# High-temperature Melted Spherules

**YDB magnetic grains and spherules are extracted with a super-magnet**

- YDB spherules range in composition from iron-rich to quartz-rich
- They formed at temperatures from 1500°C to 2000°C (3600°F)
- The iron-rich ones cannot form naturally on Earth
- Volcanoes produce glassy spherules, but not iron-rich ones
- Iron-rich ones can only come from meteorites or impact craters

*Iron-rich spherules usually are produced when asteroids or comets hit the ground and make craters*

**NOTE:** this website is a brief, non-technical introduction to the YDB impact hypothesis. For in-depth information, go to "Publications" to find links to detailed scientific papers.

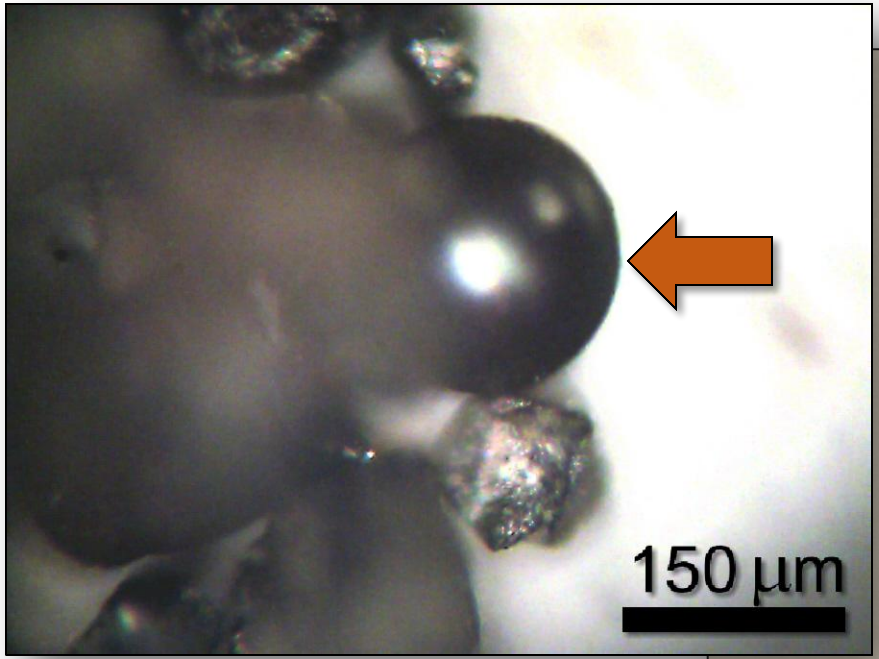
# Super-magnet

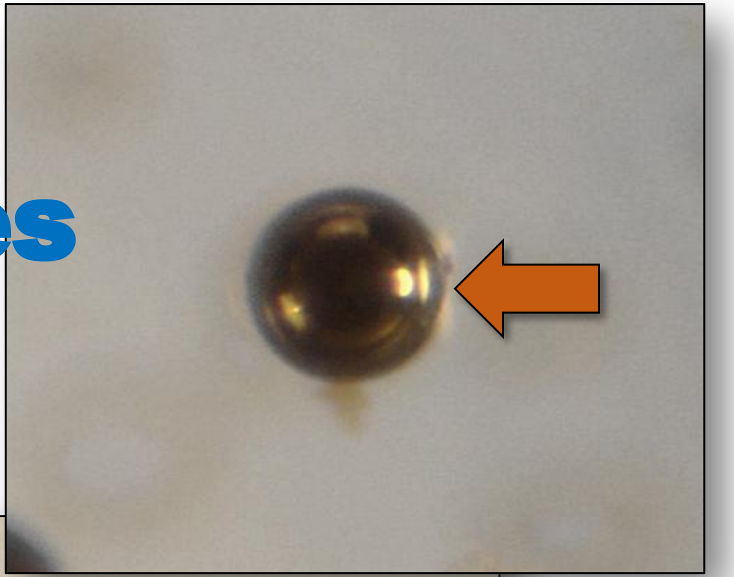
**Event Markers:**

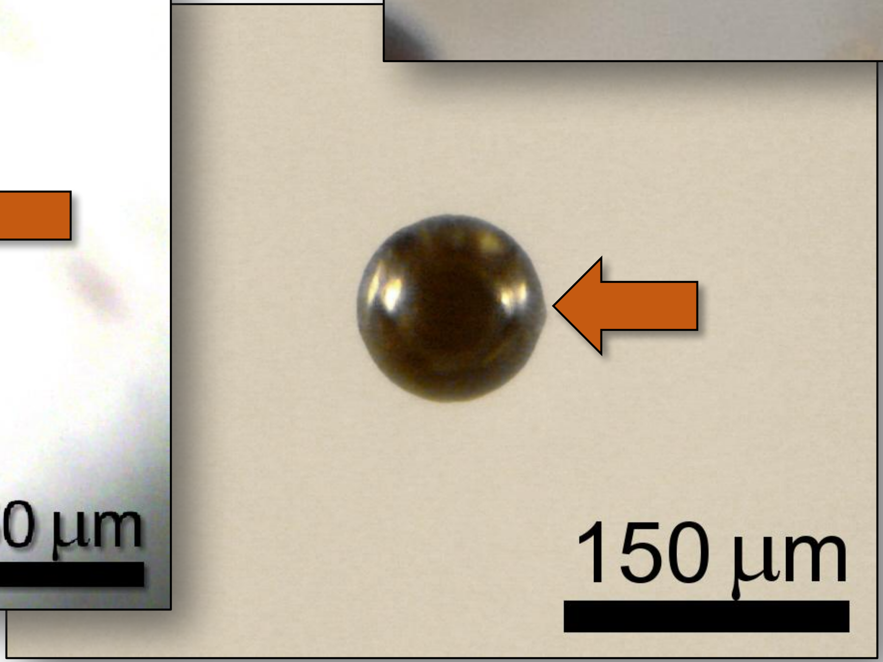
- ✓ **Magnetic material** (arrows) was extracted using a neodymium super-magnet in a protective plastic bag
- ✓ **Magnetic grains** contain small amounts of melted spherules and melted glass

# Magnetic Spherules

## Smaller than a speck of dust

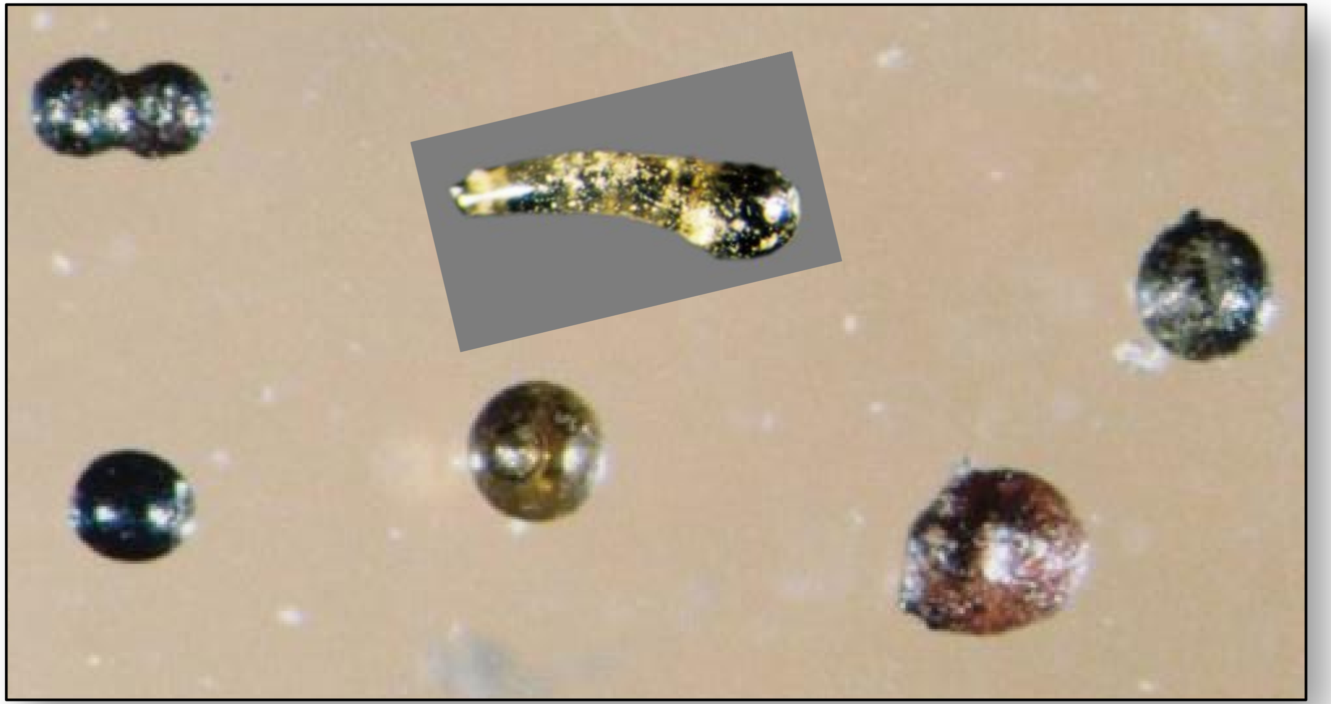





From the Gainey Site, Michigan

# Spherule Types and Colors



Assortment of YDB impact spherules: most are spherical, but a small percentage are oval-shaped, teardrop-shaped, or have two spherules welded together

Spherules range from transparent to opaque, and colors include black, blue, green, brown, red, and amber.

# Spherule Sizes

Ant Credit: Andrey Pavlov | Dreamstime.com

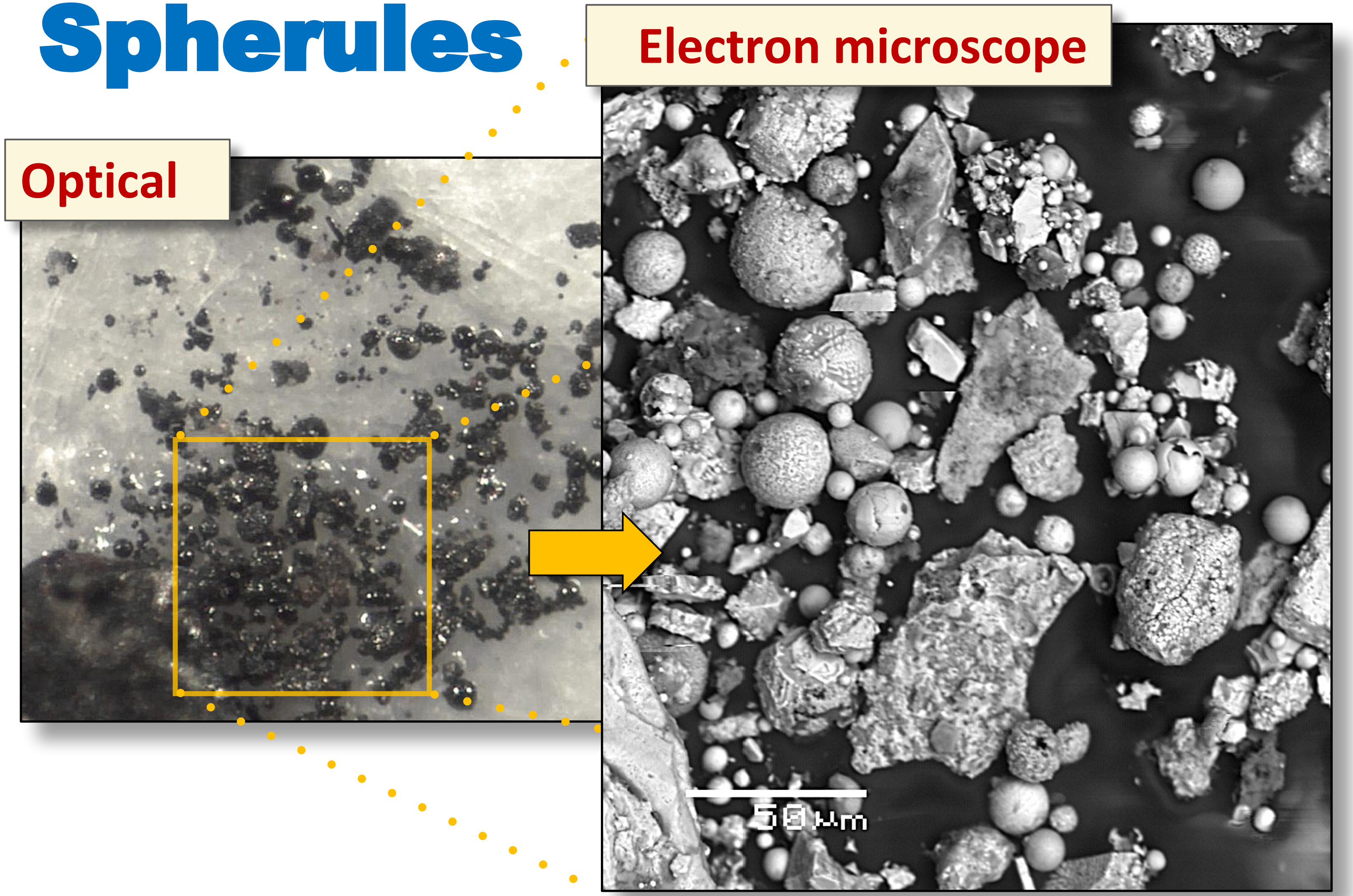
Nearly every YDB spherule discovered is smaller than an ant.
A few rare ones are up to about an inch long (2.5 cm).

# How hot to make spherules?

Credit: GaleInMotion | Bigstockphoto.com

Temperatures higher than 2000 °C or 3600 °F.
That’s hot enough to melt an automobile into a puddle of iron.

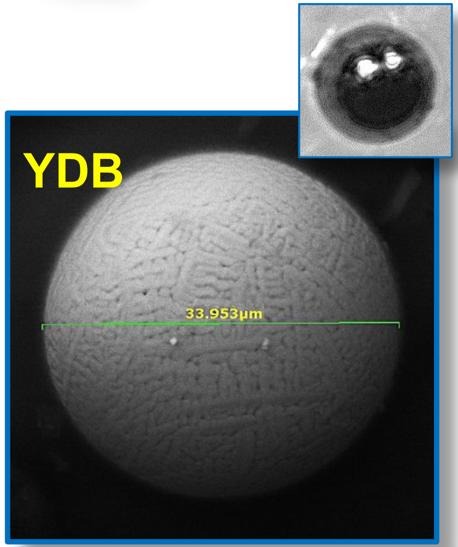
# Melted YDB Impact Spherules




Note: most spherules have *dendritic* textures, meaning their crystals are branched like a tree

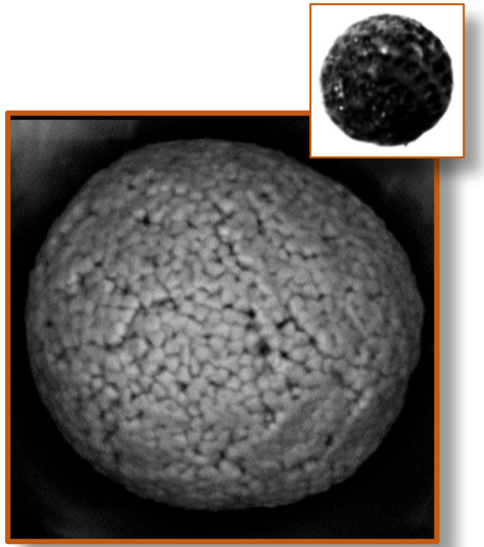
# Impact Spherules compared to Non-impact Ones

**IMPACT SPHERULES.** Typically, five types of rounded objects are found throughout sediment layers, but only one is impact related. Impact spherules are distinguished by their 'dendritic,' feathery texture (below left), indicating that the spherules melted and cooled rapidly to form tiny crystals. The four non-impact types have different textures. All look very similar with an optical microscope (upper row), but very different with an electron microscope, or SEM (lower row).




## YDB spherule

- 'Dendritic' texture
- Multiple crystals
- Melted and rapidly cooled on impact

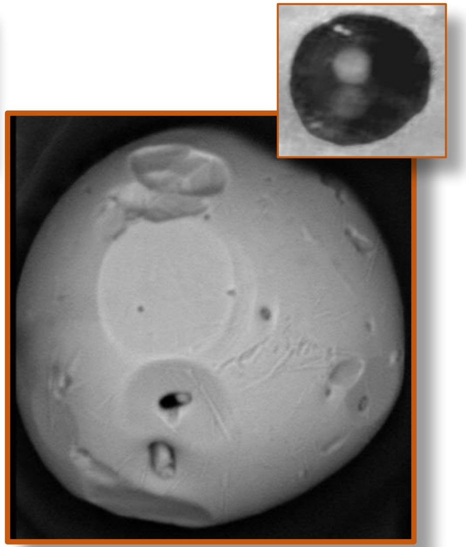


## Fe-rich Framboid

- Cubic, blocky texture
- Multiple crystals
- Non-melted; grew slowly over time

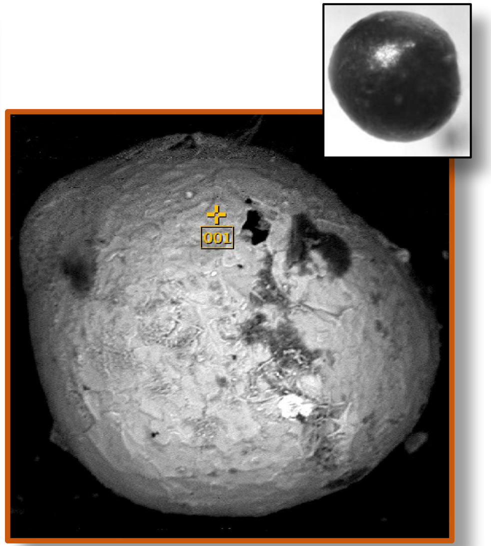
## Round quartz

- Rounded, chipped
- Single crystal
- Non-melted; grew slowly over time



## Round magnetite

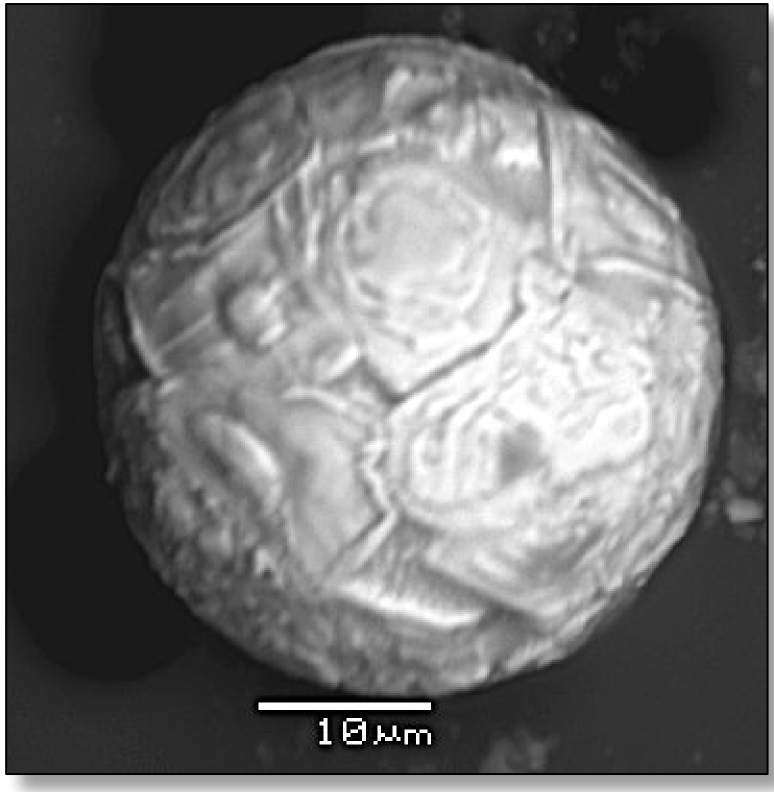
- Rounded; flat spots
- Eroded crystal
- Non-melted; grew slowly over time



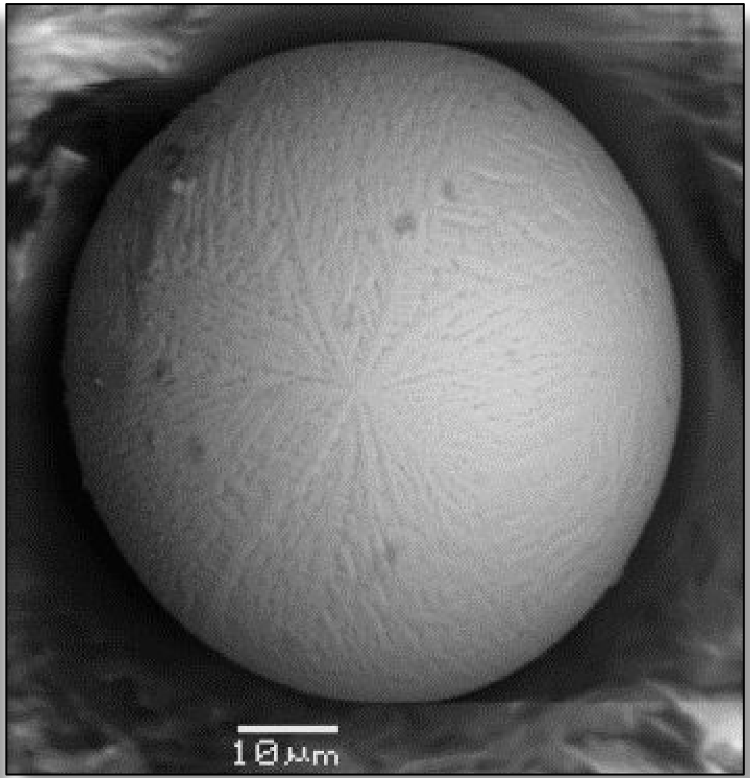
## Volcanic spherule

- Rounded
- Non-crystalline glass
- Low-temperature mix of volcanic minerals

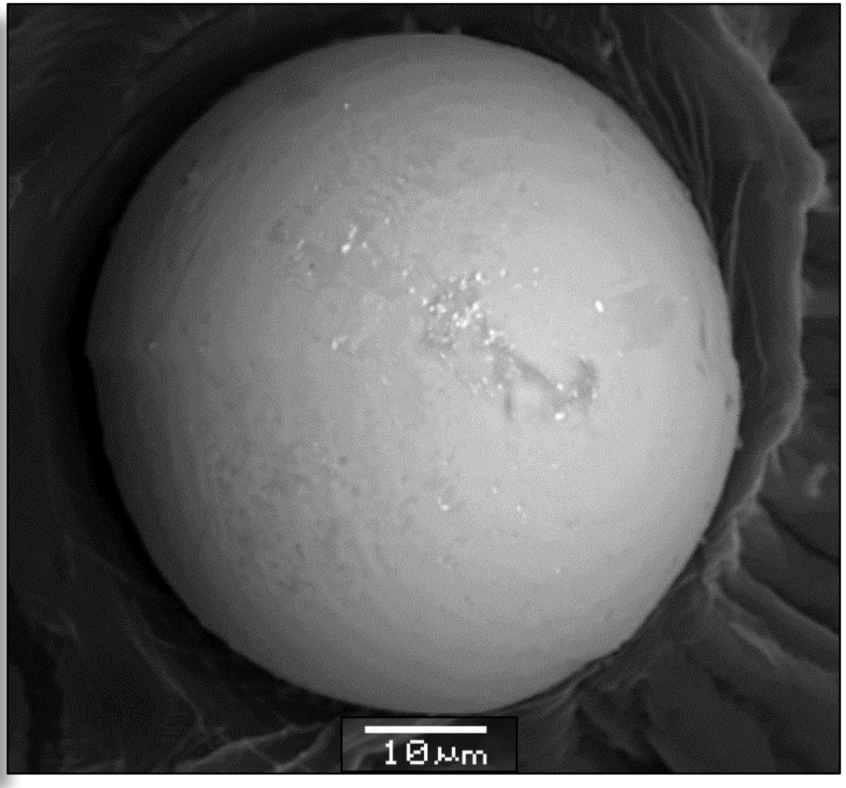
# Variations in Textures of Spherules




Highly textured iron-rich spherule




Moderately textured iron-rich spherule



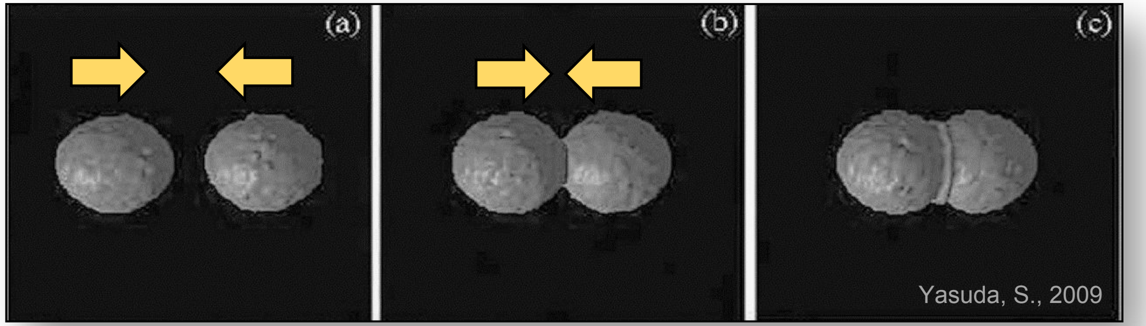

Lightly textured iron and silica-rich spherule

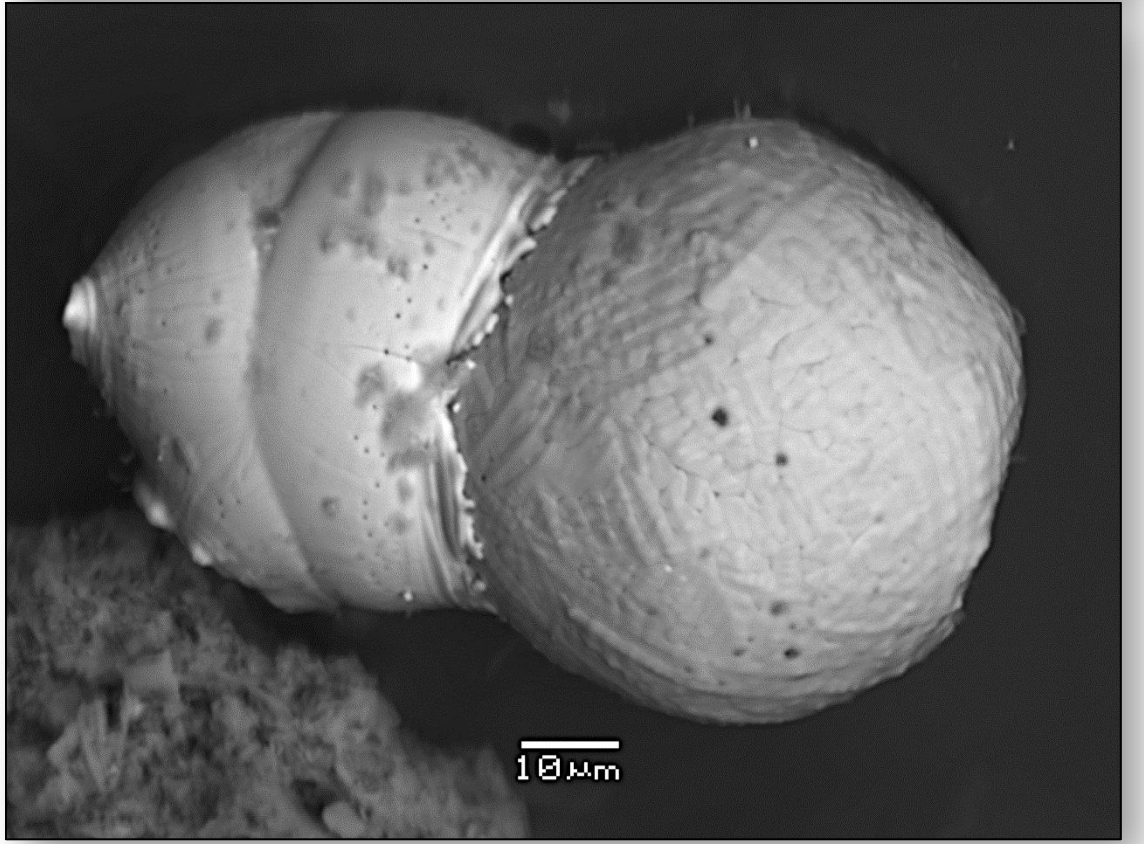
# How double spherules formed

Two molten YDB spherules (arrows) smashed into each other at high velocity and stuck.

Note dendritic texture on spherules

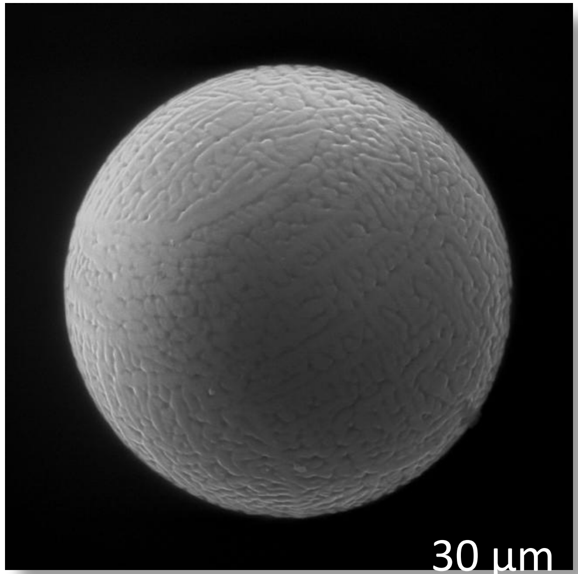
The collision gave the two spherules a “two scoop ice cream” look. The ragged edge between them formed because the iron was molten.

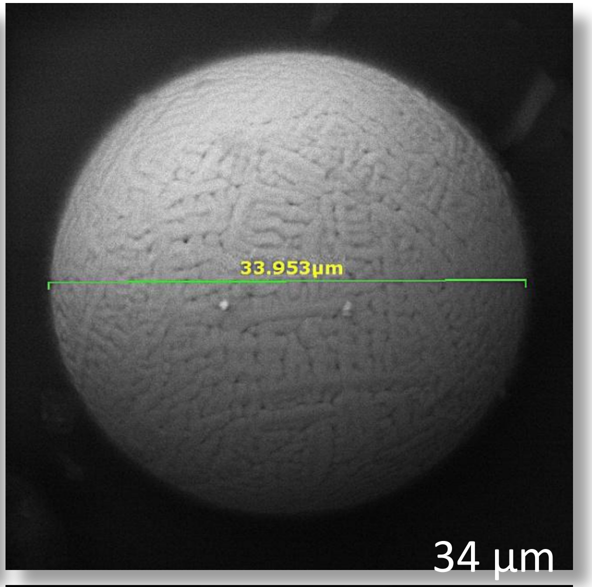


# Other YDB spherules with typical crystalline textures

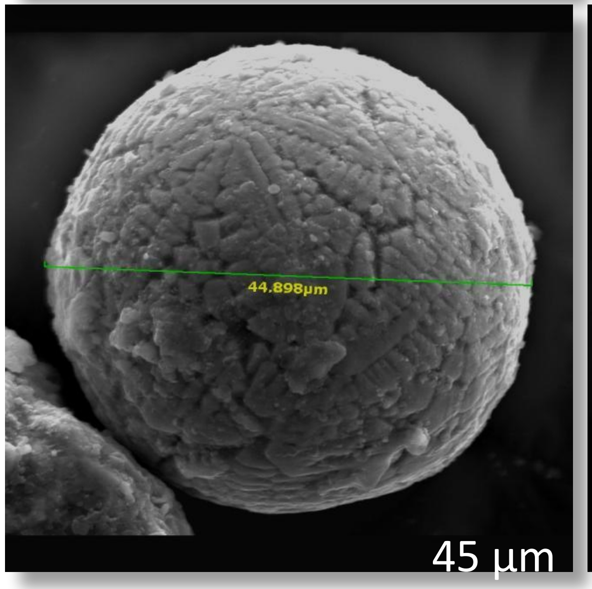
Blackwater Draw, NM
FeO=88%

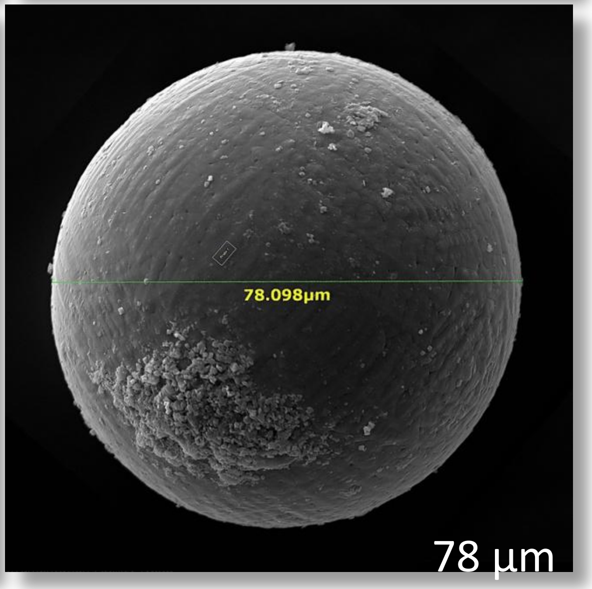



Blackwater Draw, NM:
FeO=93%

Topper, SC
FeO=75%

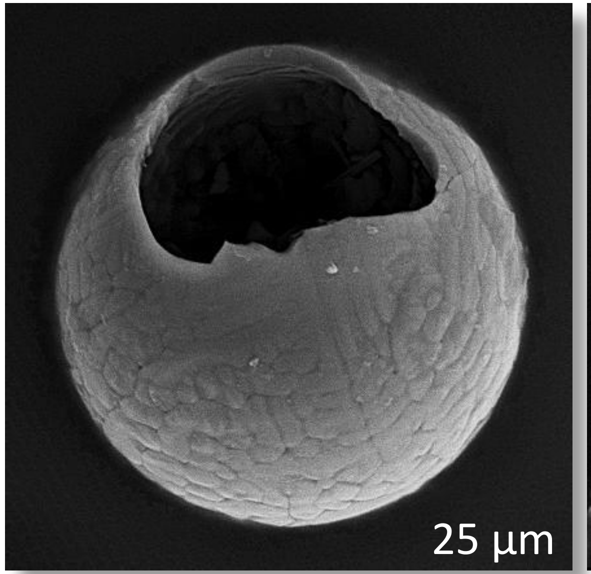


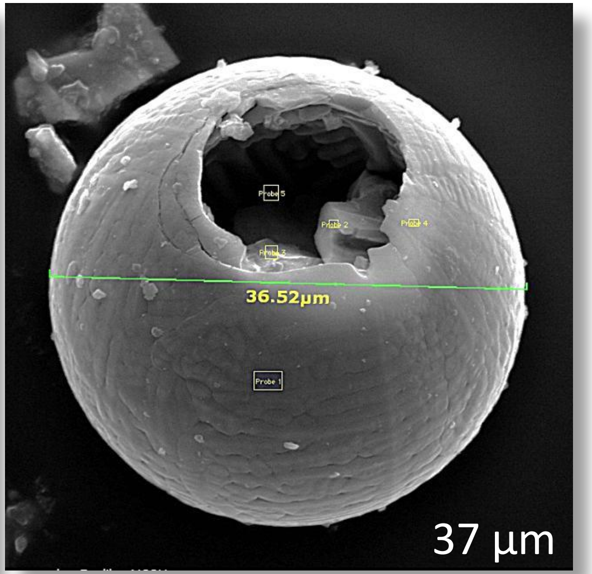




Lake Hind, Can:
FeO=95%

# Trapped gases made some spherules hollow

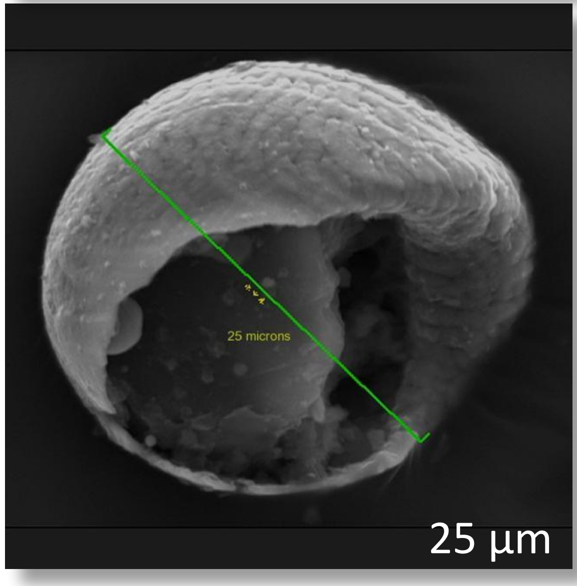
Blackwater, NM
FeO=91%

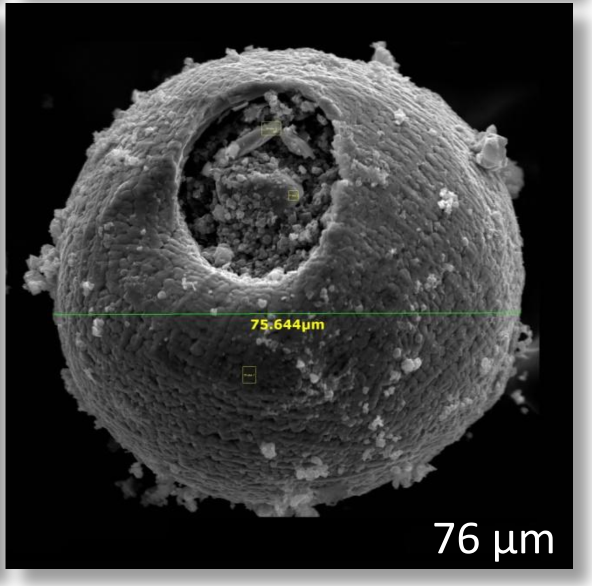



Blackwater, NM
FeO=93%

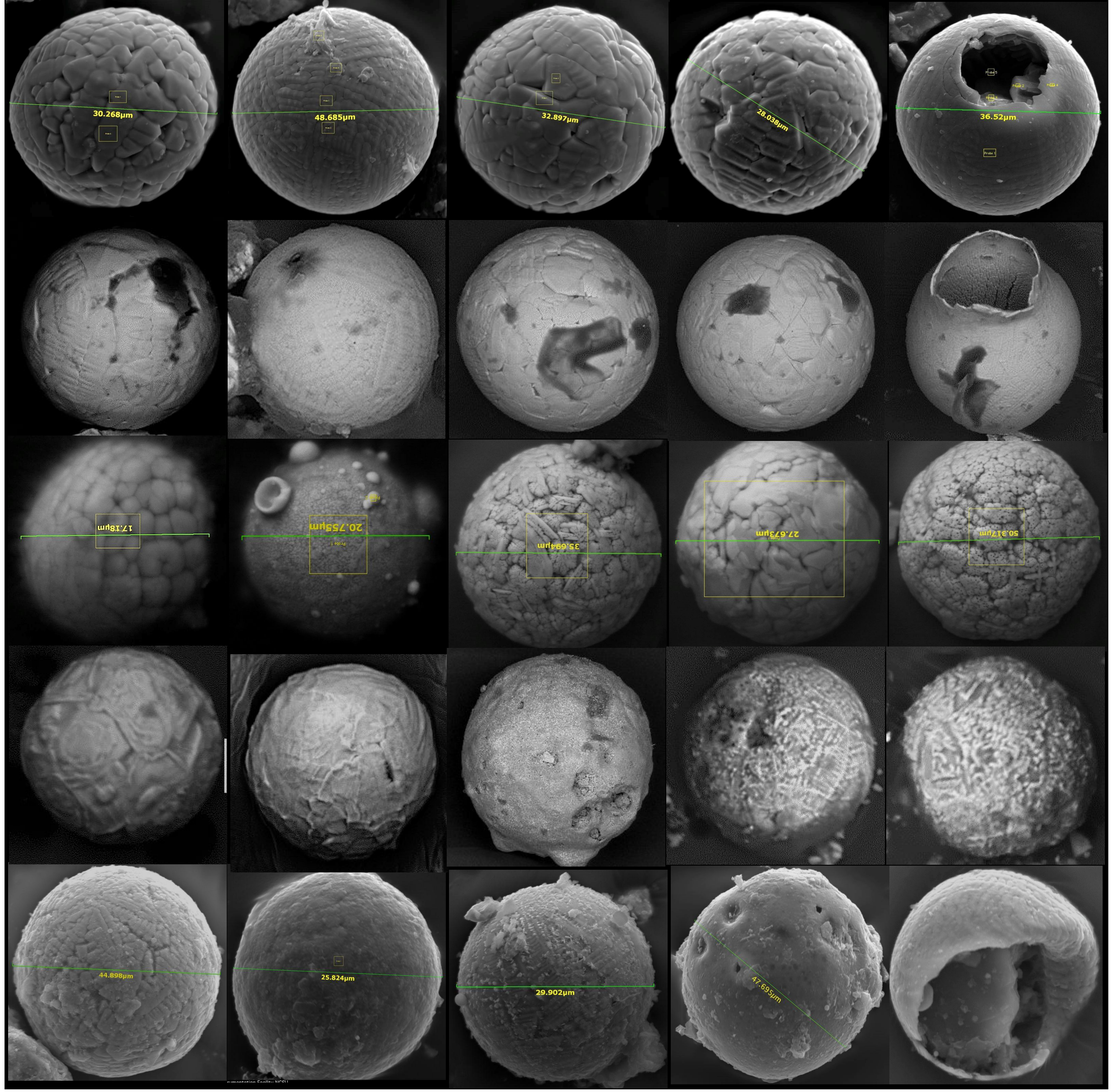
Topper, SC
FeO=92%




Lake Hind, CN
FeO=97%

# Variety of Textures and Shapes of YDB melted Spherules



Blackwater Draw, N.Mexico

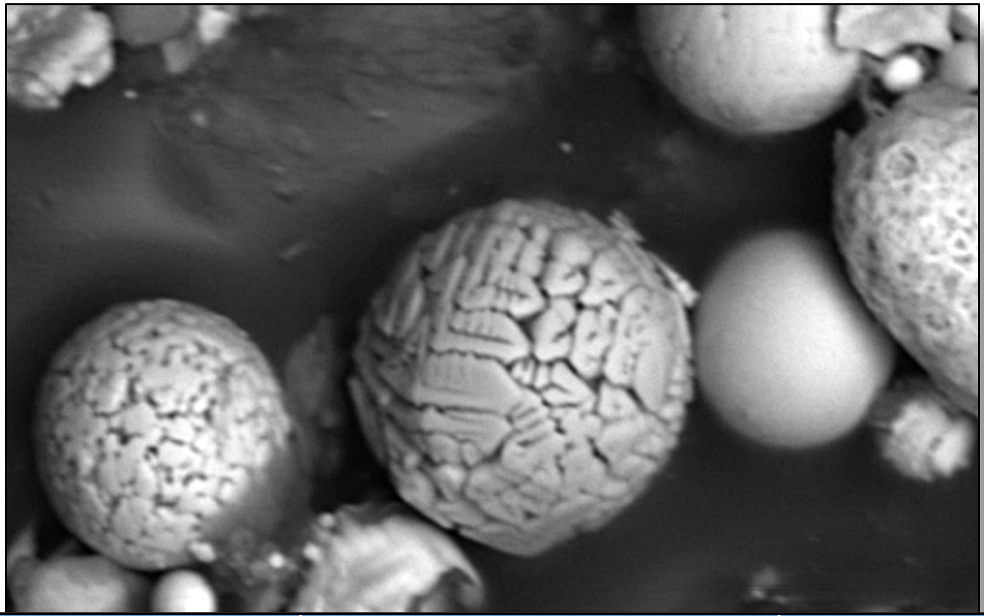
Kimbel Bay, North Carolina

Paw Paw Cove, Maryland

Tar River, North Carolina

Topper Site, South Carolina

# YDB Spherules Temperatures



| Melted Minerals in Spherules above | Elements found in Spherule minerals | Melting point of Spherule minerals |
|---|---|---|
| Rutile | $TiO_2$ | >1800°C |
| Mullite | $3Al_2O_3$+$2SiO_2$ | >1800°C |
| Cohenite | $Fe_3C$ | >1800°C |
| Corundum | $Al_2O_3$ | >2000°C |

✓YDB spherules are not from volcanoes, meteorites, or wildfires

✓These spherules can only be made by a cosmic impact

# SEM *required* to identify impact spherules

**TRUE IMPACT SPHERULES** reach peaks in a 12,800-year-old layer spread across four continents. Impact spherules can be identified by their 'dendritic,' feathery texture (previous page), indicating that the spherule melted and cooled rapidly to form tiny needle-like crystals. In addition, they typically contain lots of iron and other minerals that melt only at temperatures much higher than those produced by normal process on Earth.

**NON-IMPACT OBJECTS.** On the other hand, thousands of low-temperature, non-impact, rounded objects are found throughout sediment of all ages. The five types of round objects on the previous page look similar with an optical microscope. However, YDB impact spherules cannot be picked out that way -- the ONLY way to identify them is to use an electron microscope (SEM).

**DID NOT FOLLOW DIRECTIONS.** Several groups of researchers, led by Surovell, Pinter, Pigati, and Holliday, attempted to identify YDB spherules. They claimed they found 'YDB spherules' throughout sediment of all ages, and therefore, they are not unique. However, they failed to use SEM and so, were unable to distinguish true YDB impact spherules from thousands of other rounded objects that they found and mistakenly called spherules. Lack of SEM analyses invalidates their results.

**DID FOLLOW DIRECTIONS.** Other independent groups, led by LeCompte, Wu, and Andronikov, used SEM as required and found abundant melted YDB spherules exactly where they should be in 12,800-year-old layers. Their results contradict the work of the Surovell, Pinter, Pigati, and Holliday groups.