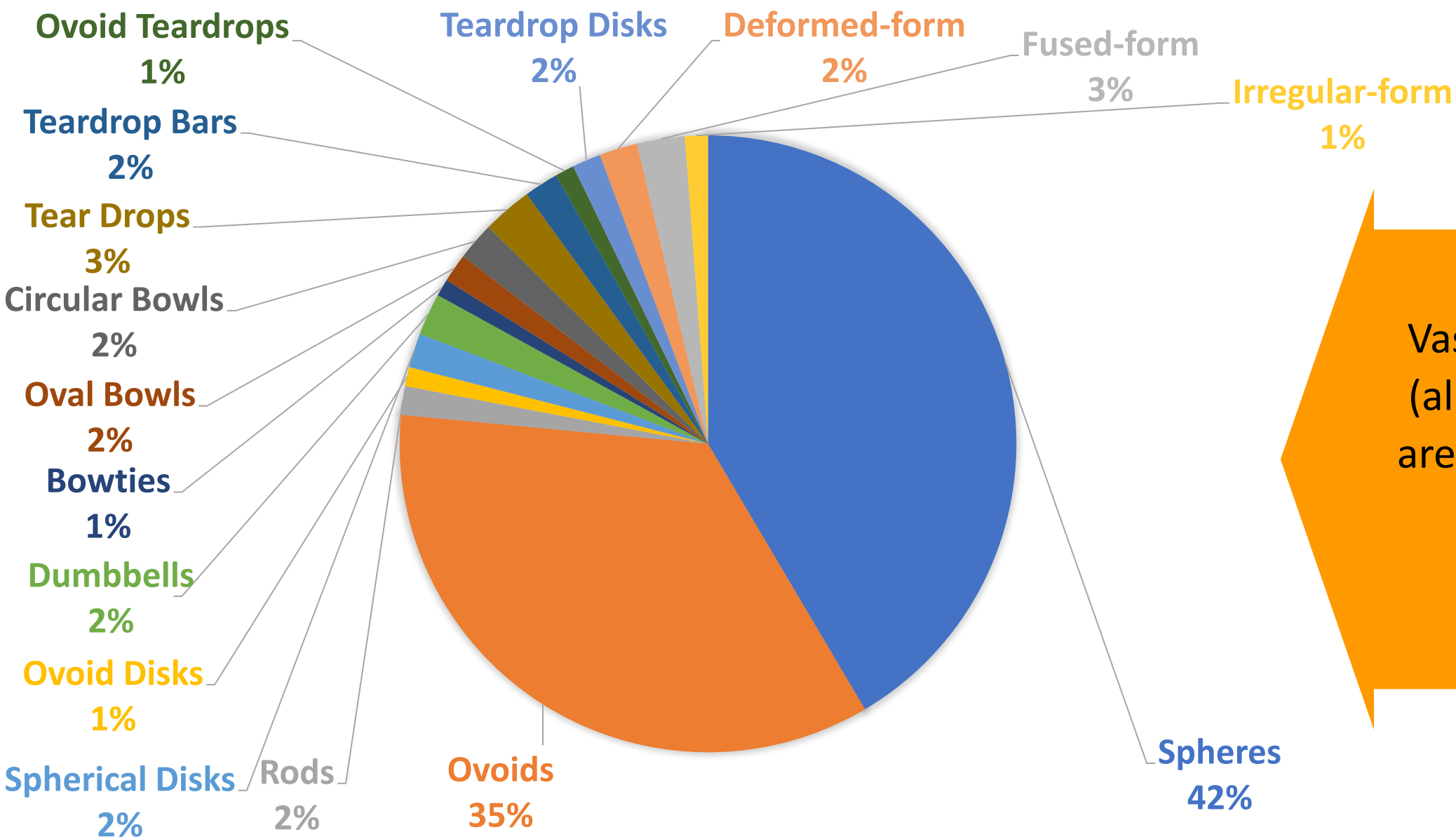


complete series

Simplified diagram

Shapes and degree of flattening or elongation in a descriptive way

Chicxulub ejecta in Gorgonilla



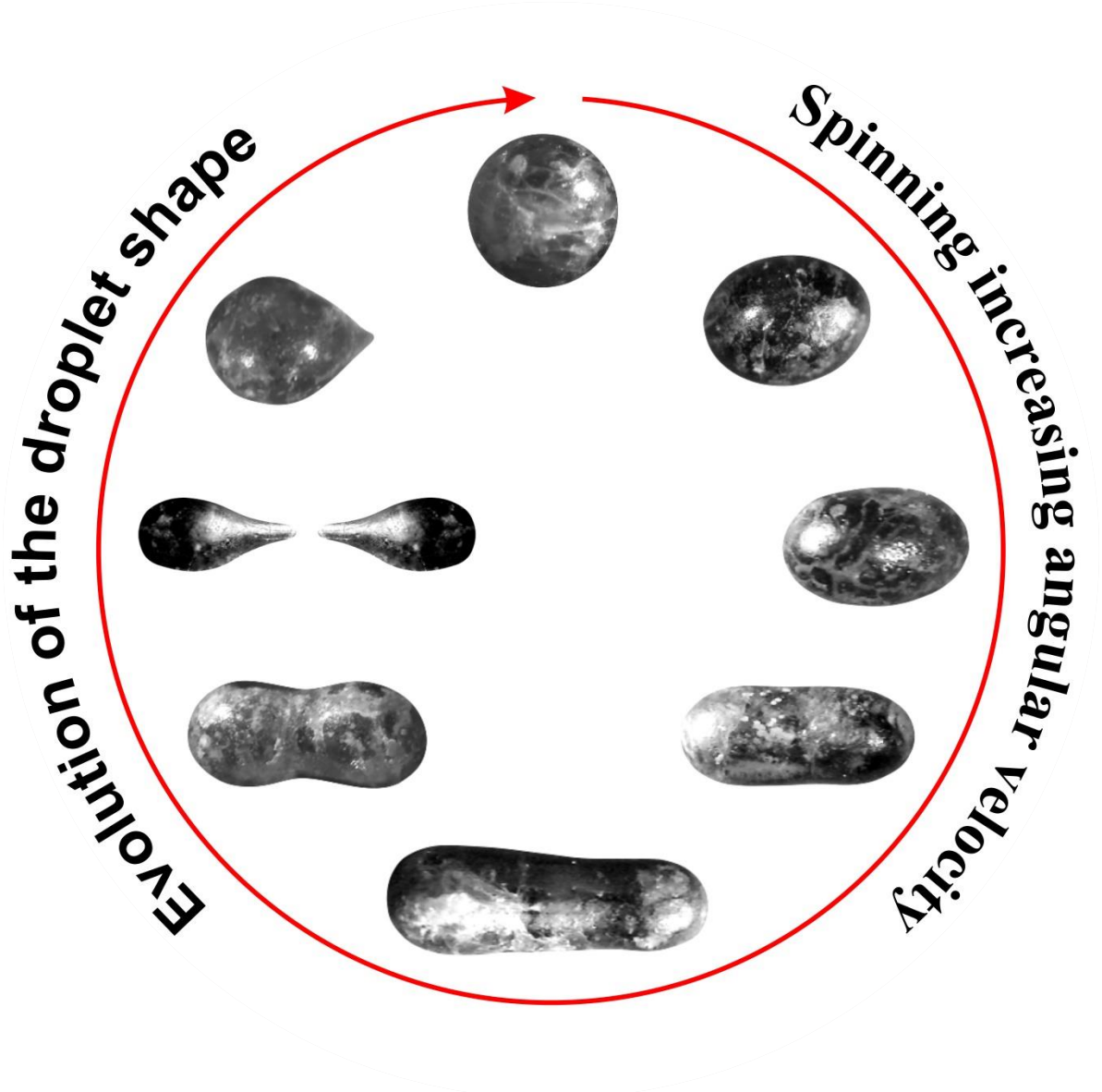
Vast majority (almost 80%) are spheres or ovoids

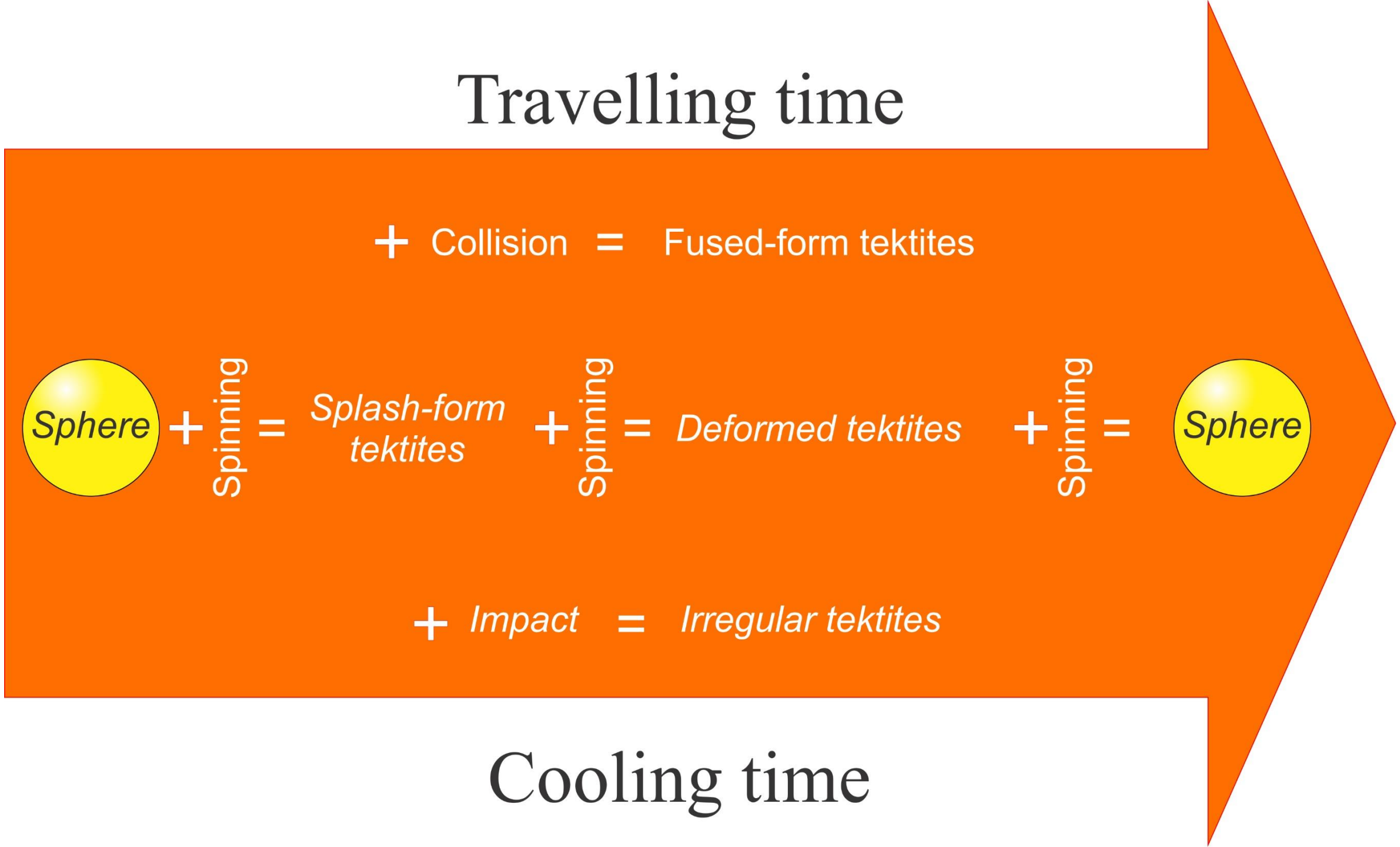
Why?

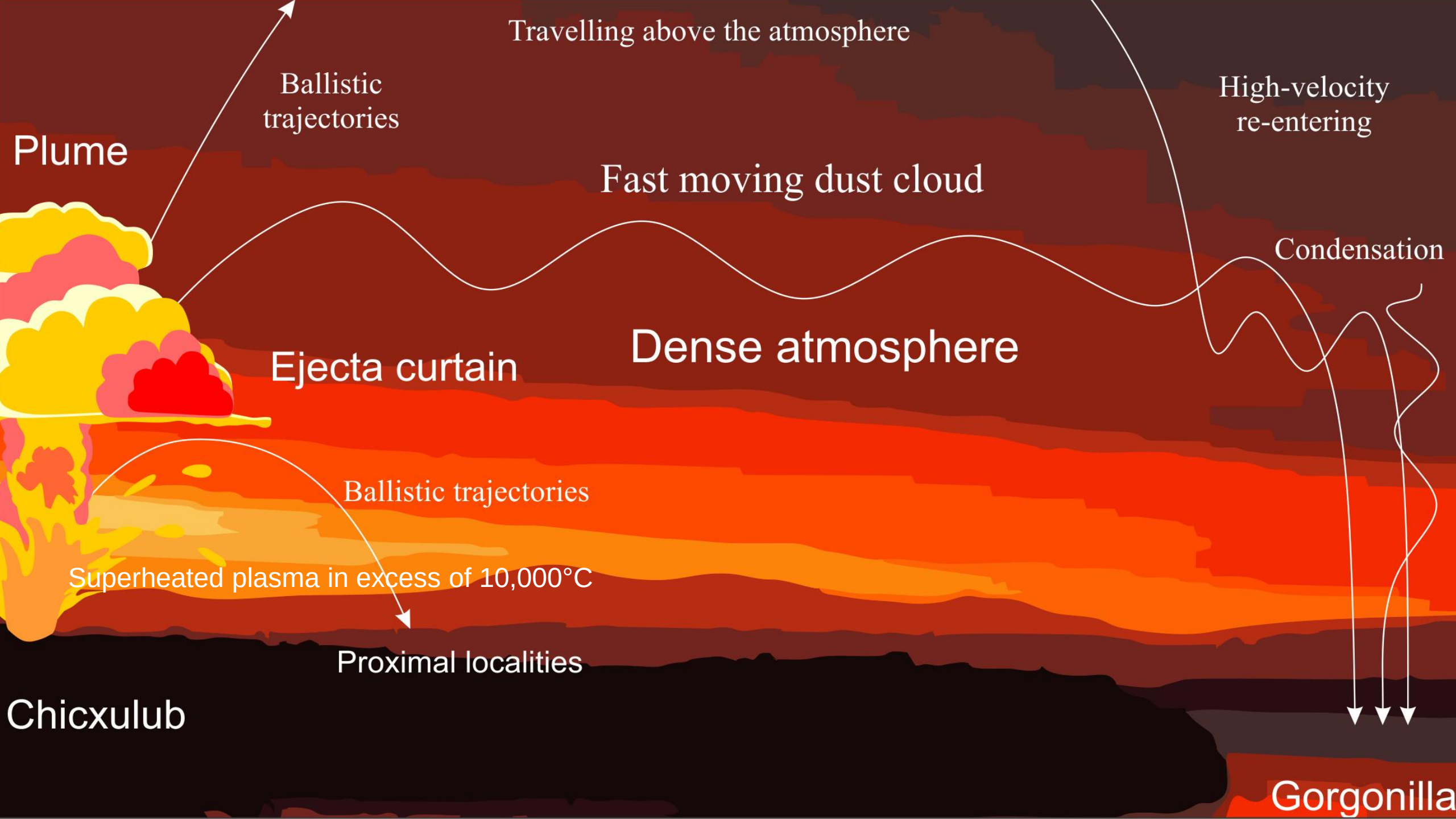
Origin

Tektite forms are transitional, beginning spherical that deforms through viscous fluid flow processes into other shapes depending rotational velocity and perhaps, if still sufficiently fluid, back to a sphere

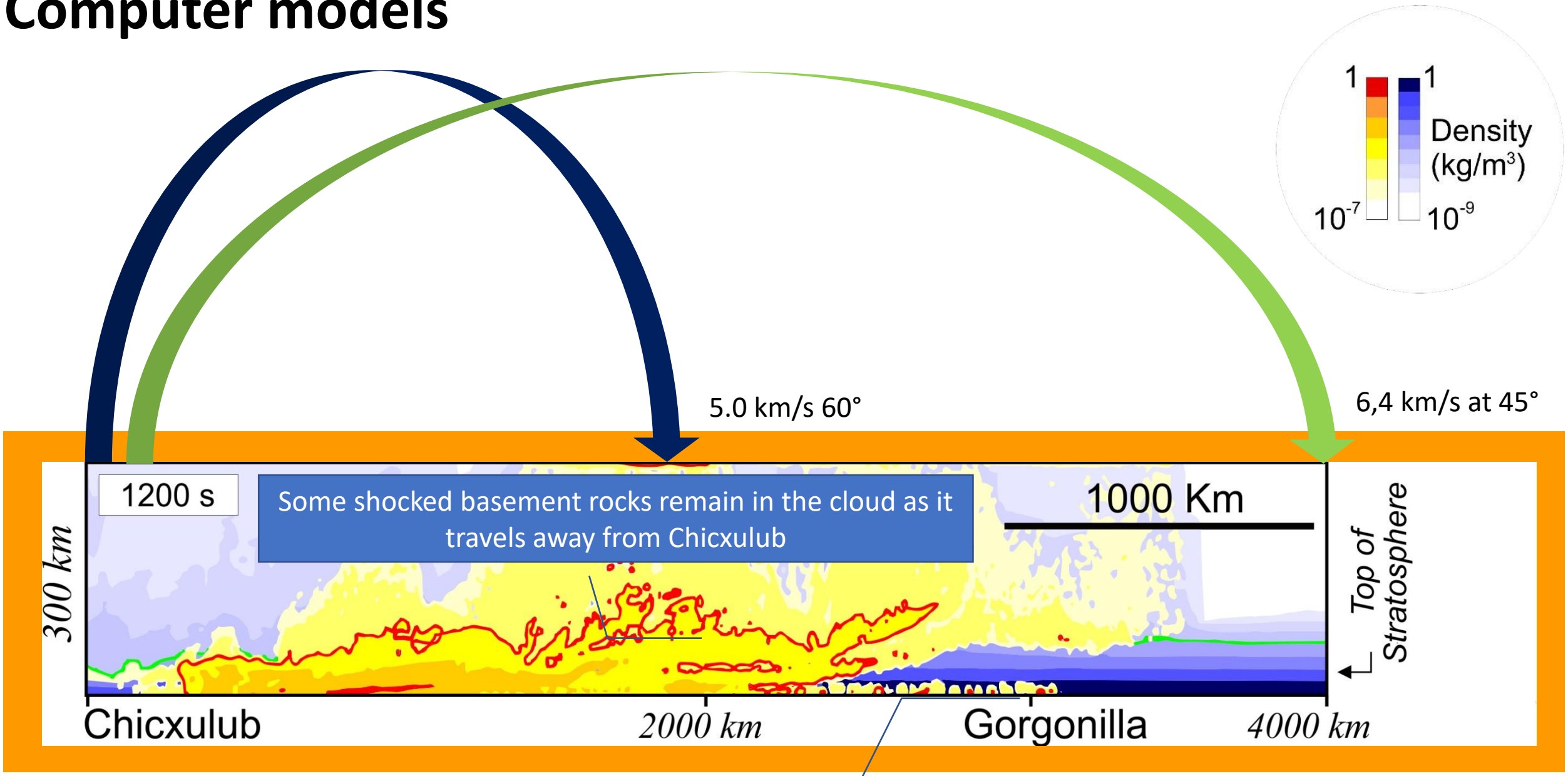
Material inside a tektite liquid, but as it cools, continuing to deform until it either becomes too stiff, ceases to spin, or lands




Travelling time
+ Collision = Fused-form tektites
Sphere
+ Spinning =
Splash-form tektites
+ Spinning =
Deformed tektites
+ Spinning =
Sphere
+ Impact = Irregular tektites
Cooling time


Travelling above the atmosphere
Ballistic trajectories
High-velocity re-entering
Plume
Fast moving dust cloud
Condensation
Dense atmosphere
Ejecta curtain
Ballistic trajectories
Superheated plasma in excess of 10,000°C
Proximal localities
Chicxulub
Gorgonilla

Computer models



Artemieva & Morgan, 2020

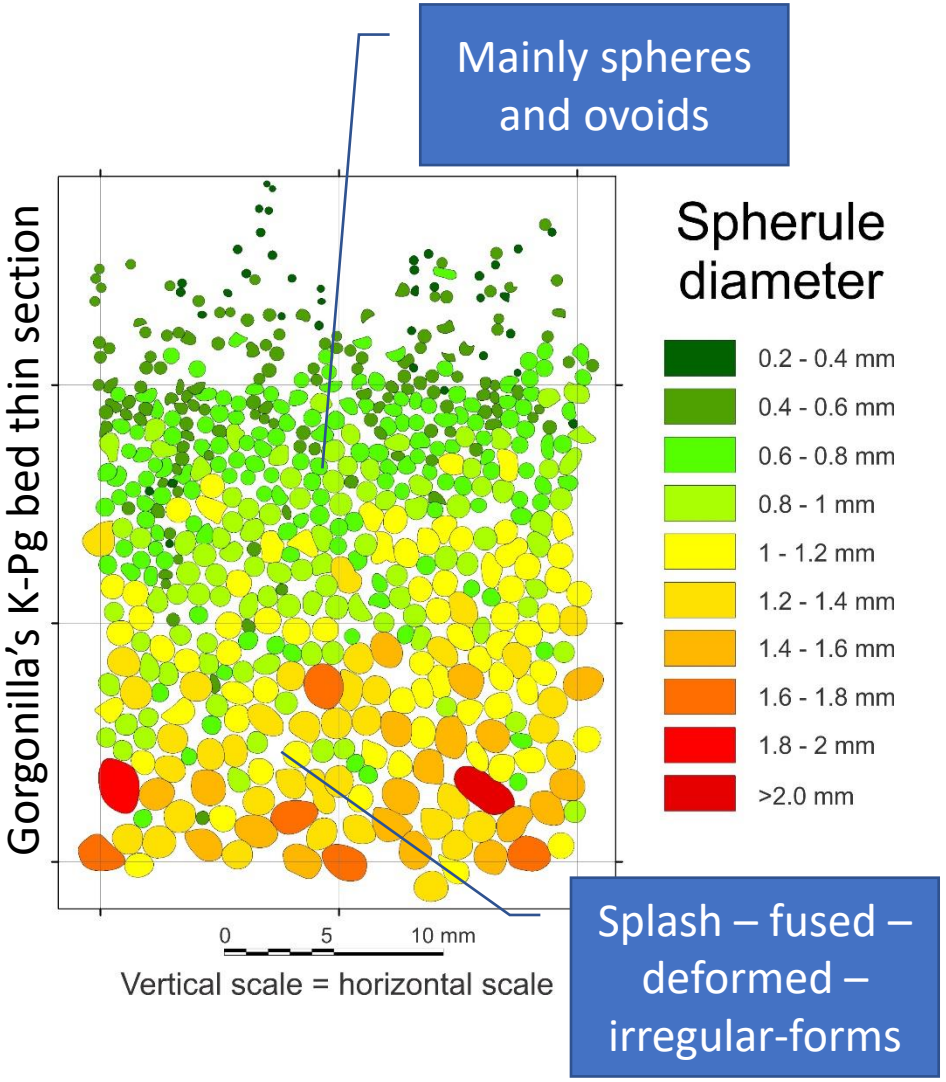
Discussion and conclusions

First approximation to the mechanisms involved in the formation of the microtektites produced by the Chicxulub

Splash-form tektites/microtektites = Melt droplets - Ballistic trajectories

Several splash-forms + Fused forms + Deformed forms = Enough time to reach different stages

Microkrystites (~ 16%) = Condensed spherules from vapor plume



Bermudez & Cui, 2020

Discussion and conclusions

100% spherules correspond to spin or spin-induced forms – No ablation-forms

The spin-induced spherule morphology: I) Splash-forms; II) Fused-forms; III) Deformed-forms IV) Irregular forms

The large % of spherical shapes - long ballistic trajectories or condensation

Condensed spherules (spheres + ovoids) = Small size (lower bond numbers); gravity – no rotation and/or shorter evolution time




hdbermudez@yahoo.com

twitter@PaleoexplorerGI

Paleoexplorer.Colombia

www.paleoexplorer.net

MONTCLAIR STATE UNIVERSITY

PALEOEXPLORER GEOLOGÍA & INVESTIGACIÓN

Imperial College London

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PARQUES NACIONALES NATURALES DE COLOMBIA

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