# Diamonds from the Sky

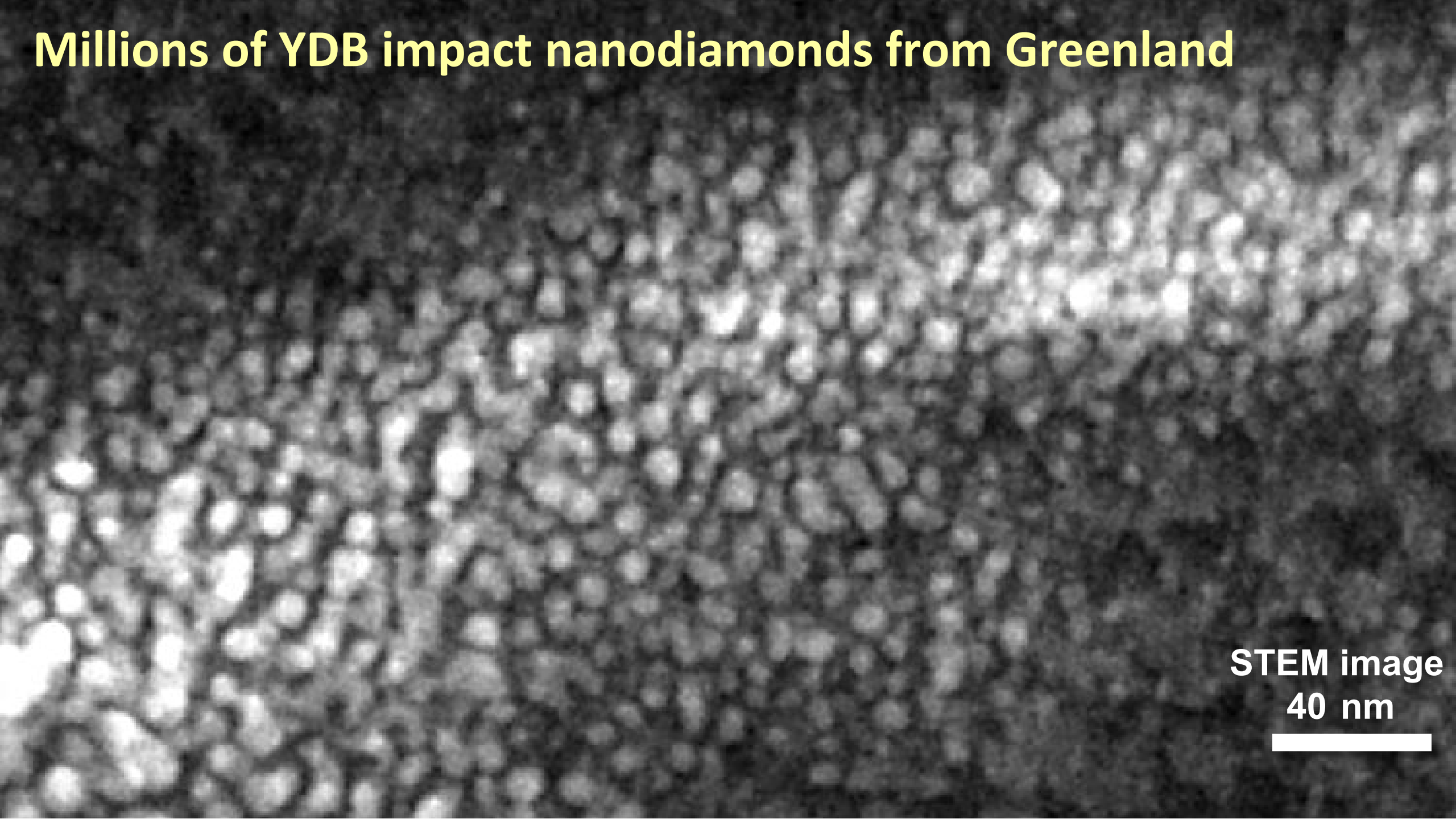
What's the most unusual evidence produced by the YDB impact event?

## NANODIAMONDS

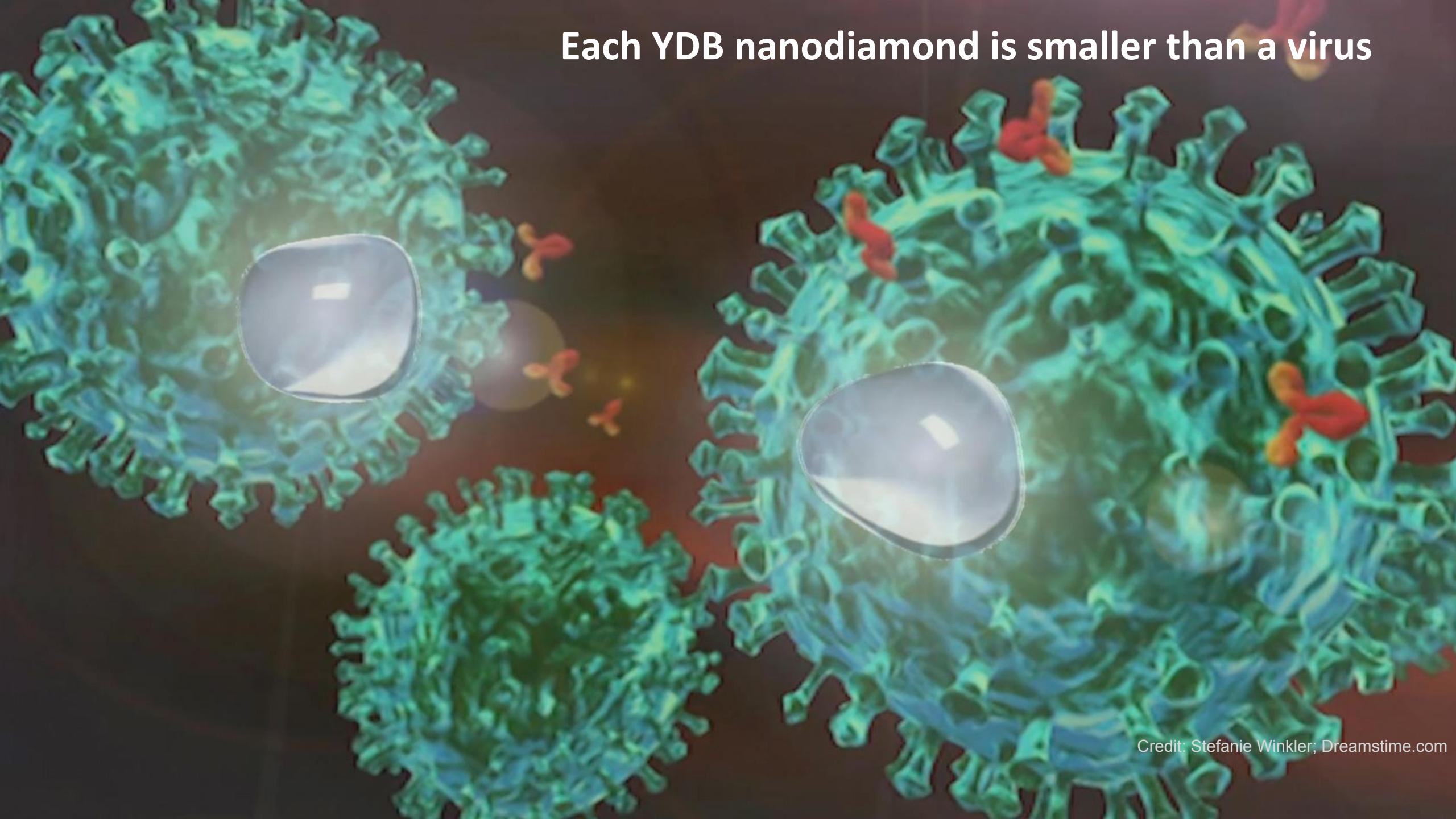
- 'Nano' refers to their size, which is far smaller than regular diamonds
- They form when carbon reaches 1000°C (1800°F), then cools quickly
- We made some in the laboratory by recreating impact conditions
- Conditions include high temperatures with almost no oxygen
- Such conditions do not occur naturally on Earth's surface
- However, they do occur in high-energy impact events
- The dinosaur-killing impact created nanodiamonds
- And, there are trillions of them in the YDB layer

**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.

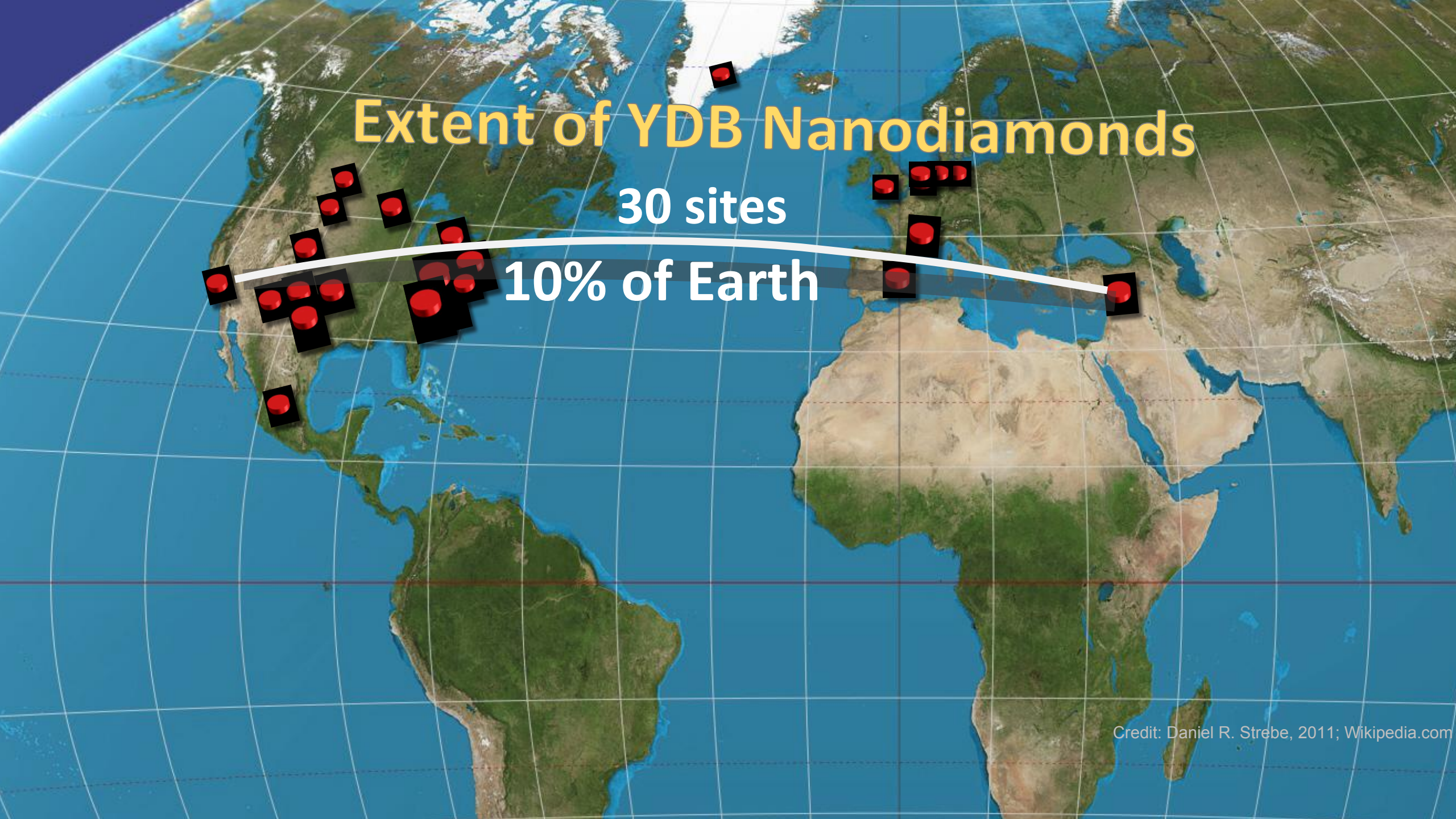
# Millions of YDB impact nanodiamonds from Greenland



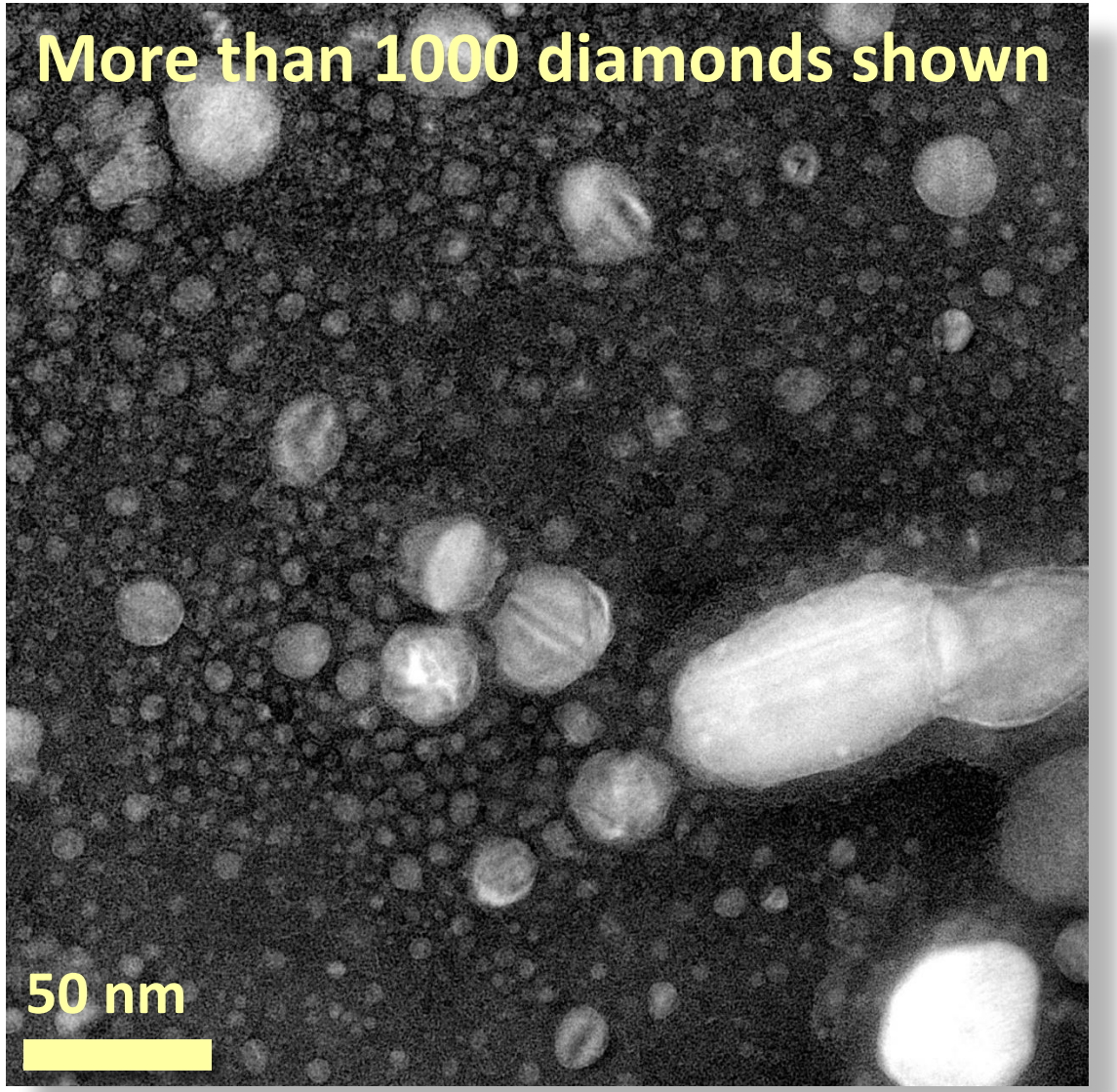
# Each YDB nanodiamond is smaller than a virus



Credit: Stefanie Winkler; Dreamstime.com


Extent of YDB Nanodiamonds
30 sites
10% of Earth
Credit: Daniel R. Strebe, 2011; Wikipedia.com


All YDB nanodiamonds pressed into a ball would look like this
Credit: KozziImages; Pond5.com




# YDB Diamonds

**YDB nanodiamonds come from:**

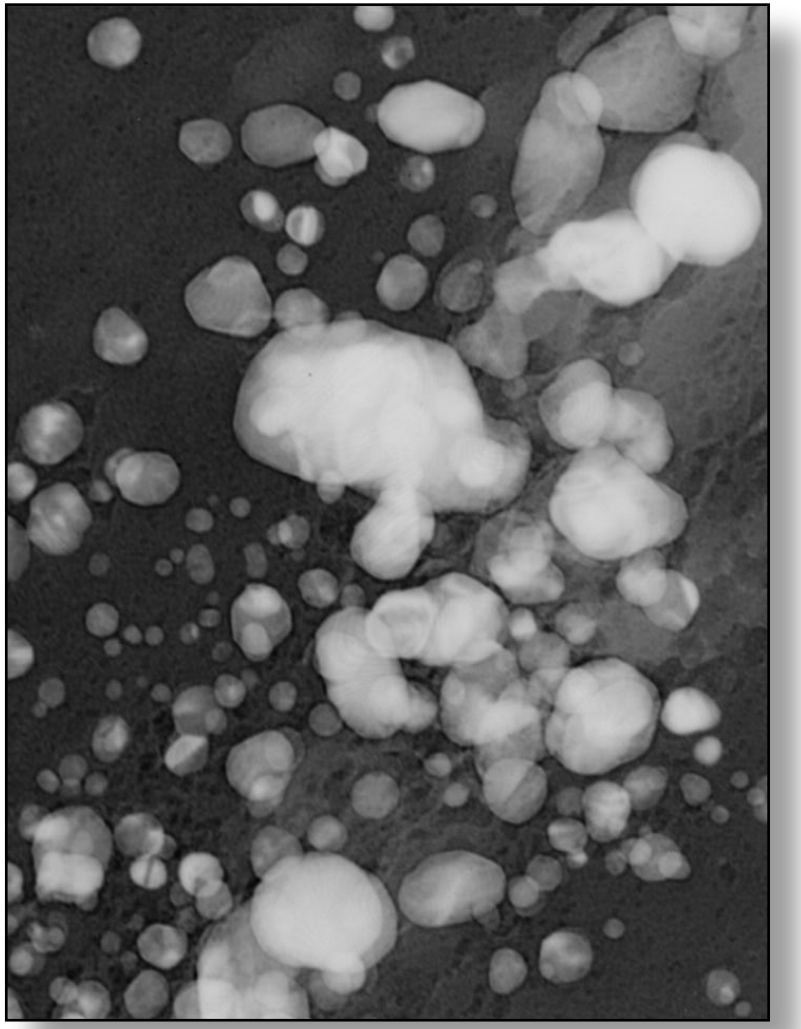
- Cosmic impacts

**YDB nanodiamonds do not come from:**

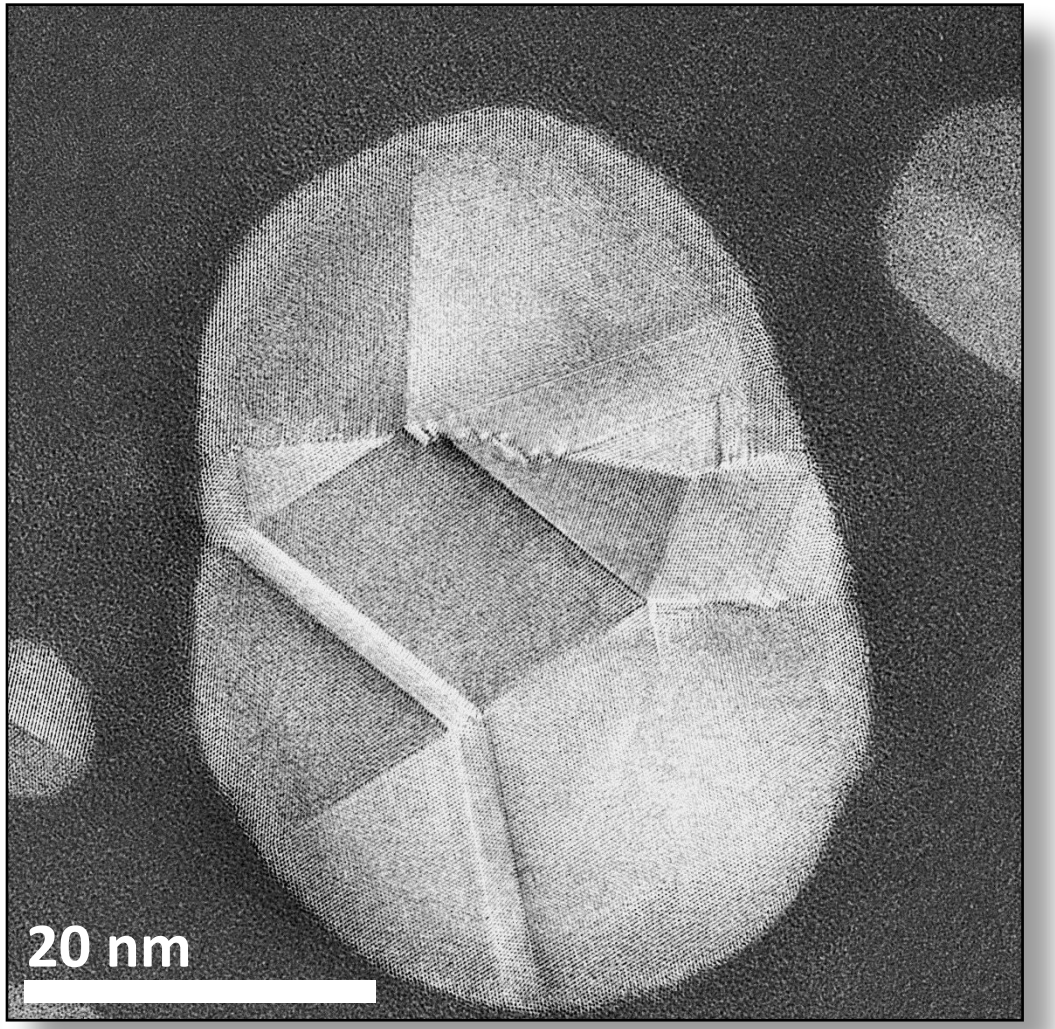
- Meteorites
- Natural wildfires
- Other natural processes

# YDB nanodiamonds

Murray Springs, Arizona



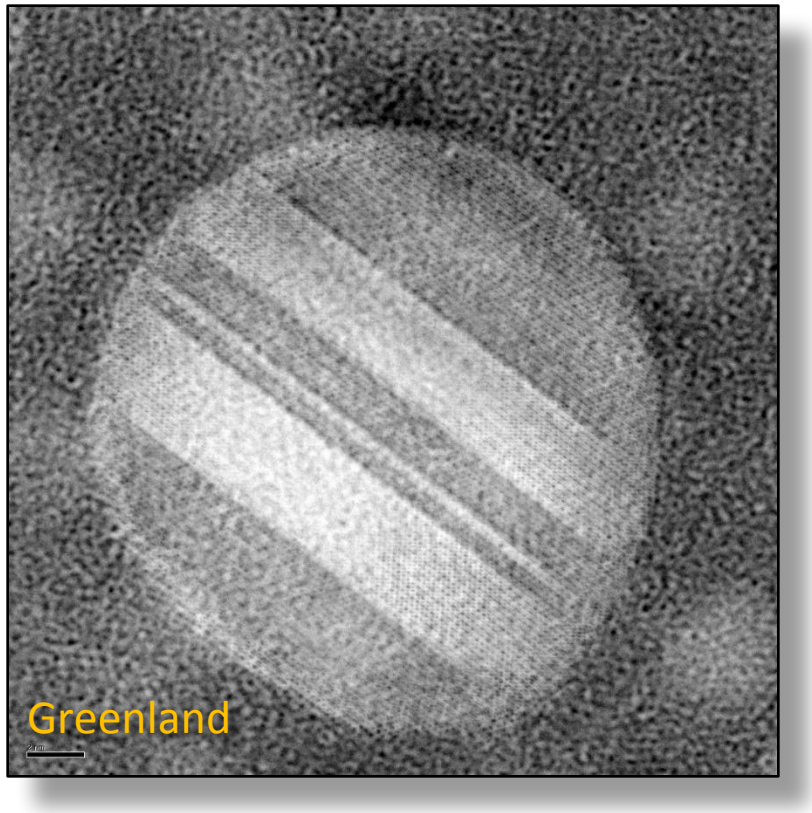
Greenland



# More YDB Nanodiamonds

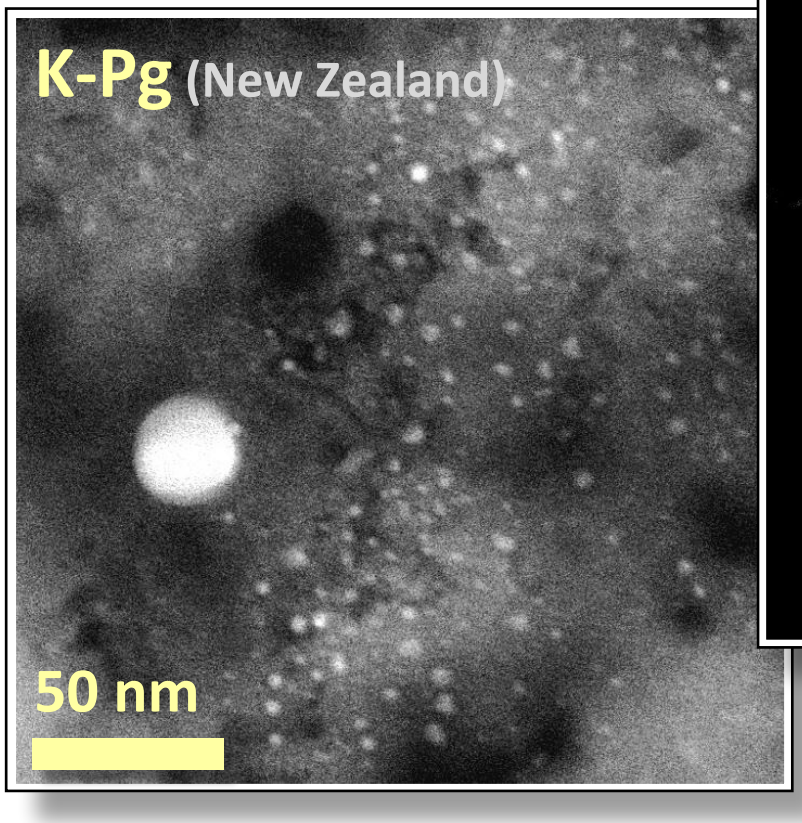
Germany

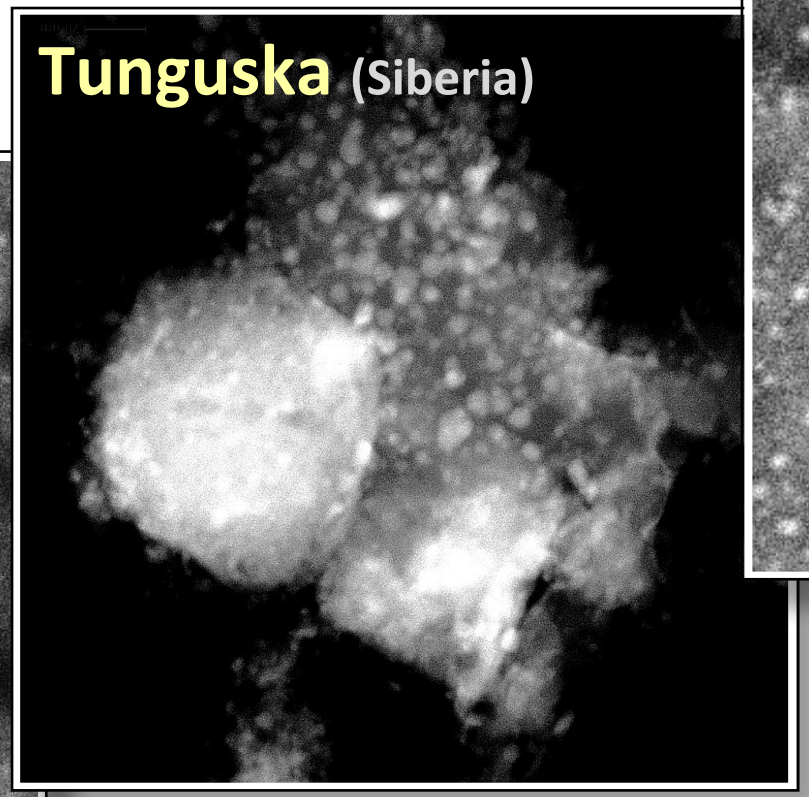

Greenland

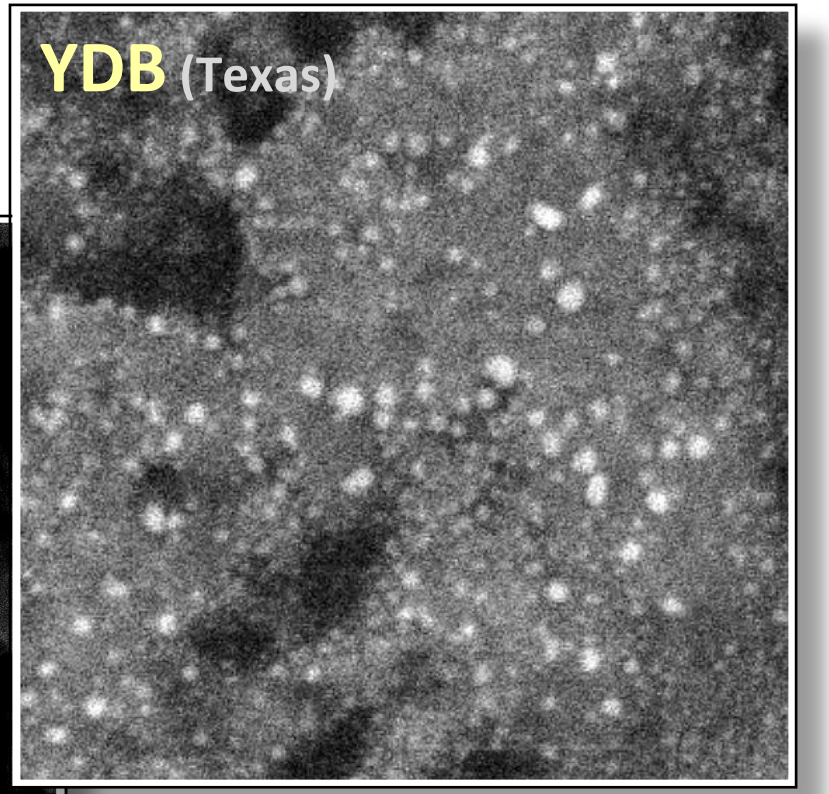


# Typical Nanodiamonds

Comparing nanodiamonds from the K-Pg (left, 66 million year), to the Tunguska airburst (middle, 1908), and to the YDB layer (right, 12,800 yrs ago).

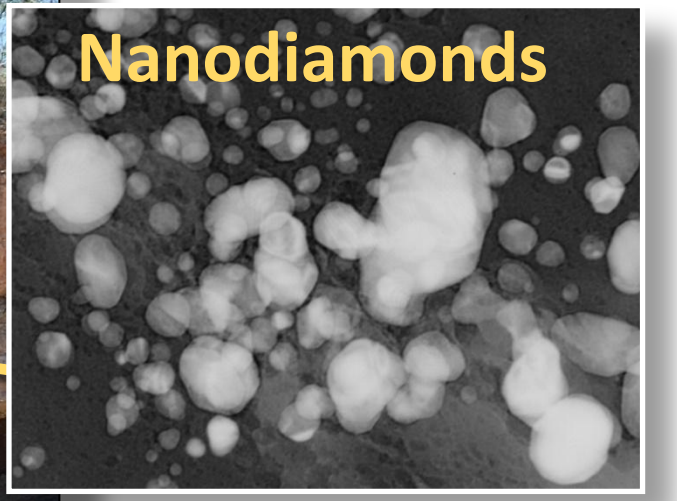


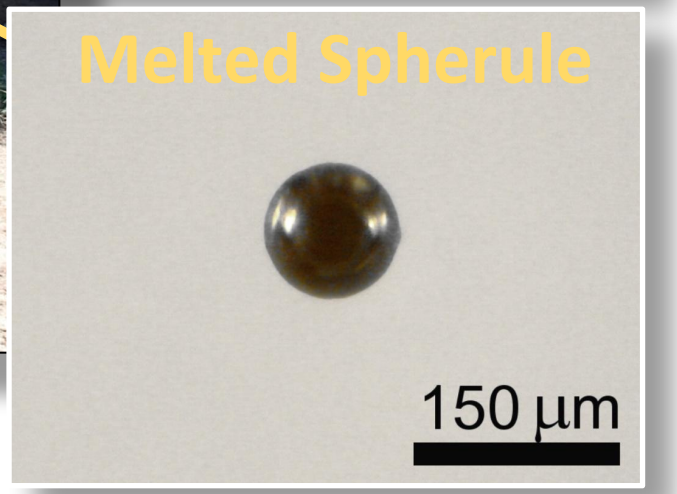




The K-Pg, Tunguska, and YDB impacts have the same types, shapes, and sizes of nanodiamonds, suggesting the YDB was an impact event.

# Murray Springs, AZ

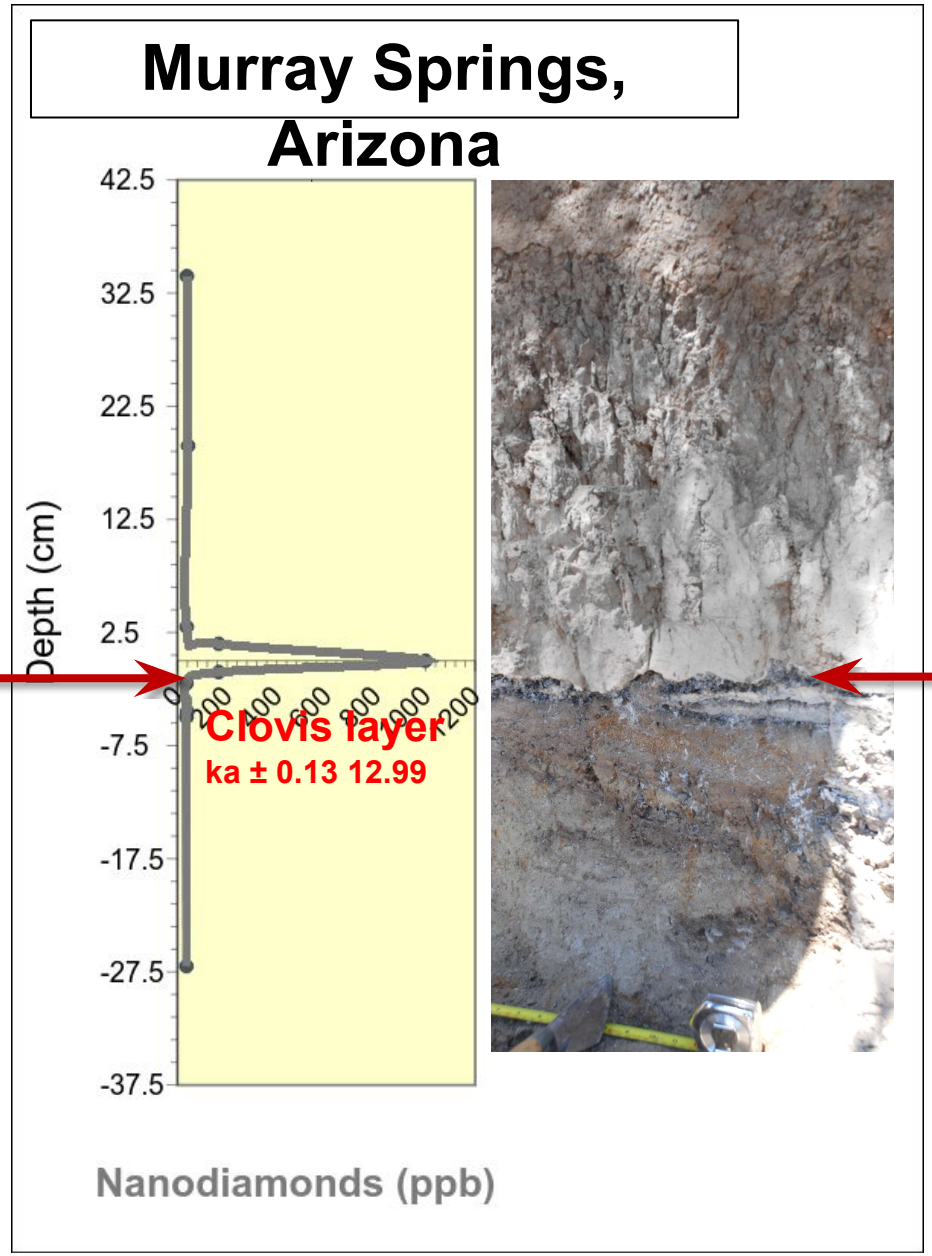


# Nanodiamonds

were found just
below the black mat,
dating to 12,800 years ago.

None were above or below
the Black Mat layer



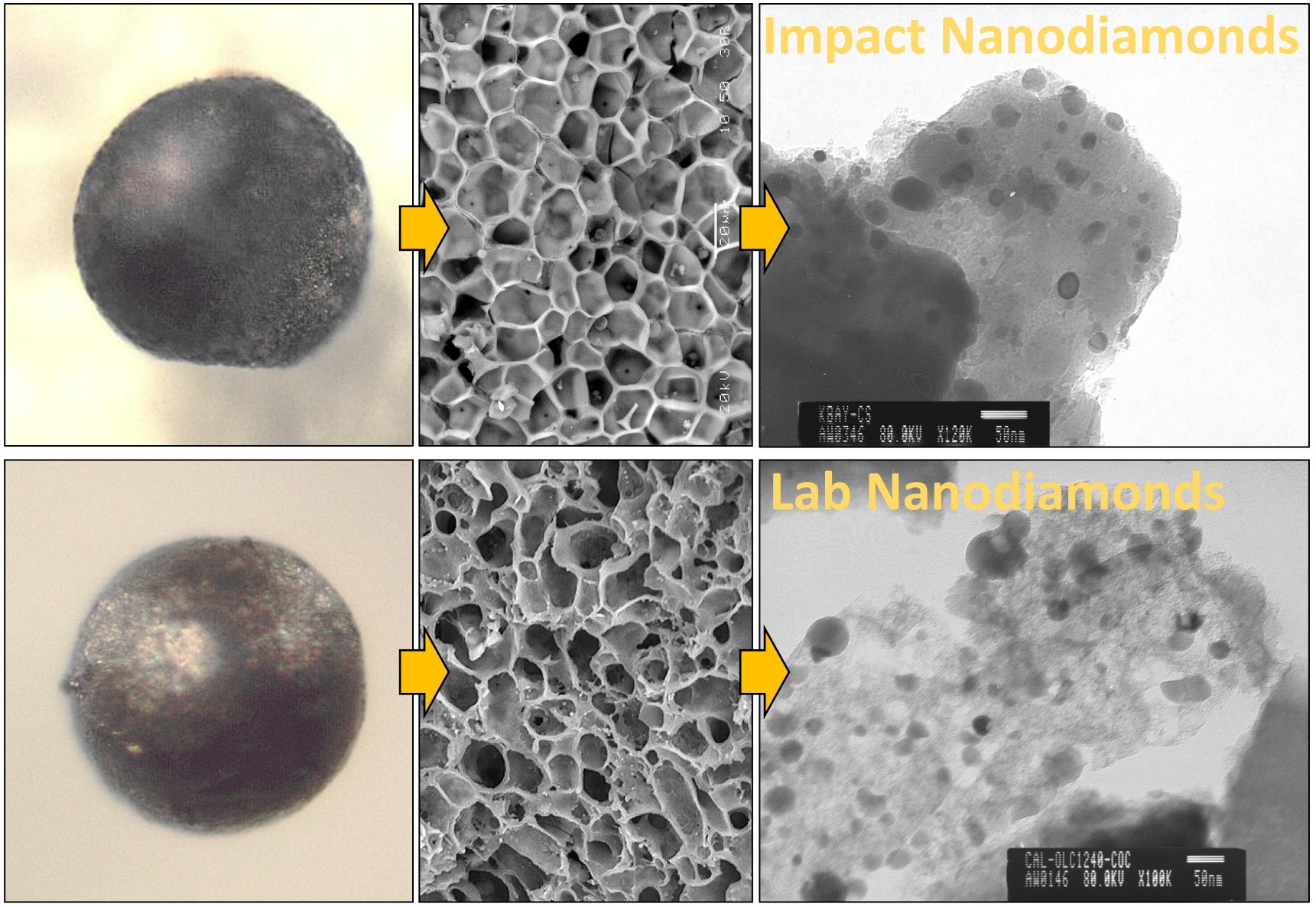
# How to create nanodiamonds

TOP ROW

1) First panel shows YDB carbon spherule, formed from tree sap that burned during impact wildfires.
2) Next panel is the interior of a carbon spherule.
3) Last panel shows nano-diamonds that formed in spherule at >1000°C without oxygen.

BOTTOM ROW

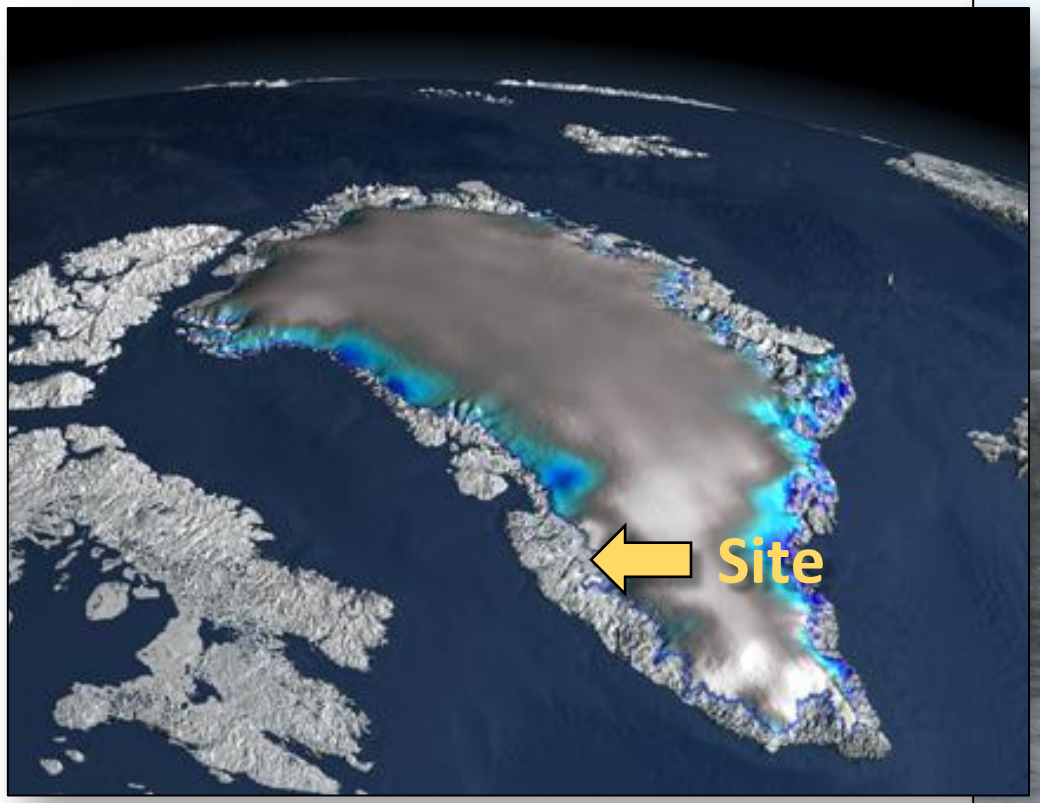
1)-3) Shows identical features formed in the laboratory under extreme impact conditions that don't occur naturally, except in impacts.



# Diamonds in Greenland

- Because we found YDB diamonds on land, we thought it likely that they would be trapped in 12,800-year-old ice in Greenland.
- Our group collected samples of ice and returned to the US to process them.
- One issue was to find the age of the ice layers, because we need to know the exact age of the 12,800-year-old layer. To do that, we used an isotope of oxygen ($^{18}O$), which is sensitive to temperature.
- The Greenland YDB ice samples were loaded with nanodiamonds, carbon spherules, and iron-rich spherules.
- We are planning a new expedition to collect more ice from another site in Greenland that may give us new clues to the YDB impact event.

# Greenland Site




Credit: NASA/Goddard Space Flight Center
Scientific Visualization Studio

## Sampling Site with YD Layer

Credit: Doug Hamilton

# Another Greenland Site with the YD Layer

## DUST IN THE ICE

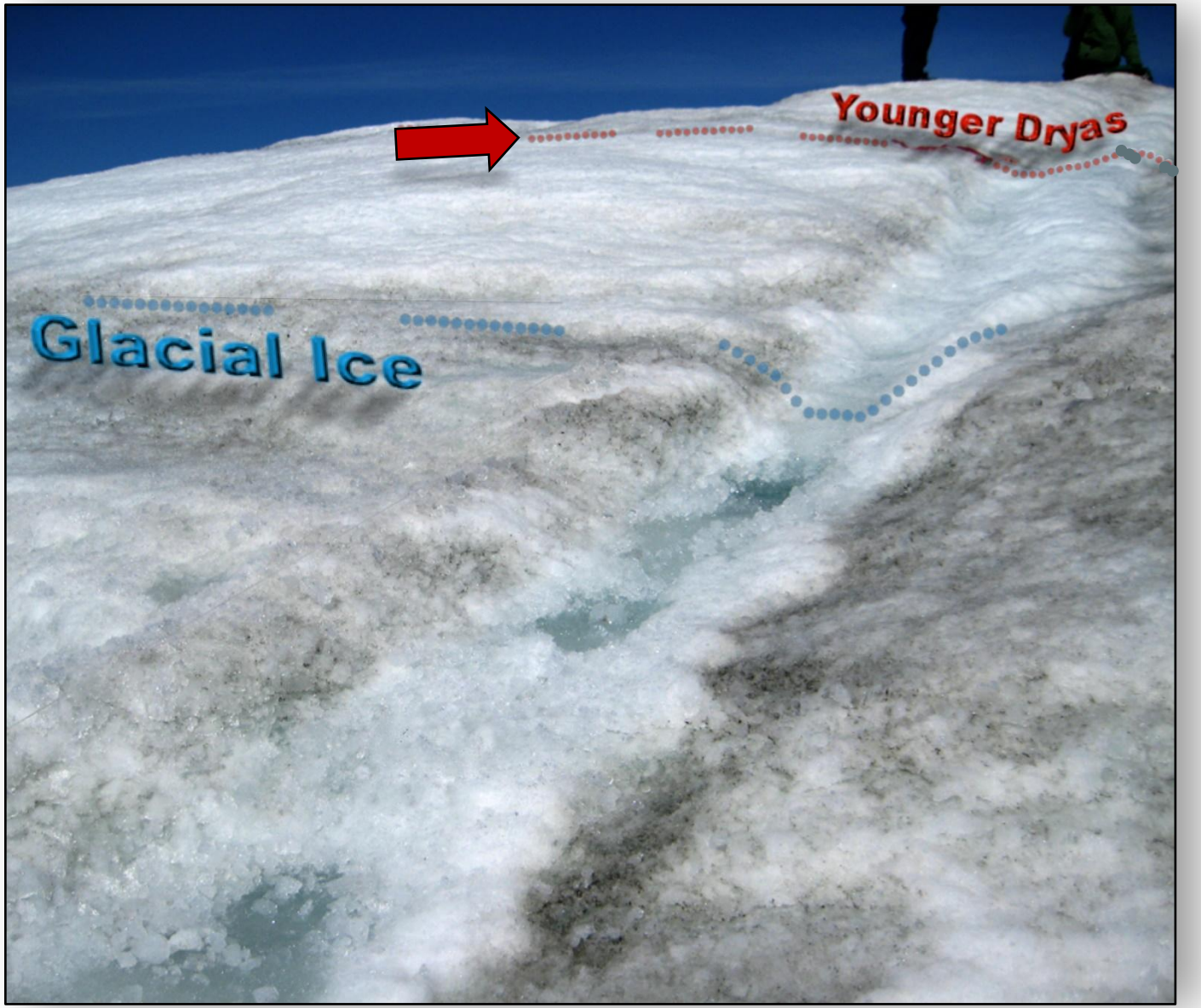
During cold periods such as the Younger Dryas, prevailing winds became much stronger, carrying much more dust from North America to Greenland. That dust made the ice noticeably darker (dark bands at right). The opposite is true for warmer climate. Weaker winds carry less dust, and so, the ice is nearly white.

The image shows the climatic sequence from right to left: 1) gray ice during the last Ice Age (blue arrows), 2) followed a thin band of white ice during a brief period of warming, 3) followed by an even thinner dark band indicating the Younger Dryas (red arrows), and 4) followed by white ice representing our modern climate. The thin white band next to the dark YD band shows that the abrupt change is unusual.


Credit: Reeh et al., 2002

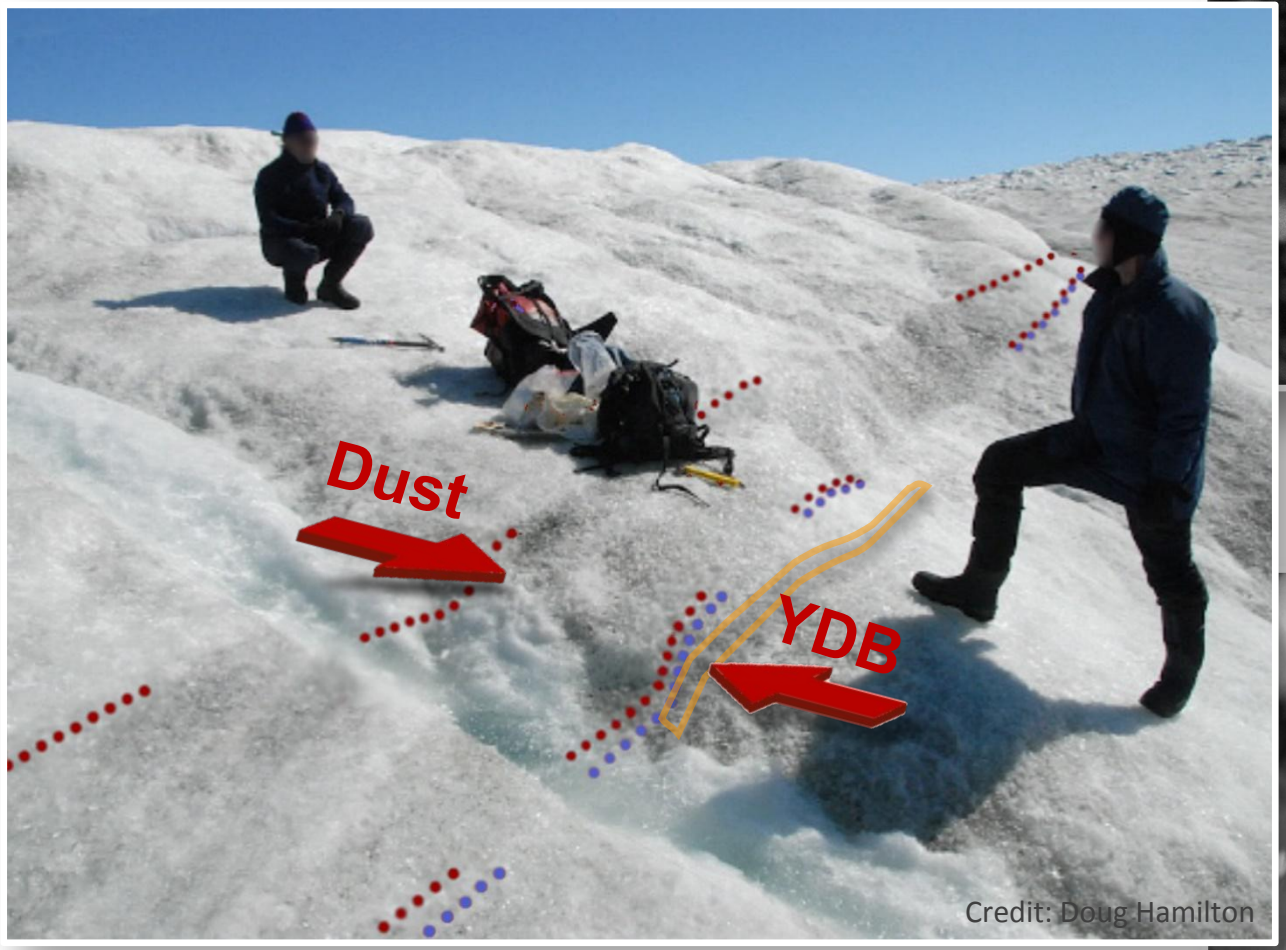
# Dust in the ice

This is the sampling site at the ice margin in West Greenland. As with the previous image, this photo shows a similar climatic sequence from lower left to upper right: 1) gray ice during the last Ice Age (blue text), 2) followed a band of white ice during a brief period of warming, 3) followed by an even thin, dark band indicating the YD (red text and arrow), and 4) followed by white ice at the top of the slope, representing the start of our warm modern climate.

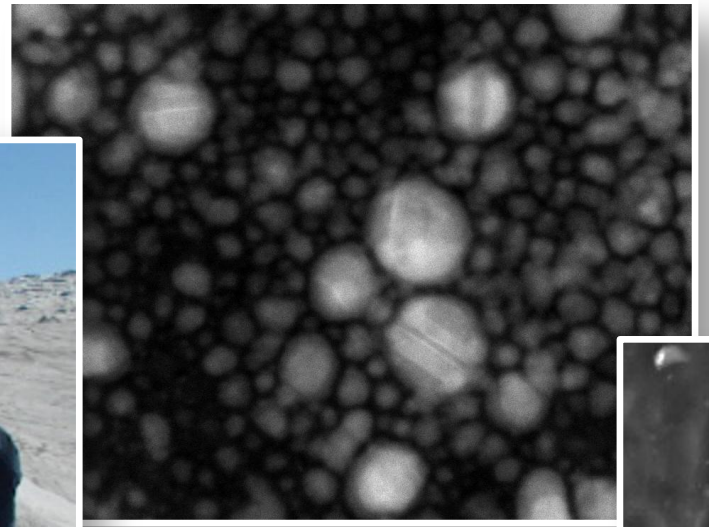



Credit: Doug Hamilton

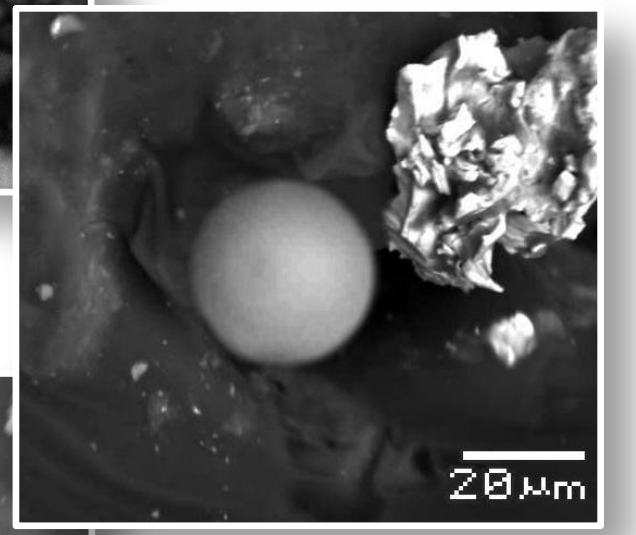
# Western Greenland



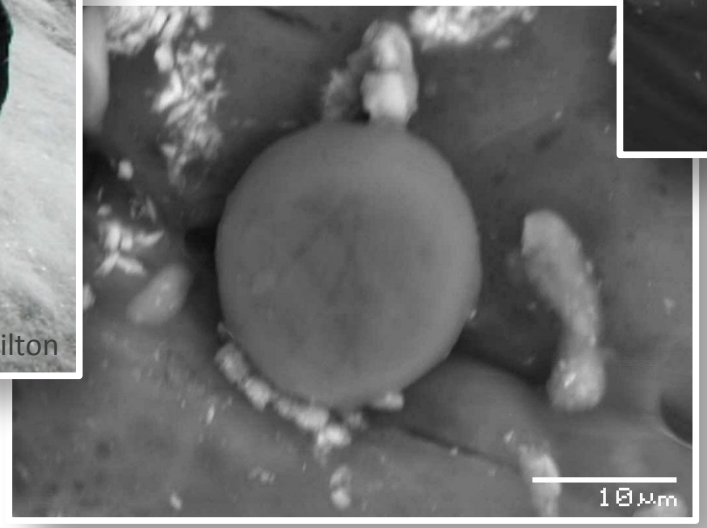

**YDB Impact.** The thin band of ice marked "YDB" contains trillion of nanodiamonds, along with melted iron spherules and carbon spherules.



Nanodiamonds

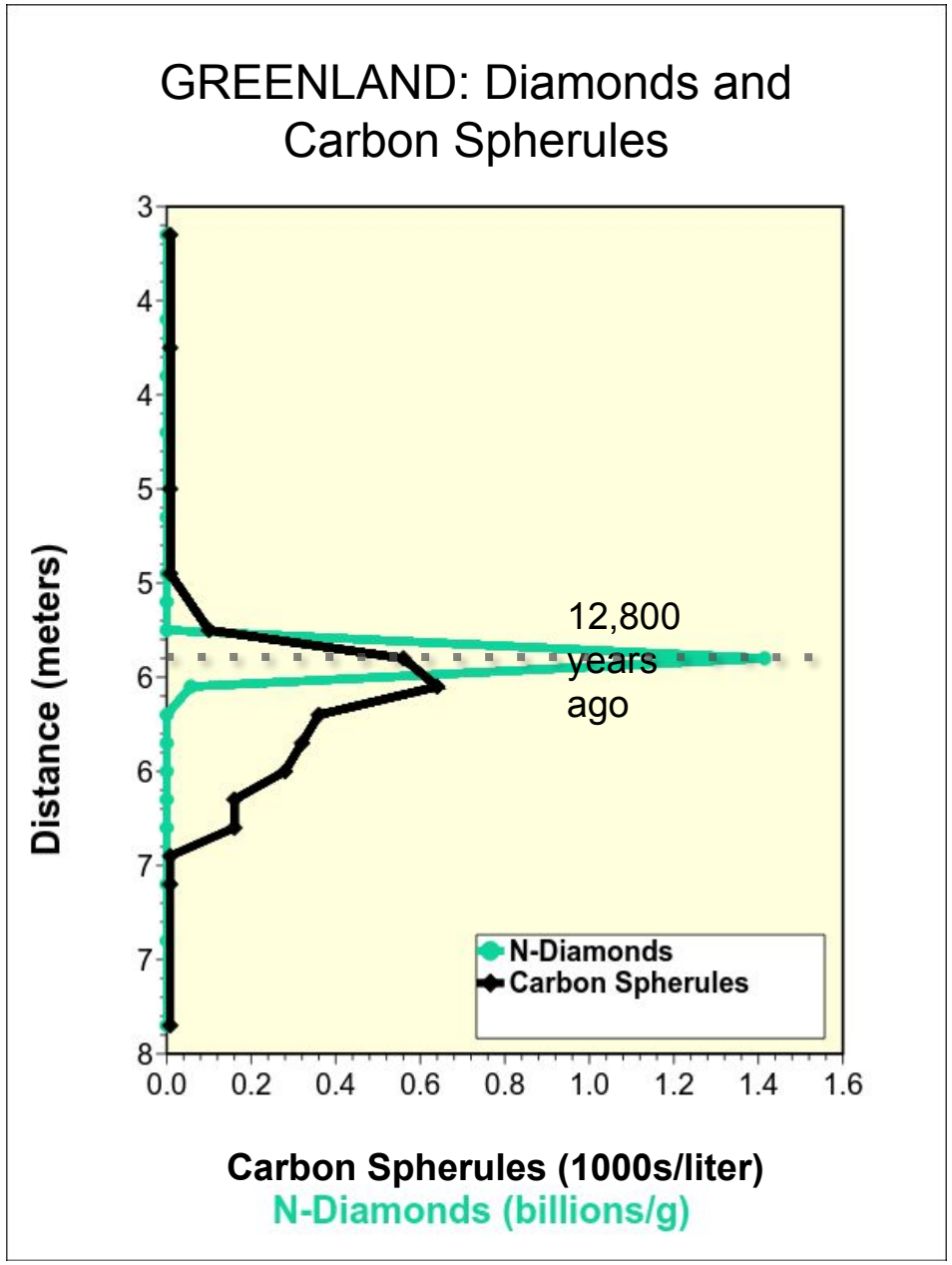



Carbon Spherule

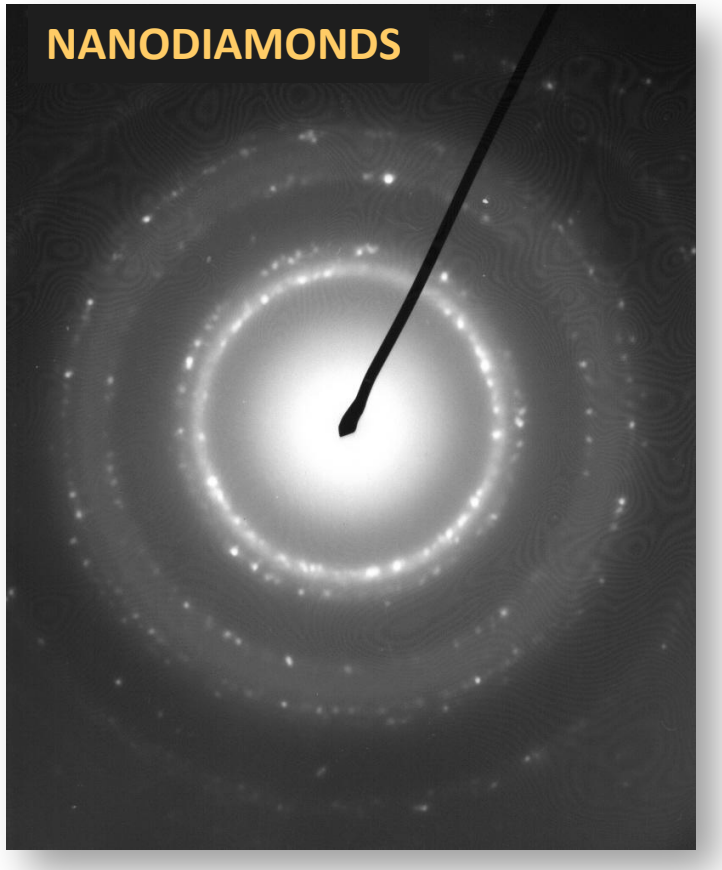



Melted Spherule

This chart shows distance along ice sheet and location of YDB materials




# West Greenland




When the electron beam within a transmission electron microscope passes through a group of nanodiamonds, diffraction bends the beam to produce the unique pattern of light shown above.

# Nanodiamond Summary

- The dinosaur-killing impact (K-Pg) created trillions of nanodiamonds
- Few nanodiamonds were found above or below the K-Pg layer
- Trillions of nanodiamonds were also found in the YDB layer
- No large peaks in nanodiamonds are above or below the YDB layer
- Evidence shows YDB nanodiamonds are identical to those in the K-Pg
- Nanodiamonds form by heating carbon to more than 1000°C (1800°F)
- This was confirmed in the laboratory by recreating impact conditions
- Such conditions do not occur on Earth due to natural processes
- Such conditions do exist during cosmic impacts