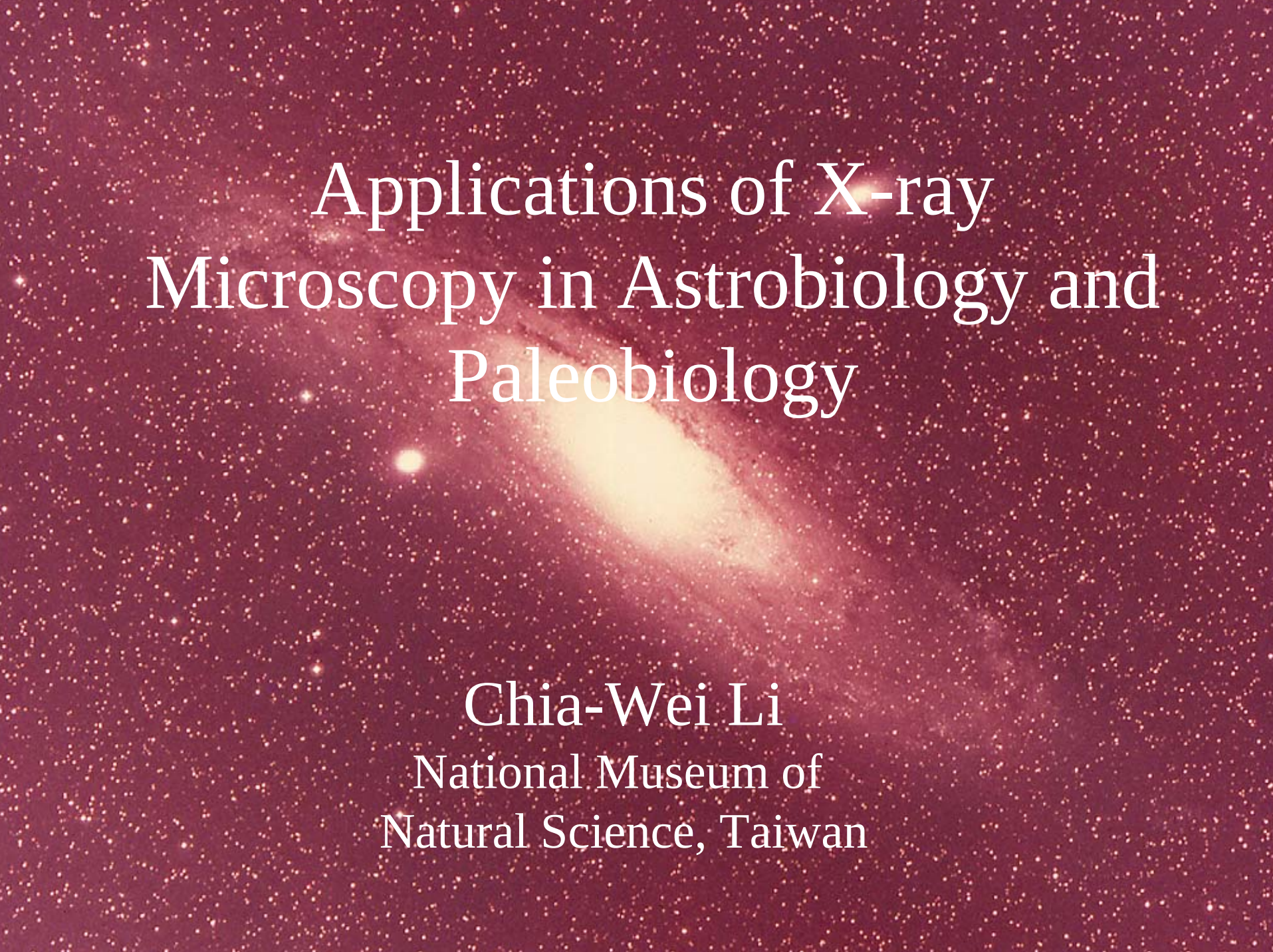
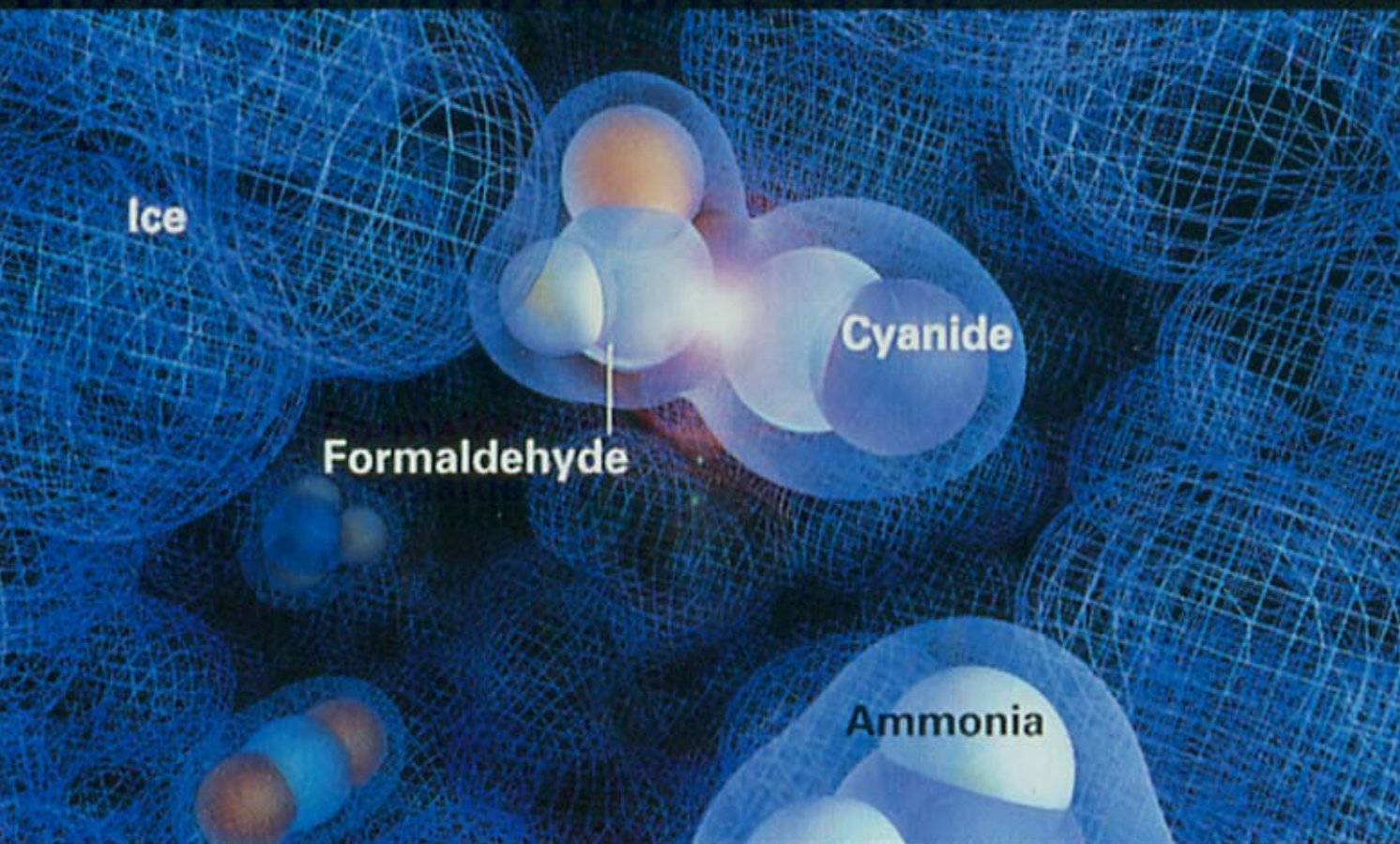




Applications of X-ray Microscopy in Astrobiology and Paleobiology

Chia-Wei Li
National Museum of
Natural Science, Taiwan

DID LIFE BEGIN IN A BALL OF ICE?



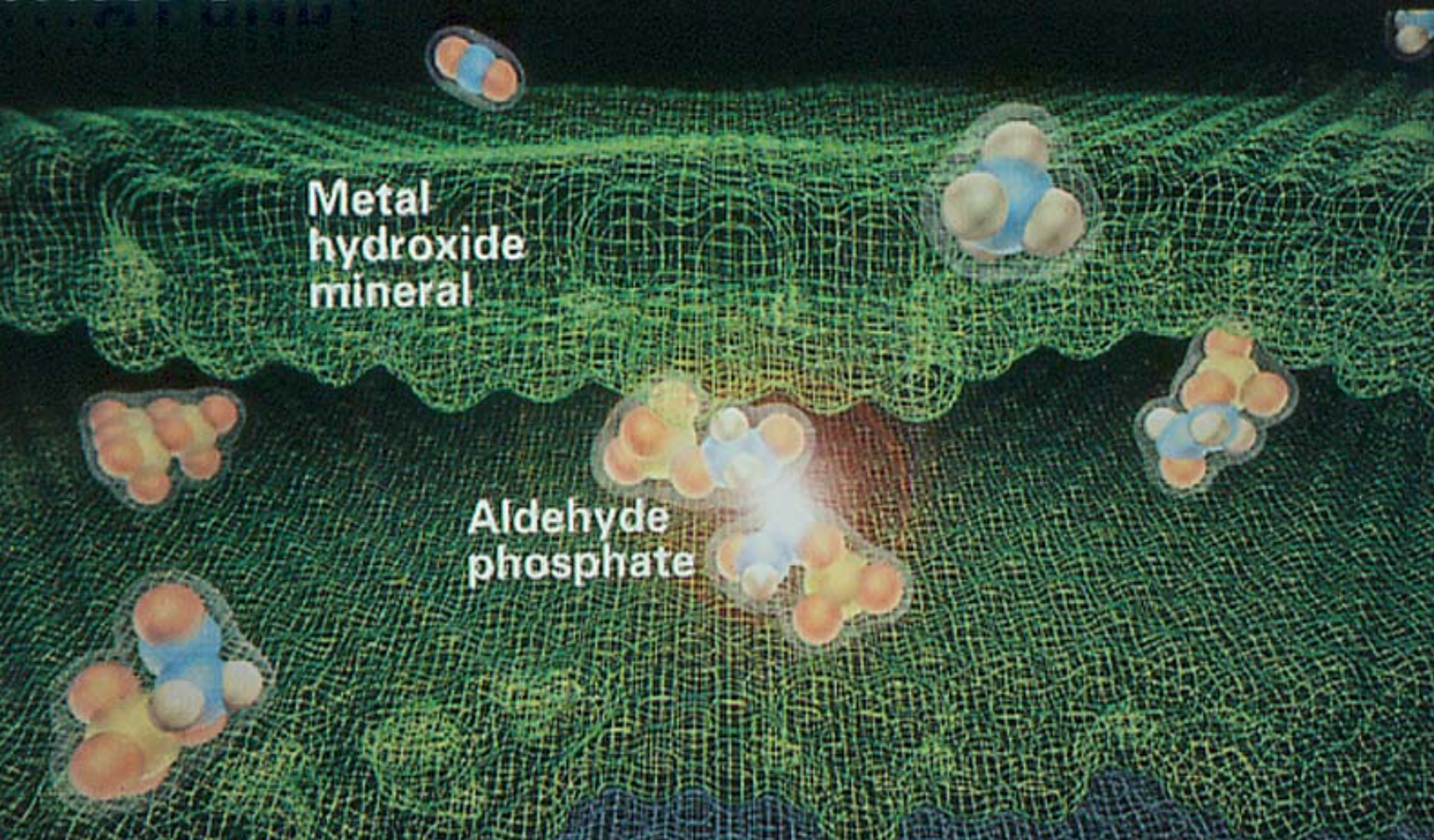
1,000 feet of ice

Ice caps the ocean and shields it from UV light. At the base of the ice, pockets of water bring organic compounds together for possible reaction.

Deep-sea vent

LANDSCAPES BY JONATHAN HERBERT; CHEMICAL REACTIONS BY KEN EDWARD

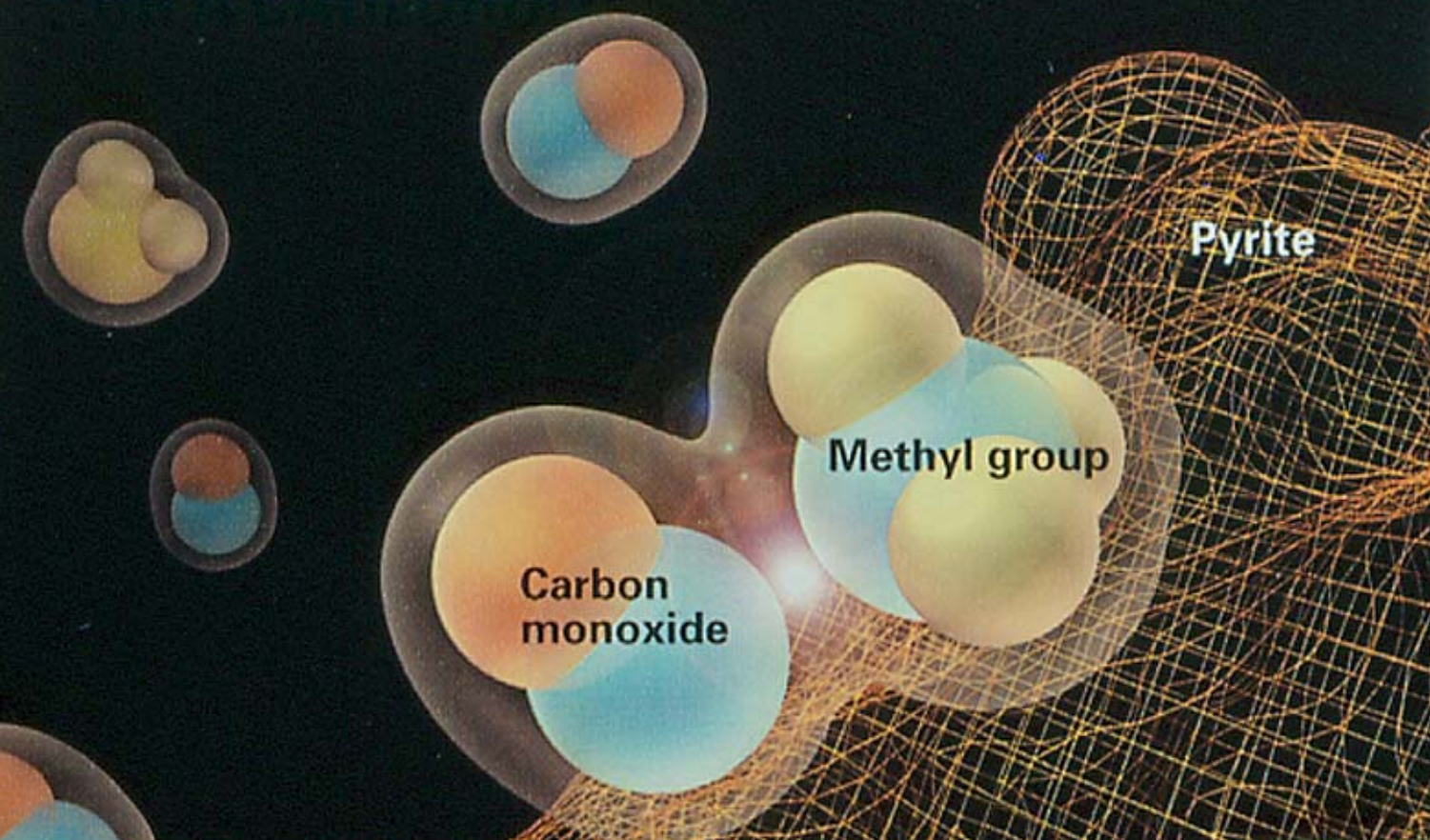
...A POND?



Pond

Glaciers, volcanoes, geysers, and interplanetary debris supply compounds to water that collects in ponds and shallow basins.

...OR A CAULDRON?



— Hot spring

At volcanic sites such as hydrothermal vents and geysers, gases deliver vital compounds to the surface, where reactions ensue.

Deep-sea vent



Life From Mars?



BURST OF CREATIVITY

Meteorites bombarded the planet 4.6 billion to 3.8 billion years ago, making earth uninhabitable

The earth formed
4.6 billion years ago

First evidence of life:
fossils of blue-green algae
that lived 3.6 billion to
3.4 billion years ago

First cells
with a nucleus

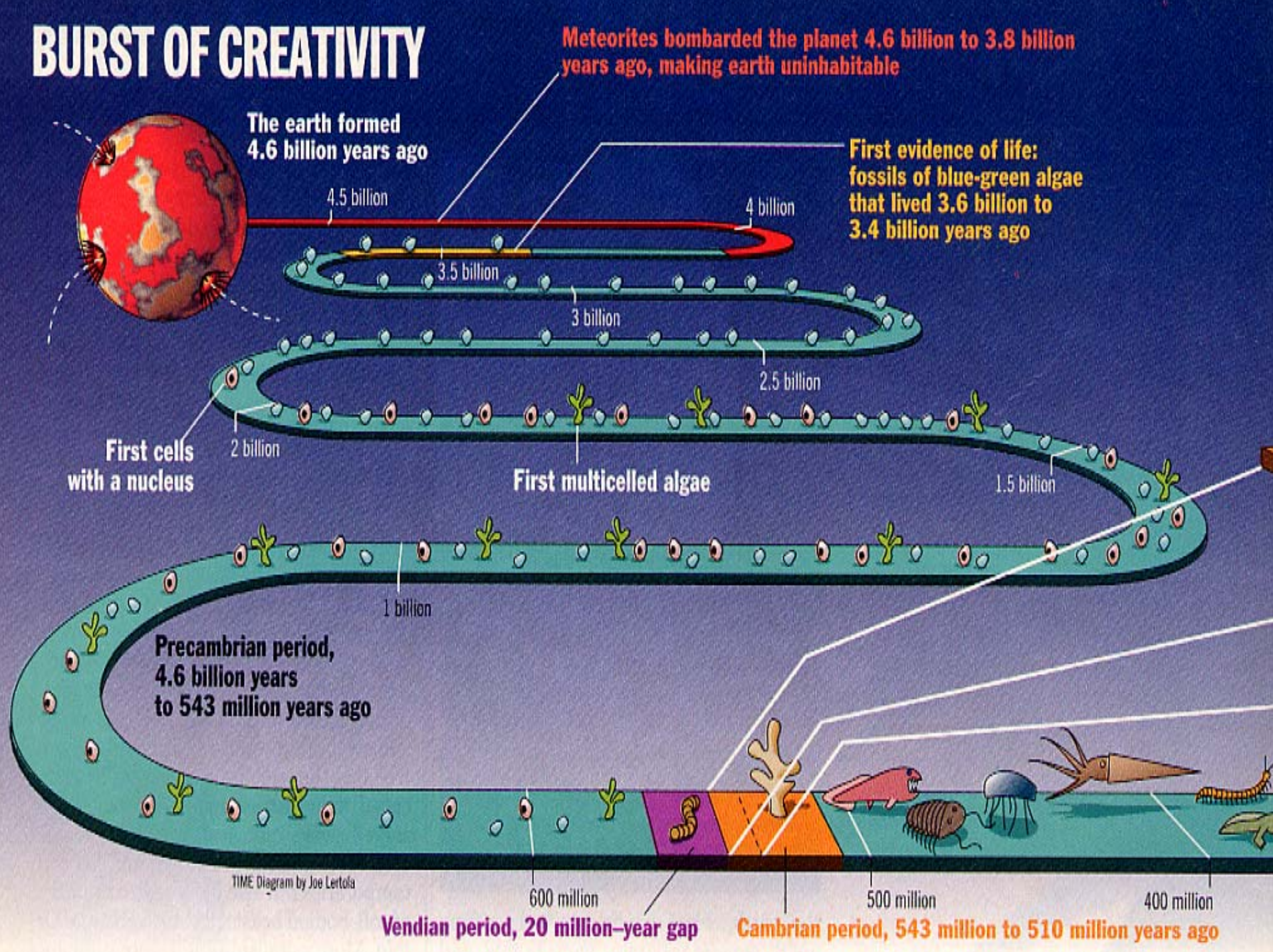
First multicelled algae

Precambrian period,
4.6 billion years
to 543 million years ago

Vendian period, 20 million-year gap

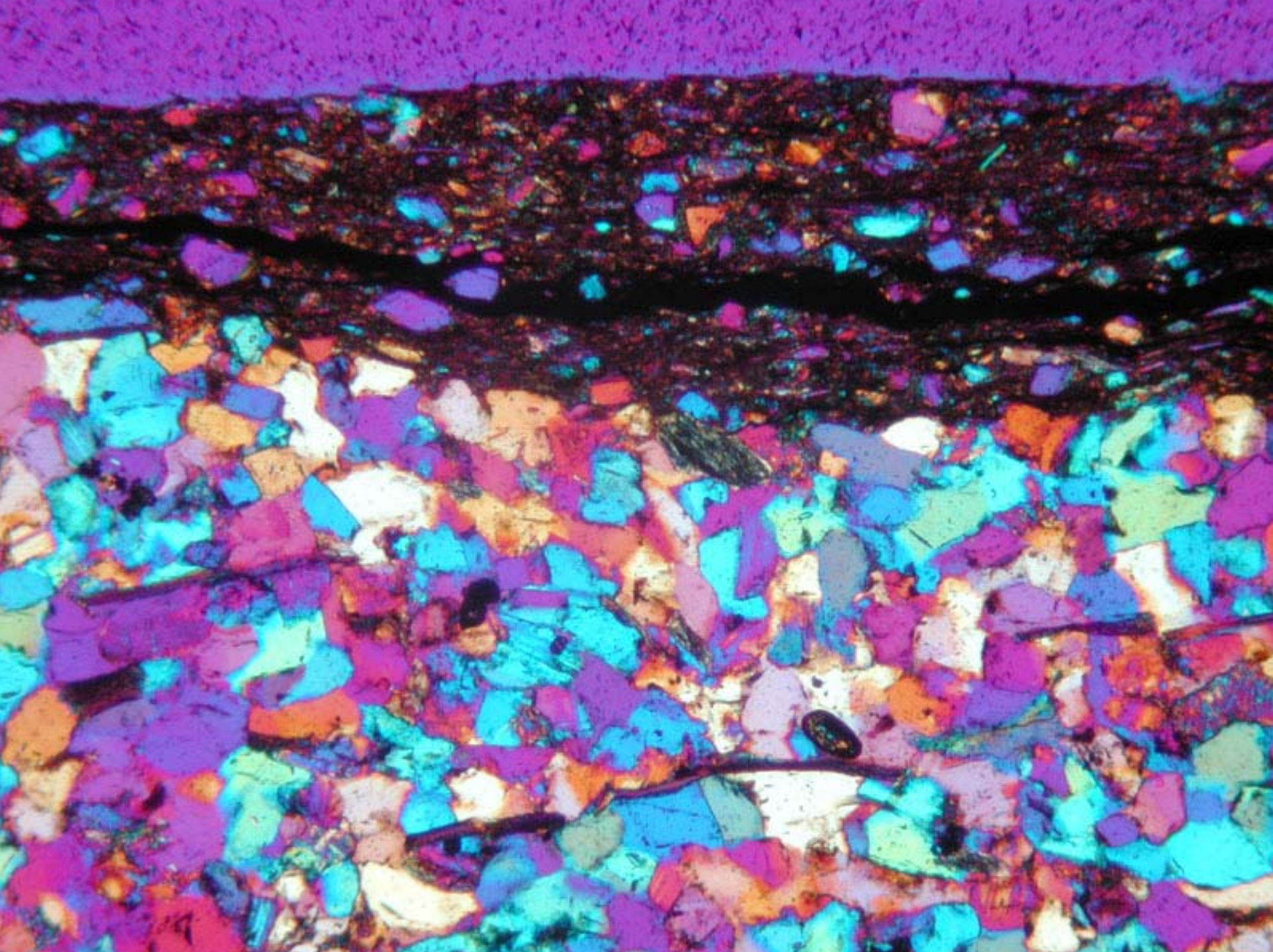
Cambrian period, 543 million to 510 million years ago

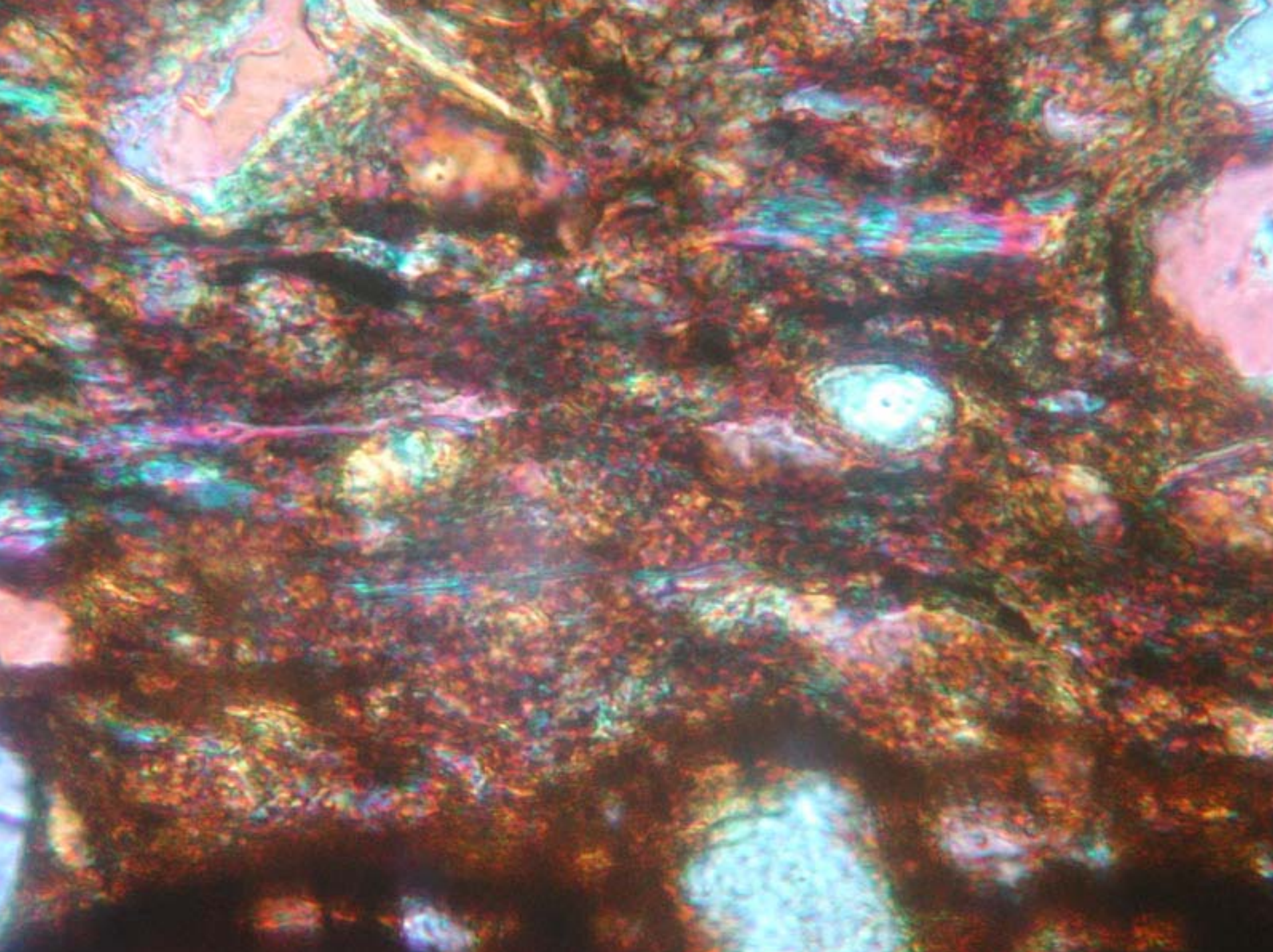
TIME Diagram by Joe Lertola

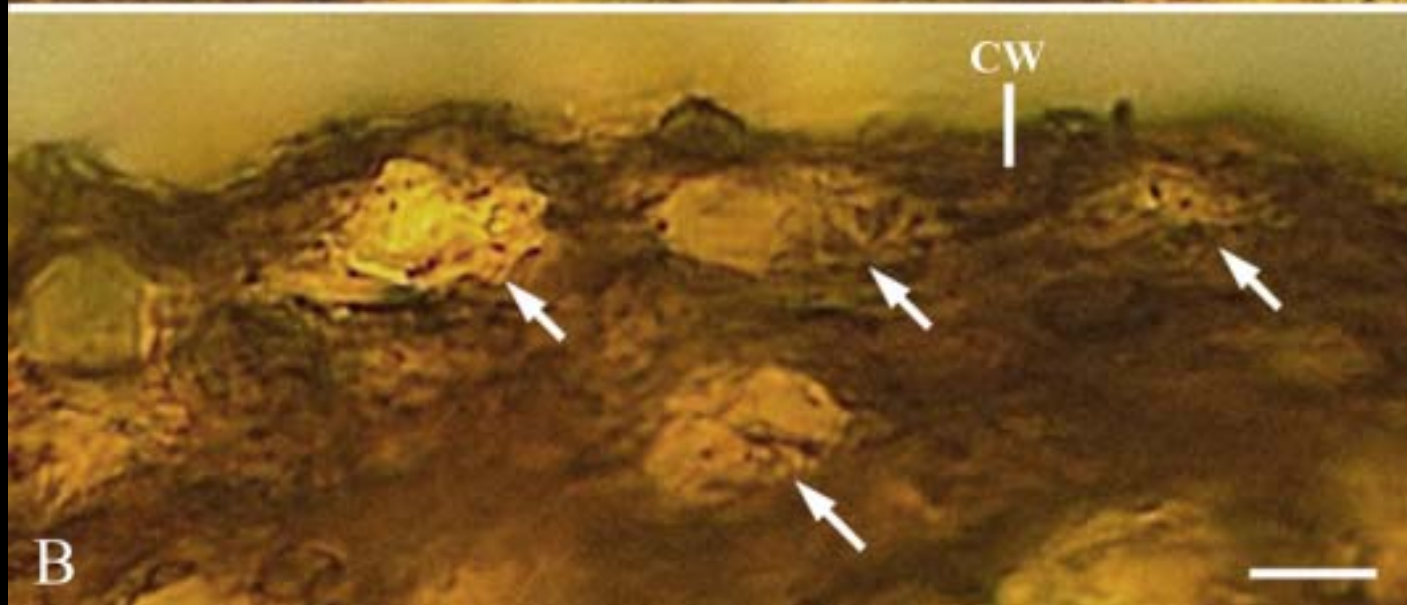
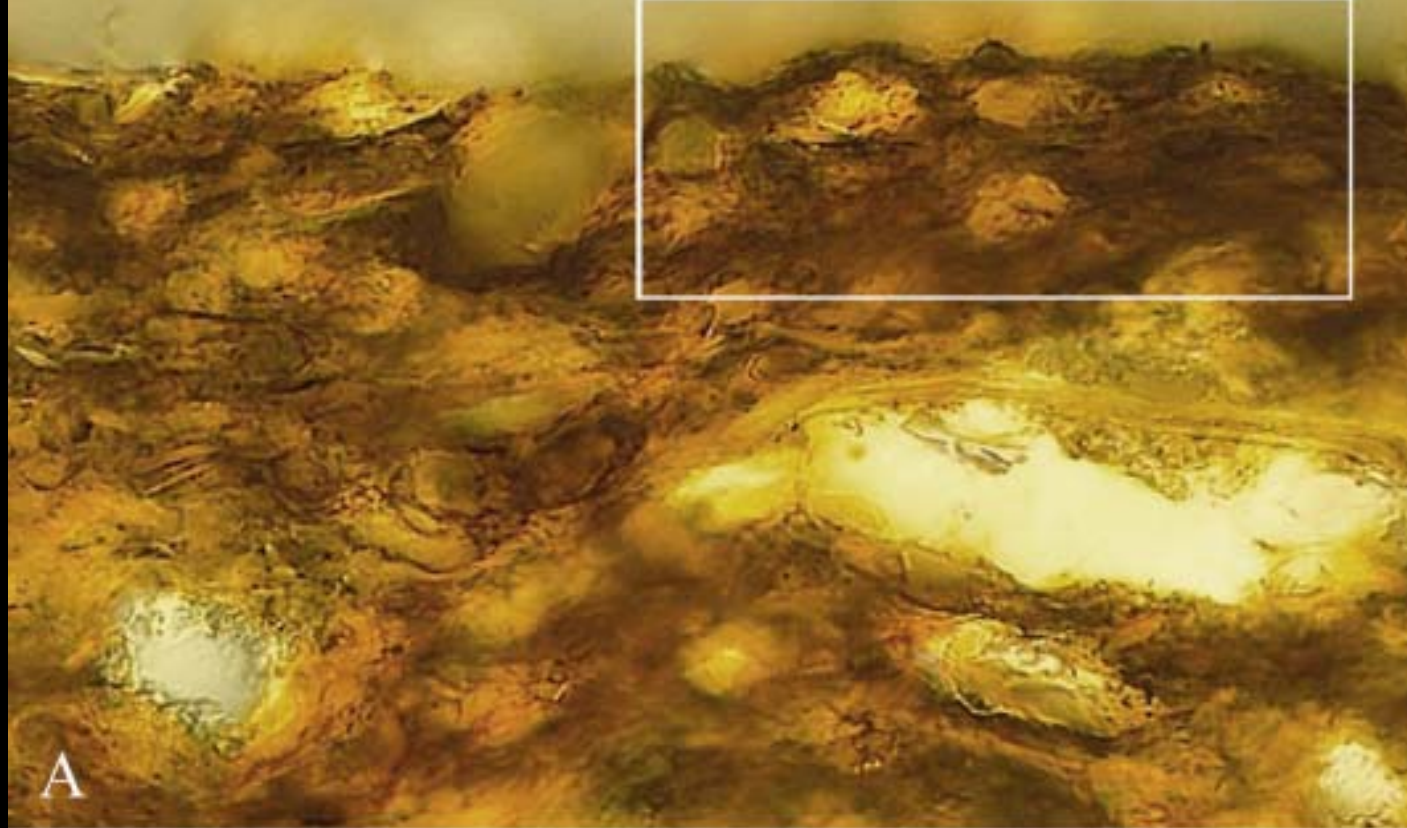


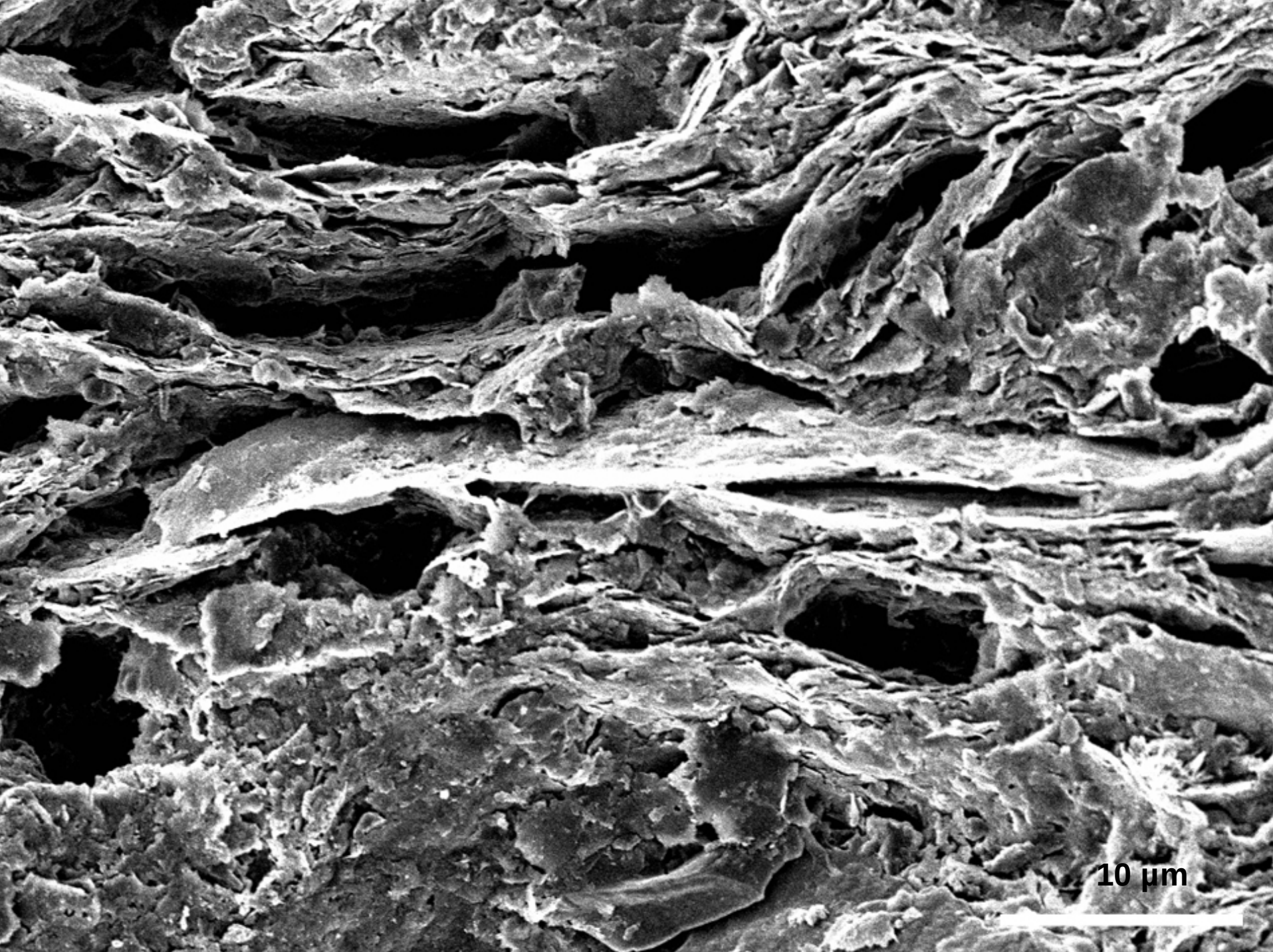




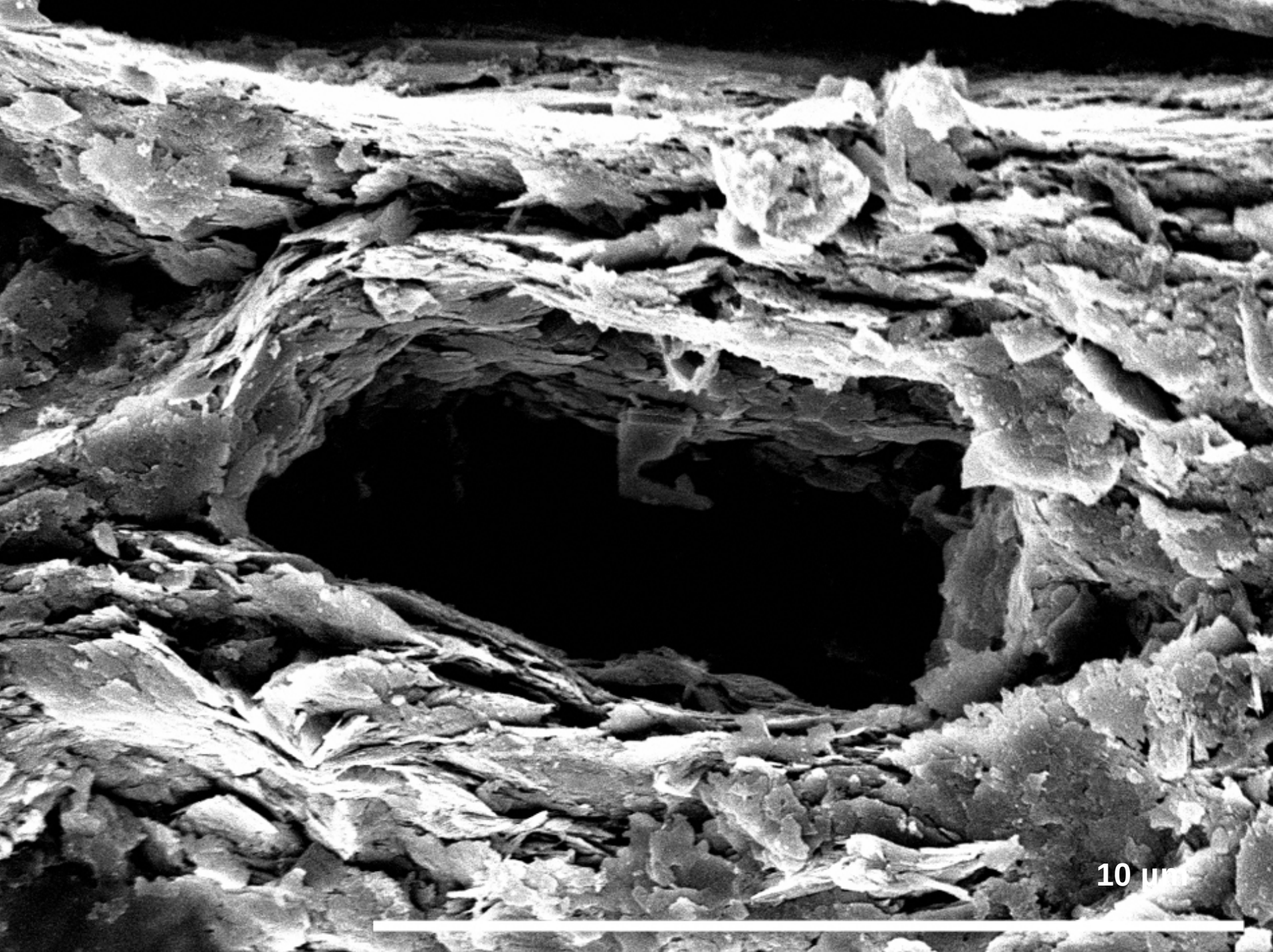




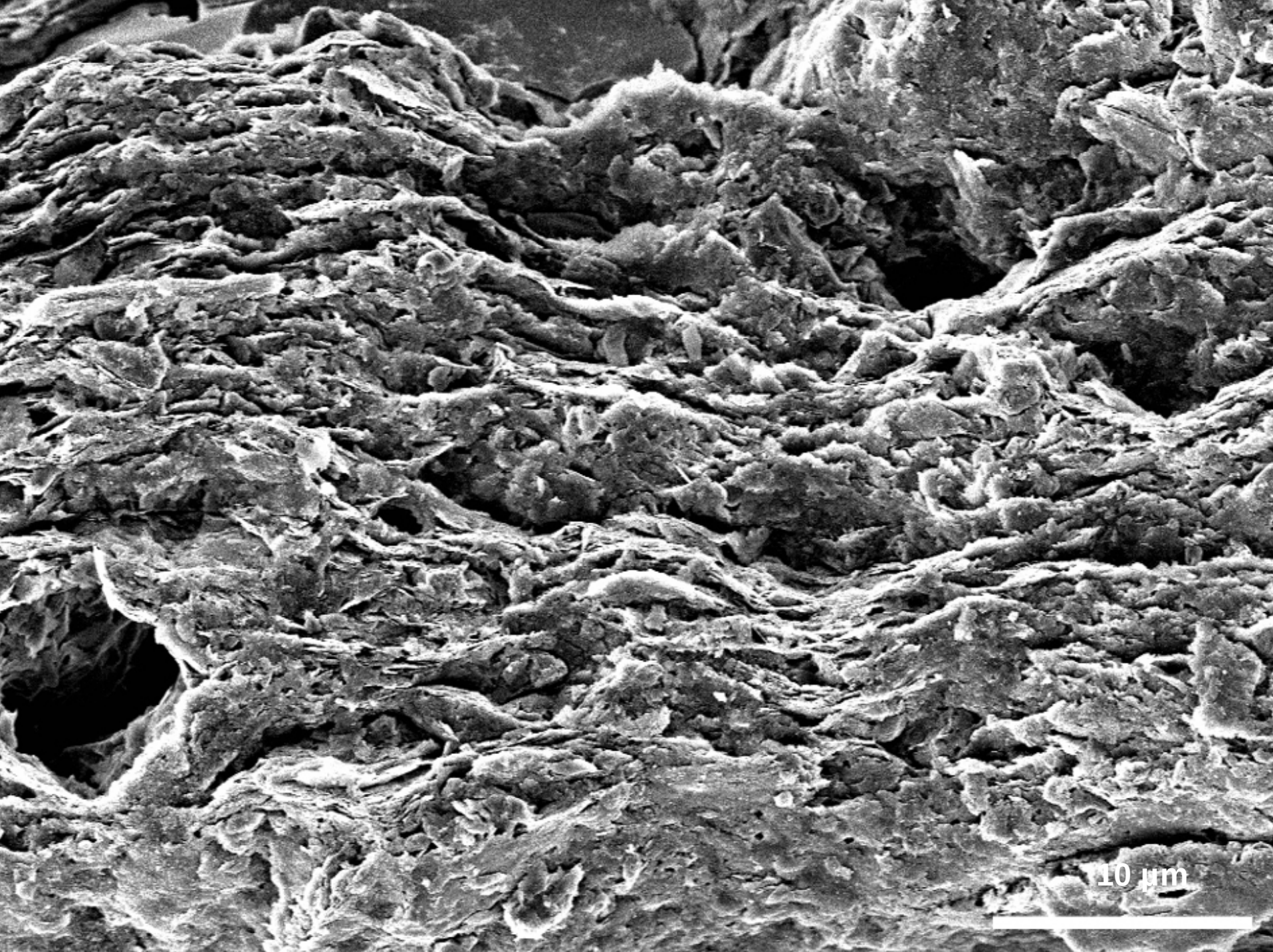




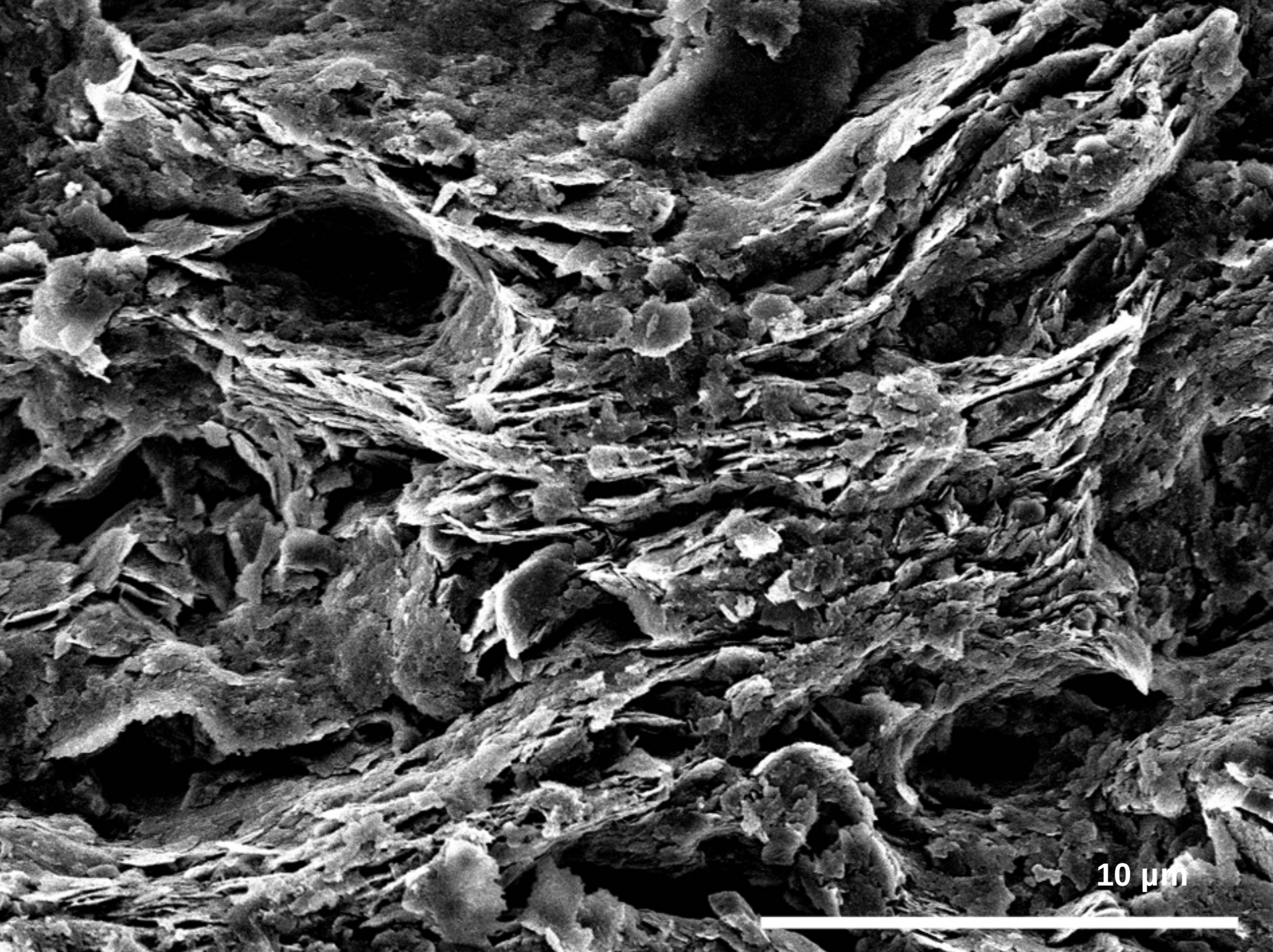
10 μm



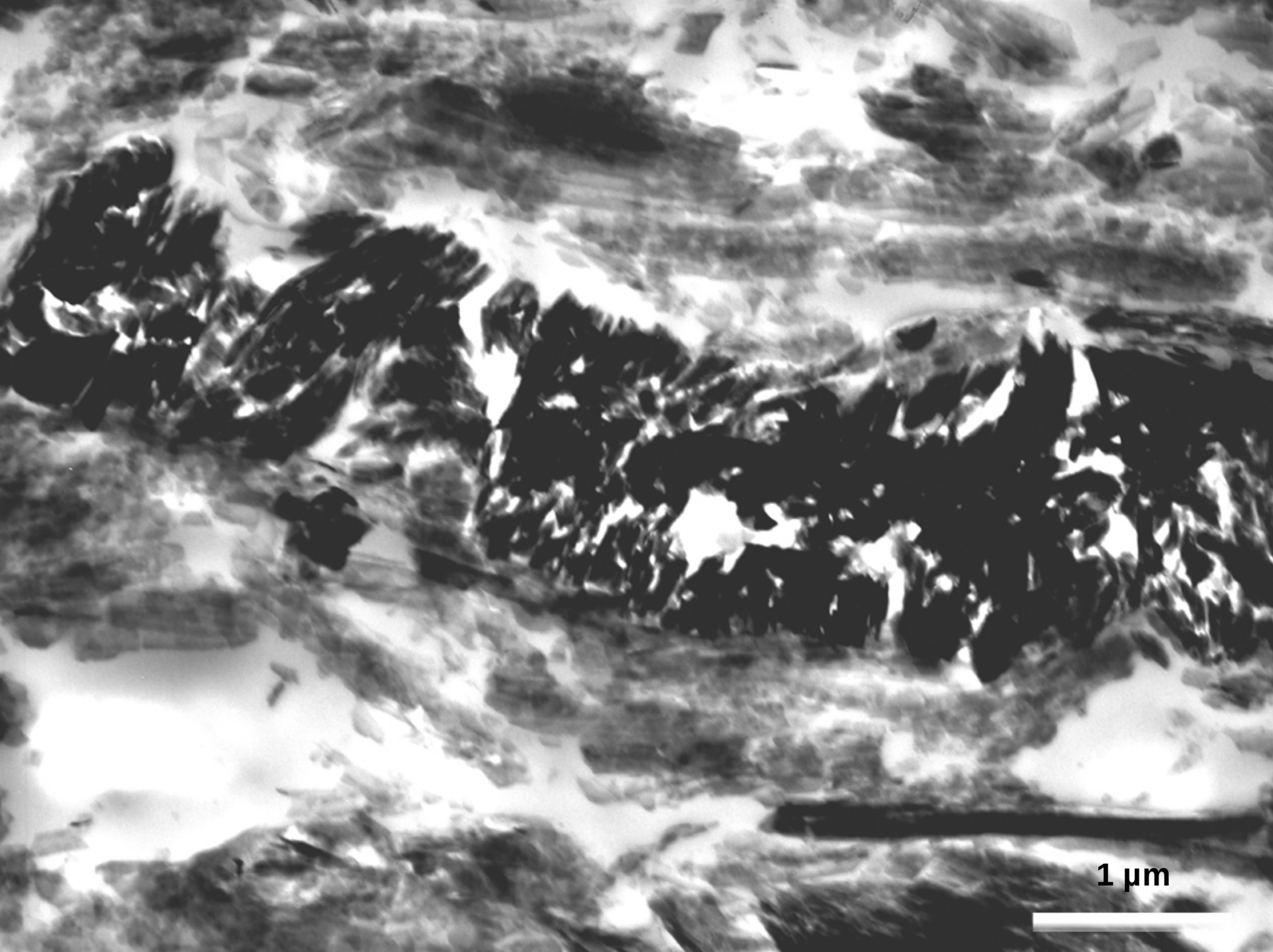
10 μm



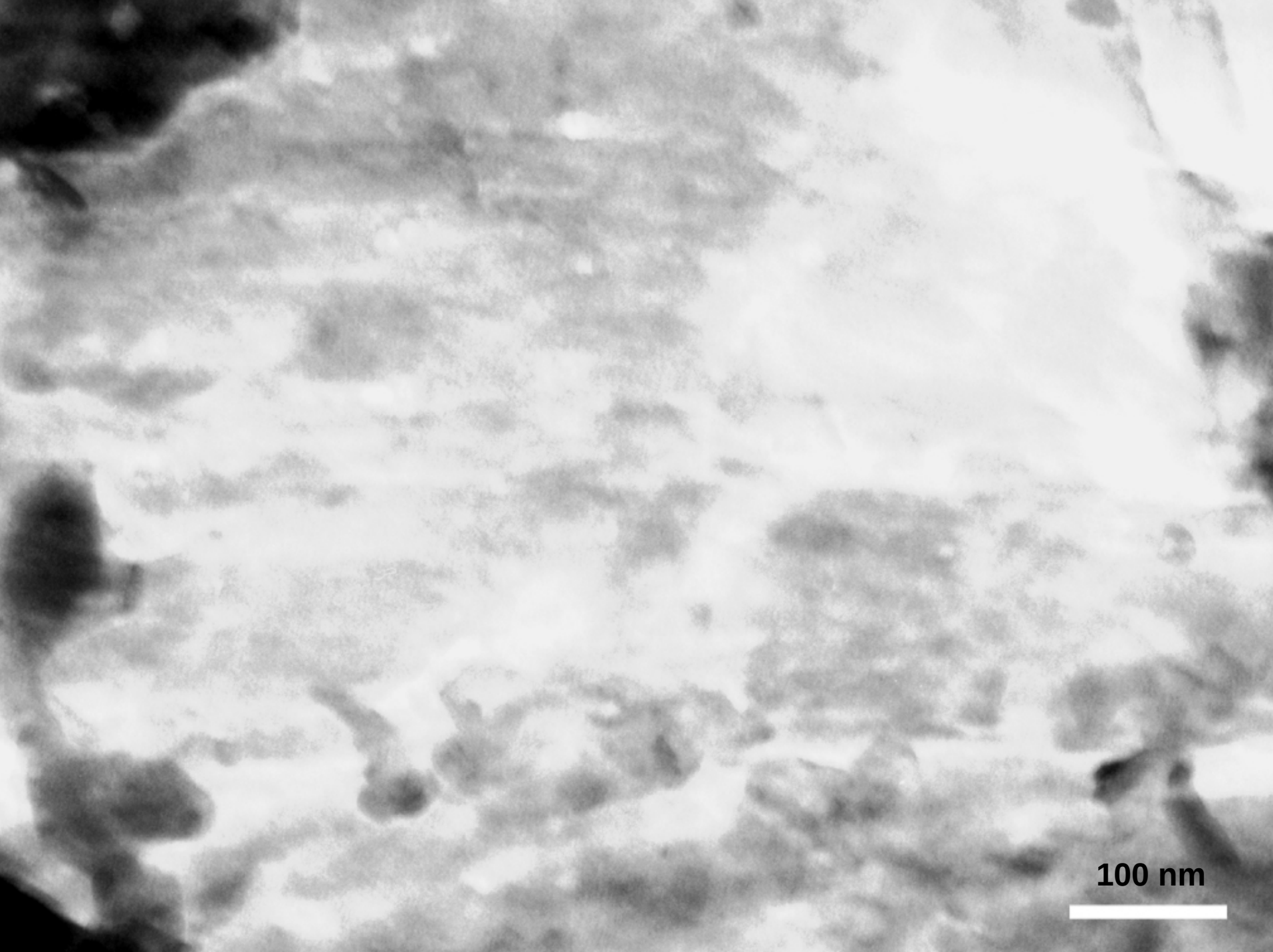
10 μm



10 μm



1 μm

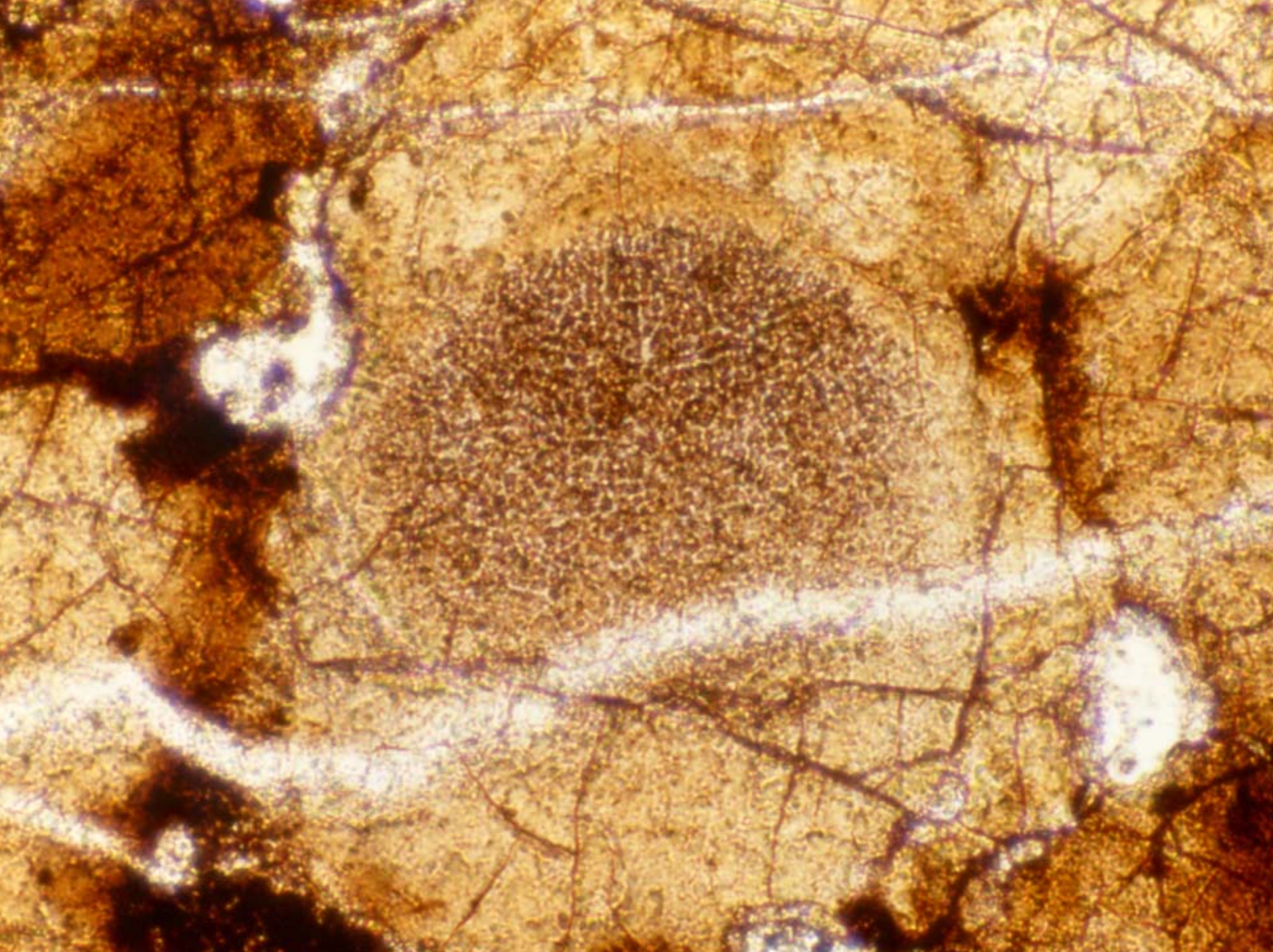


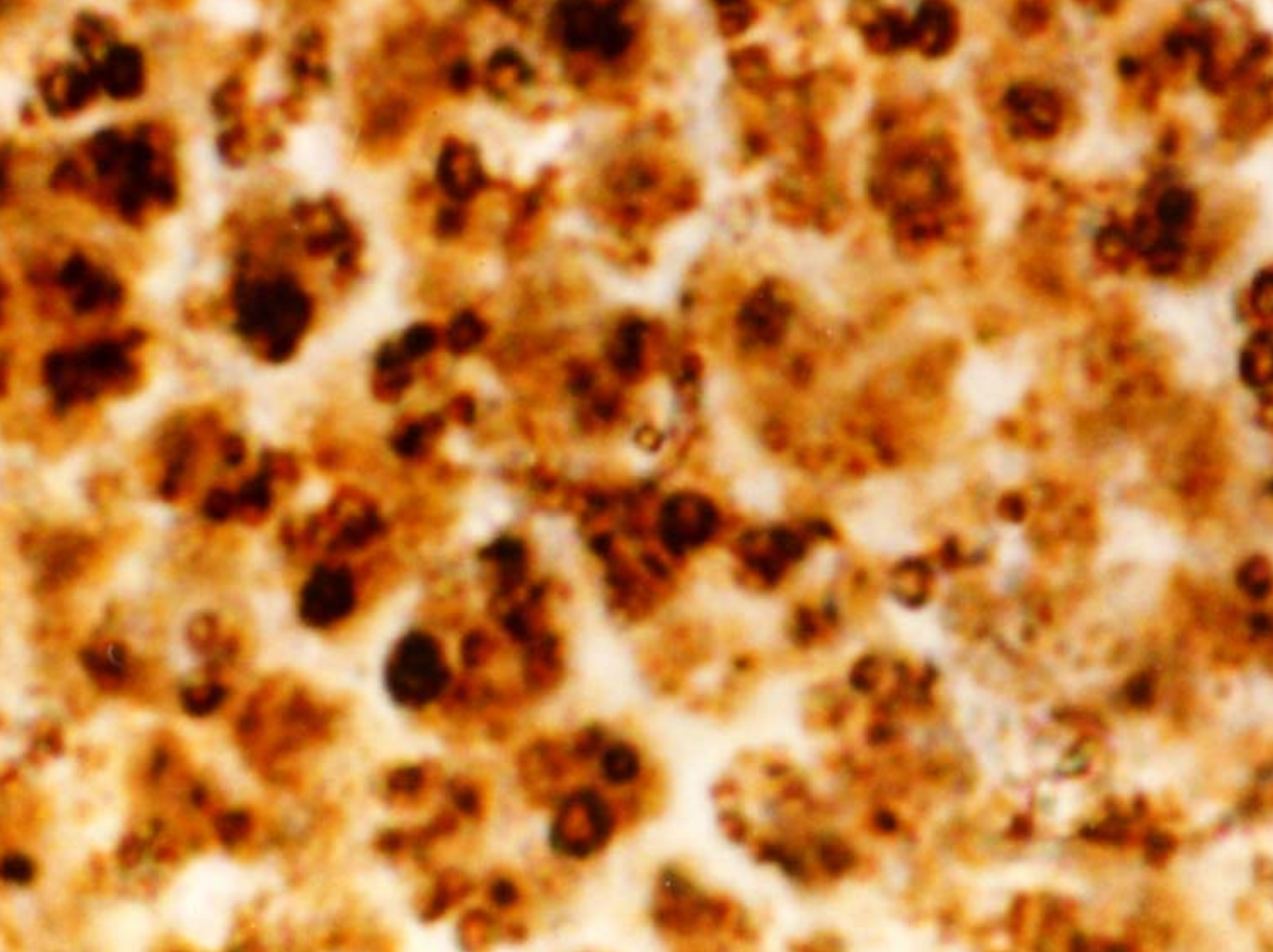
100 nm

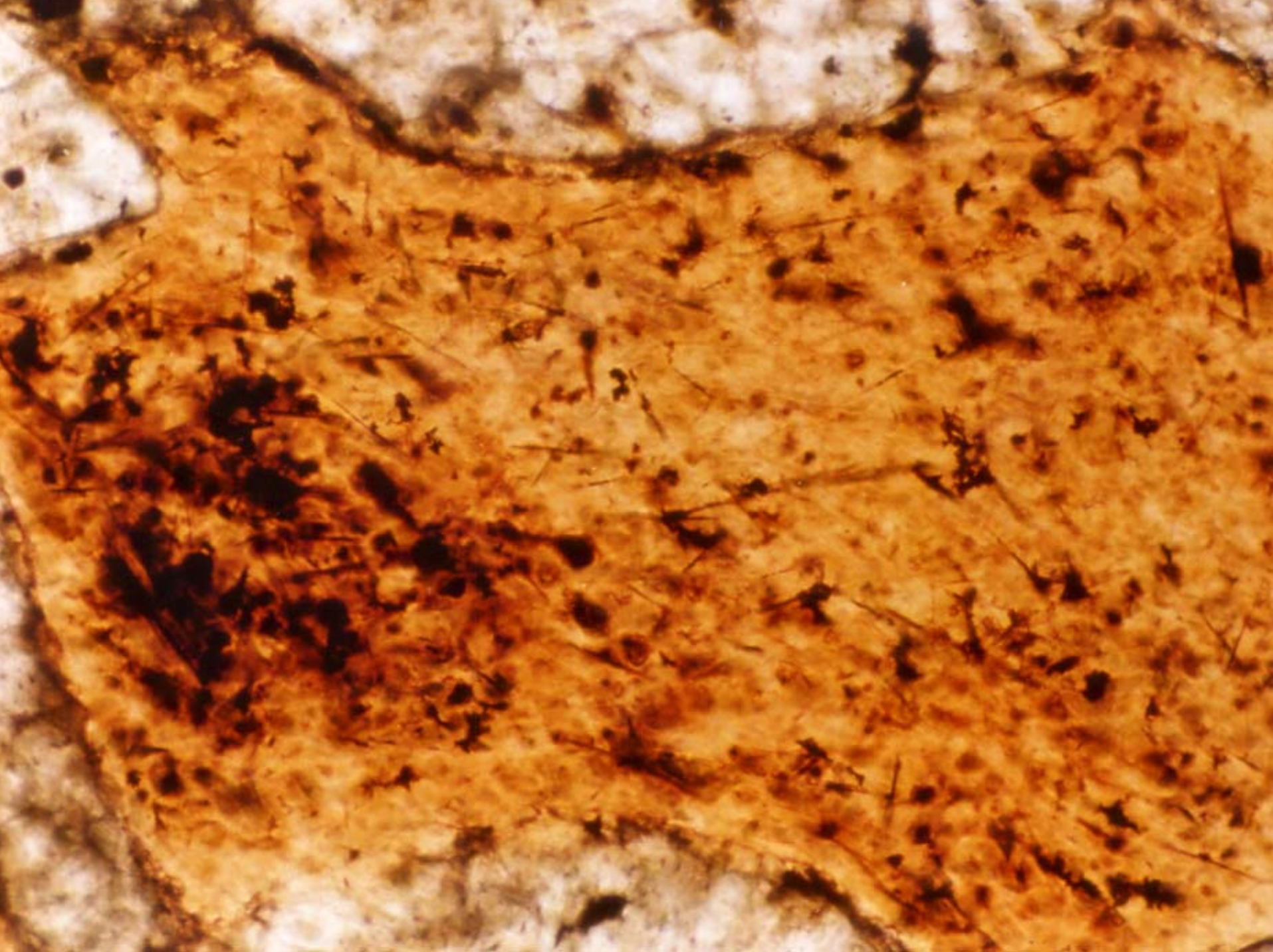


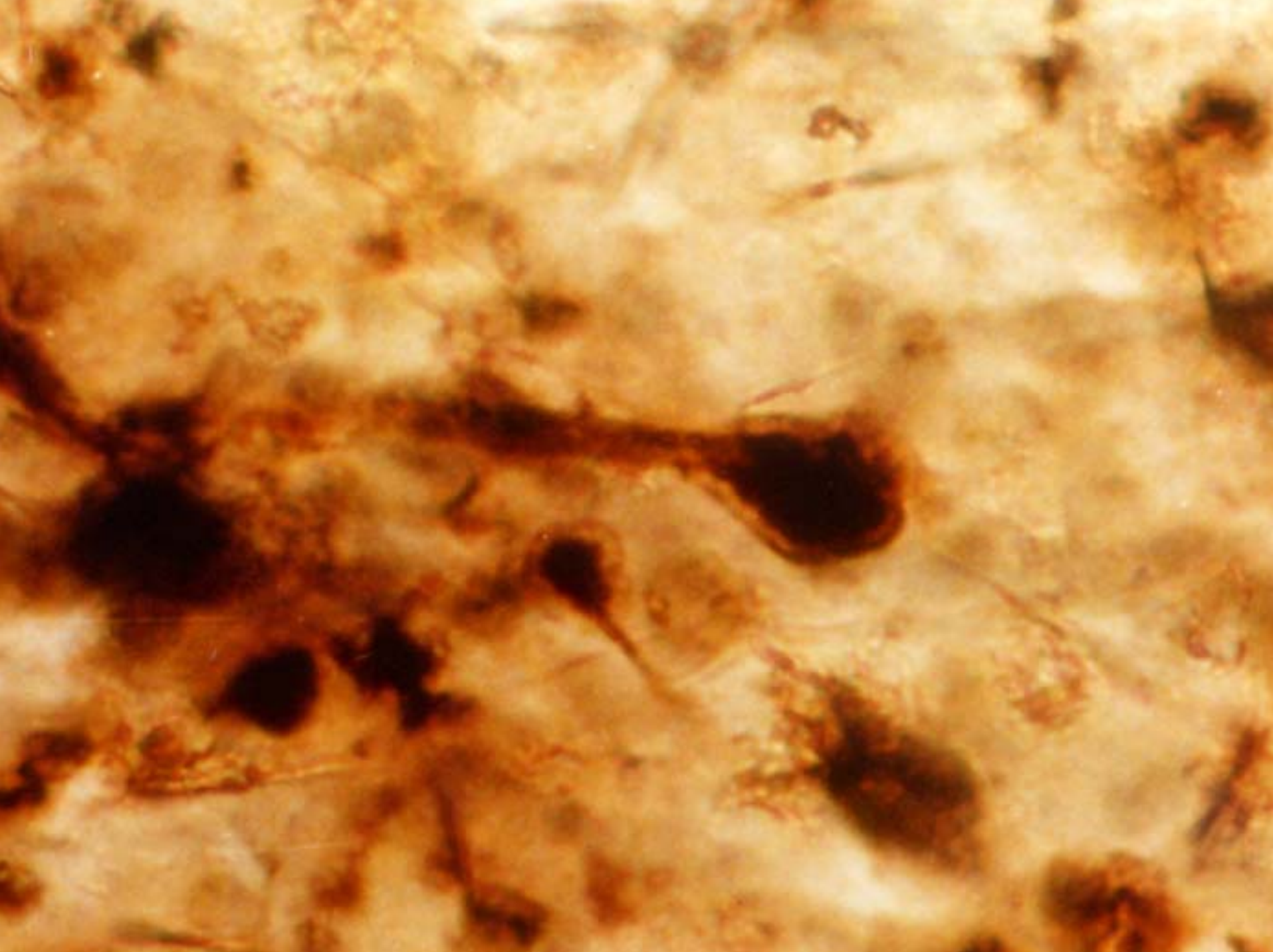














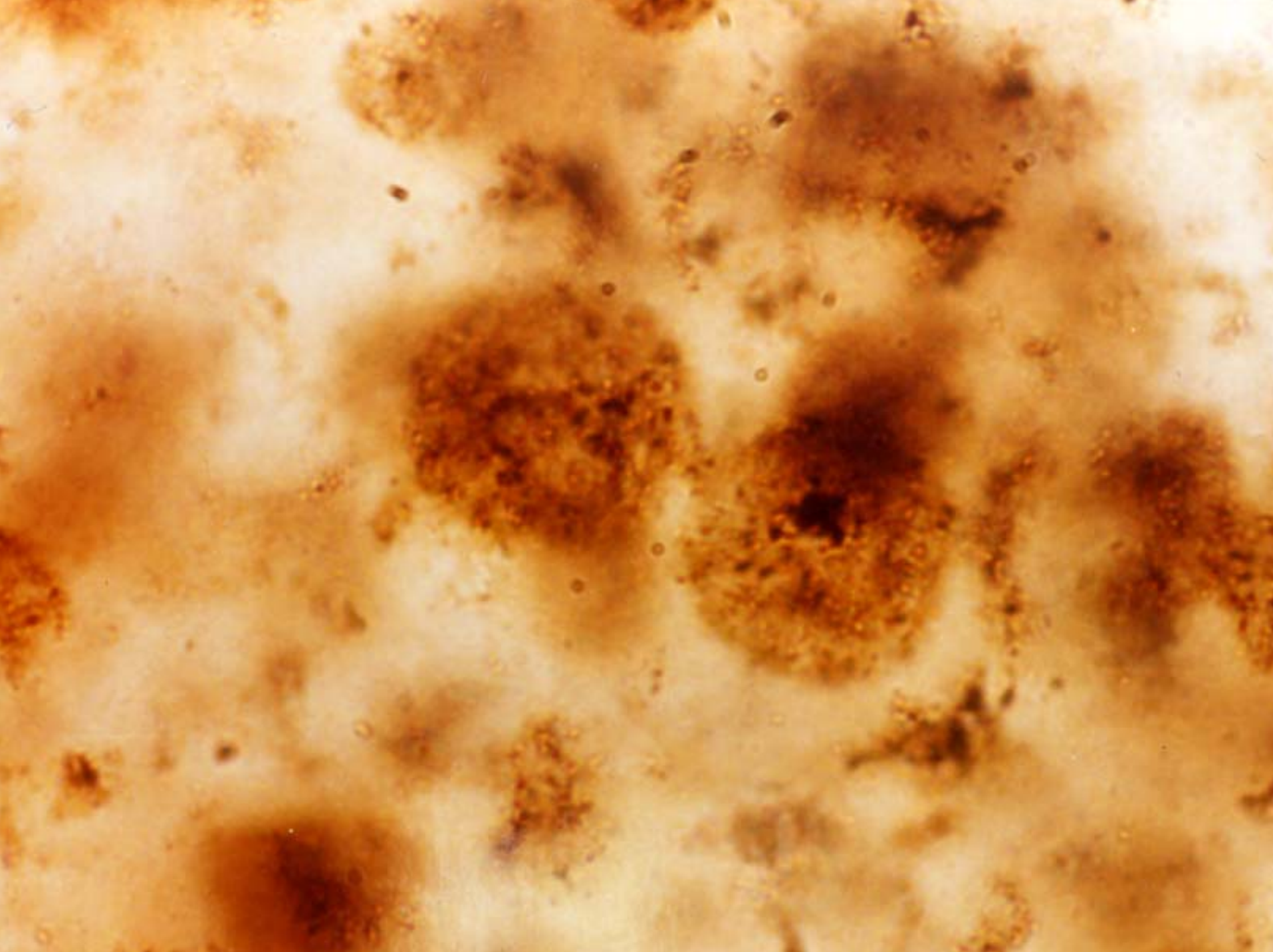




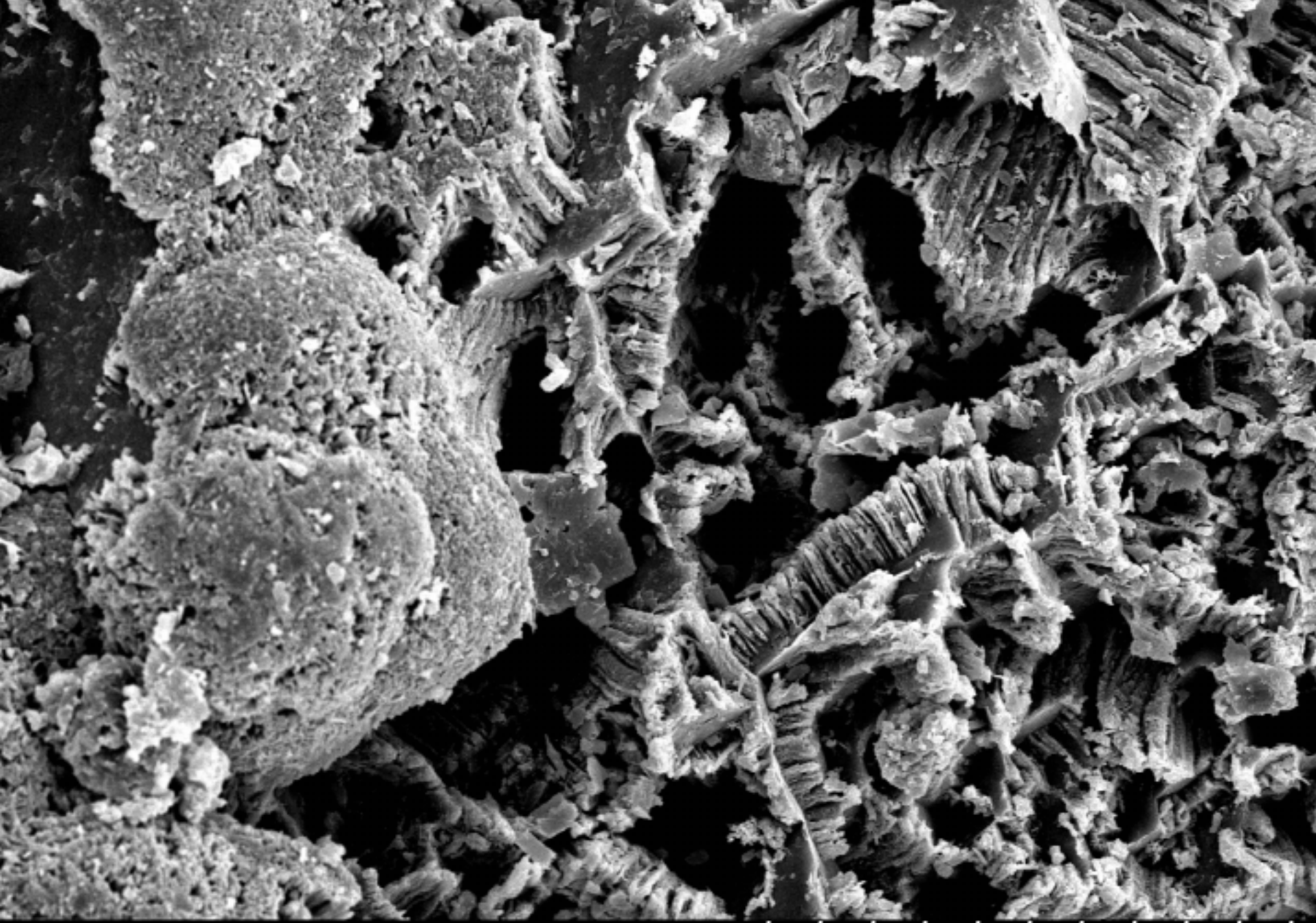
wsb60-102 10.0kV x130

400um



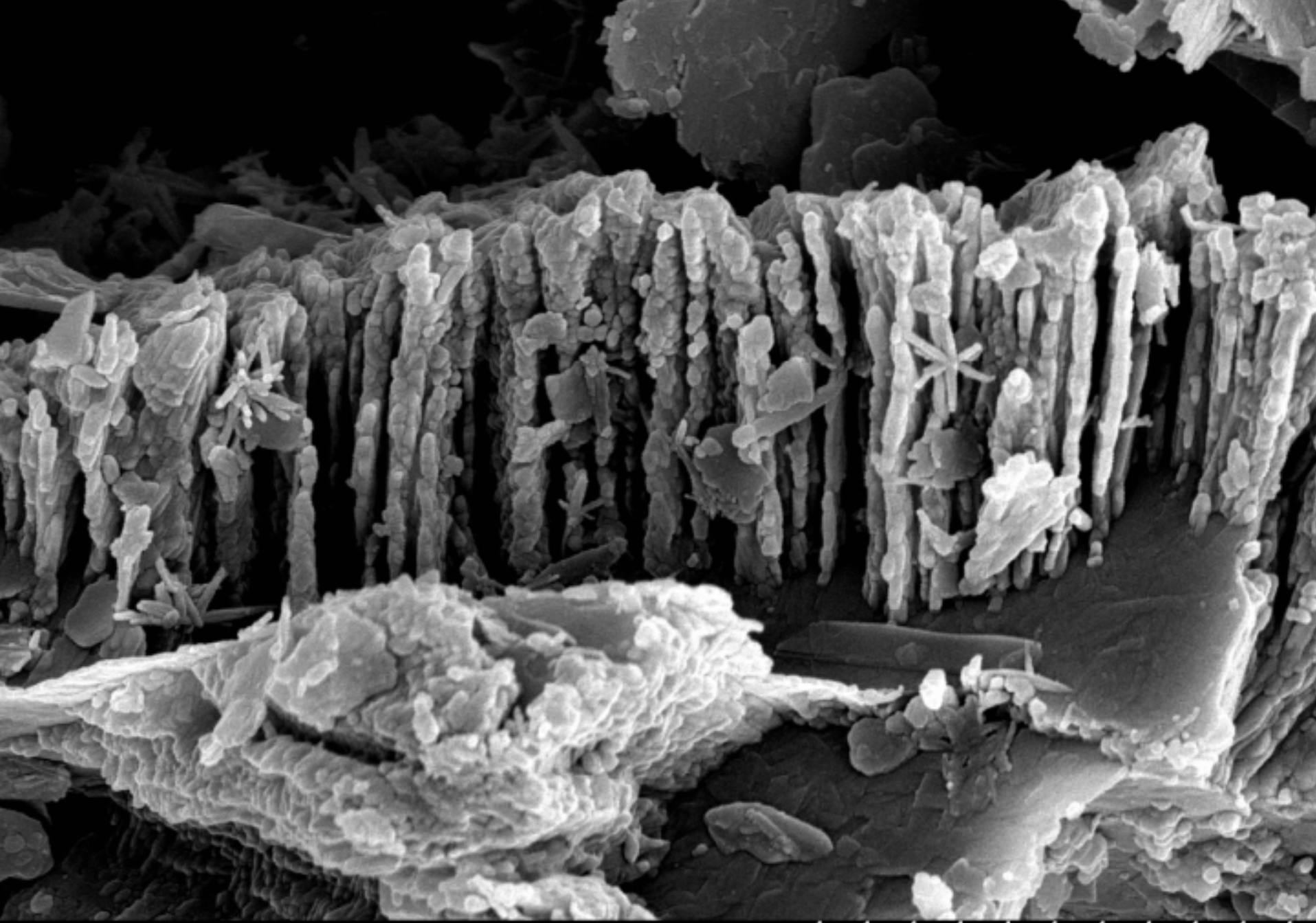






wsb60-31 10.0kV x2.50k

20.0um



wsb60-34 10.0kV x15.0k

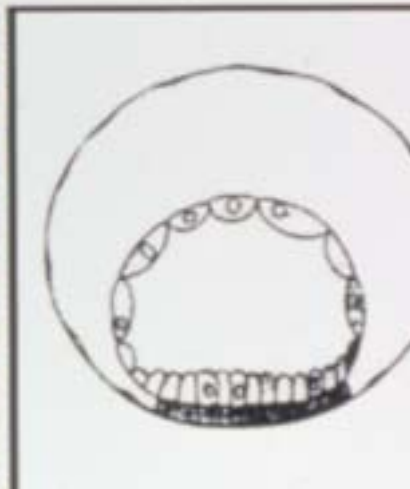
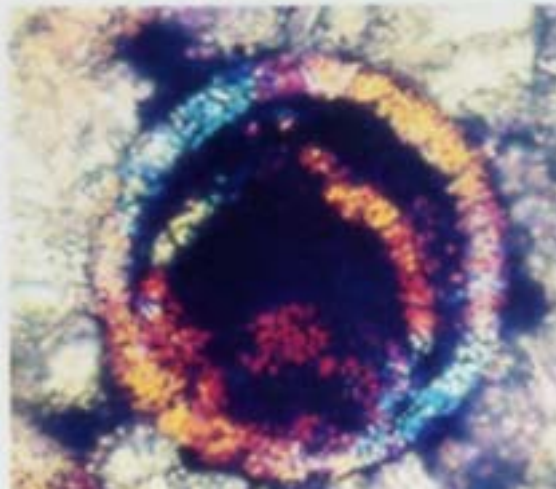
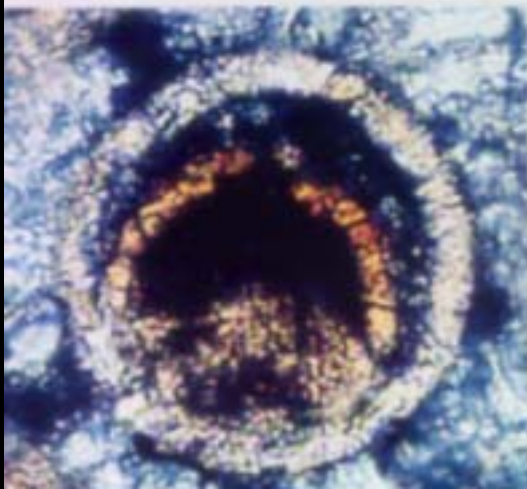
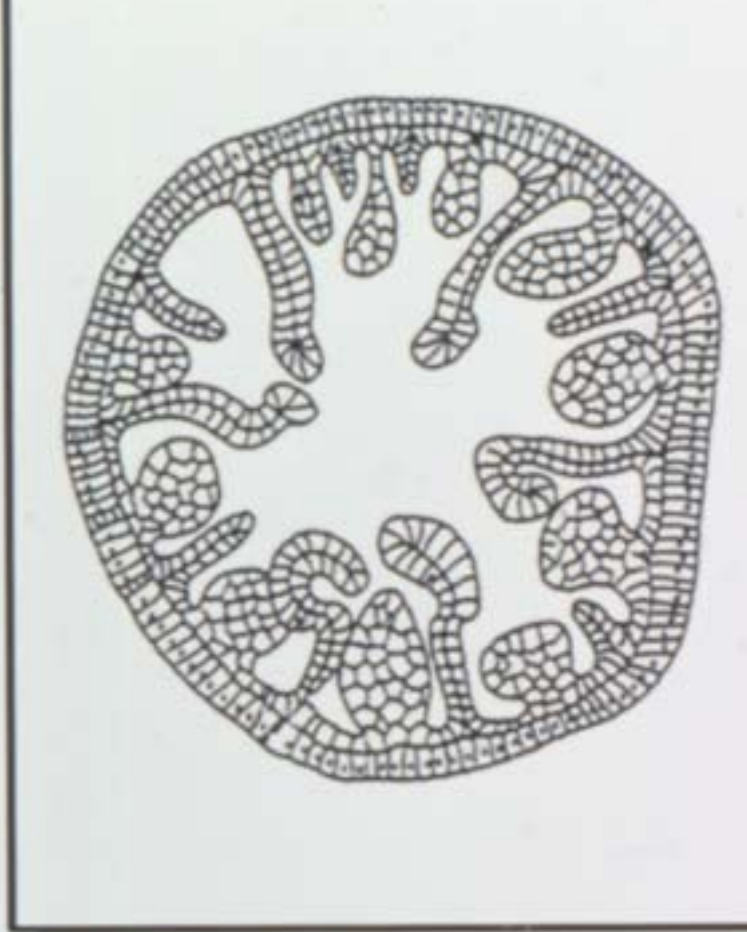
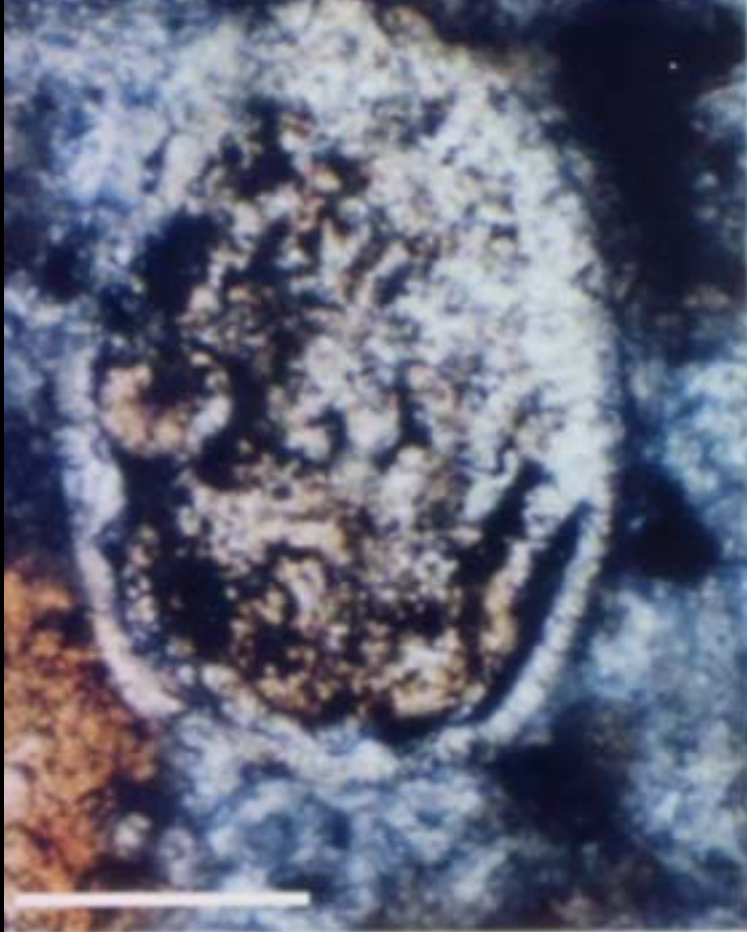
3.00um











23



26



29



32

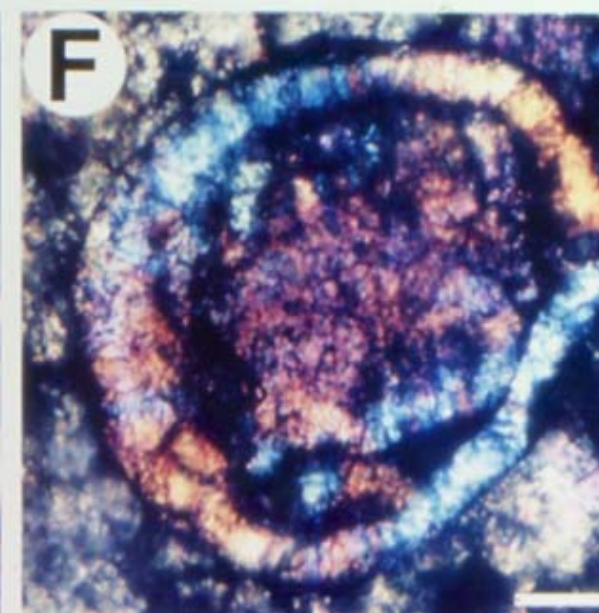
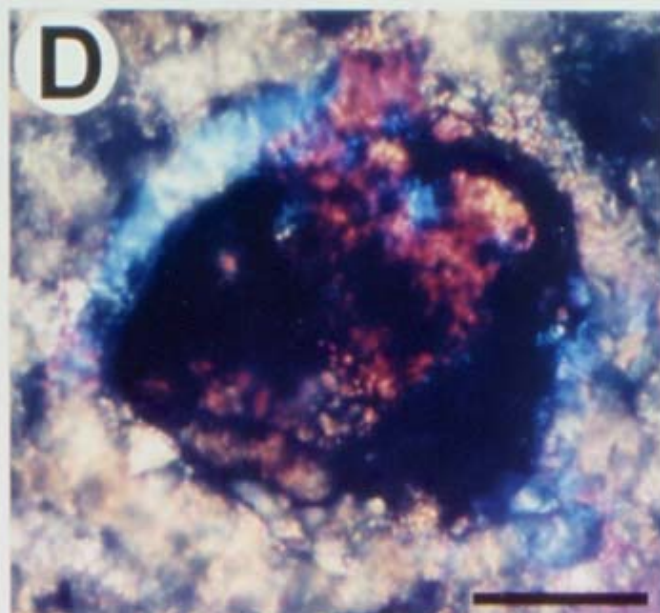
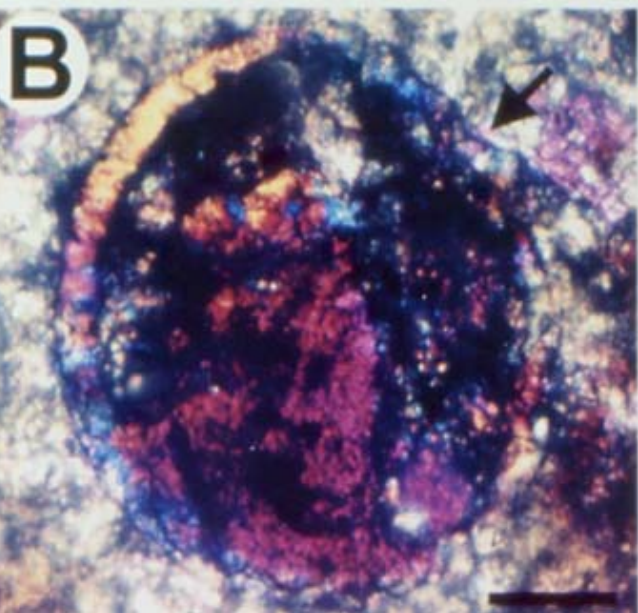
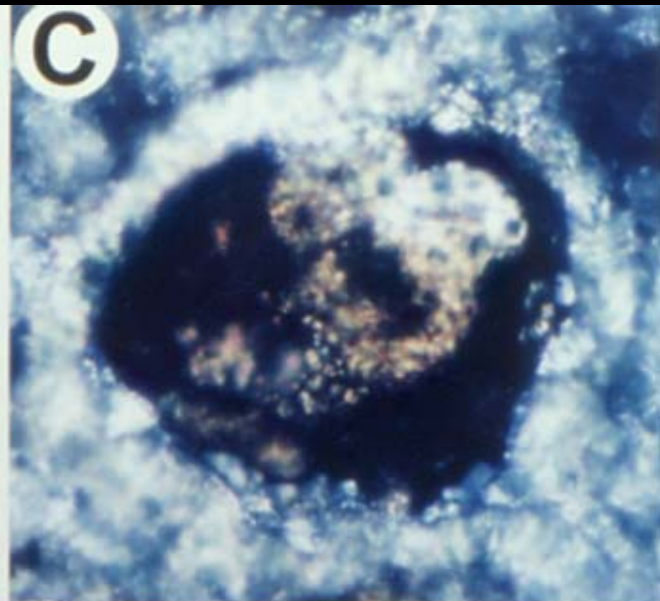
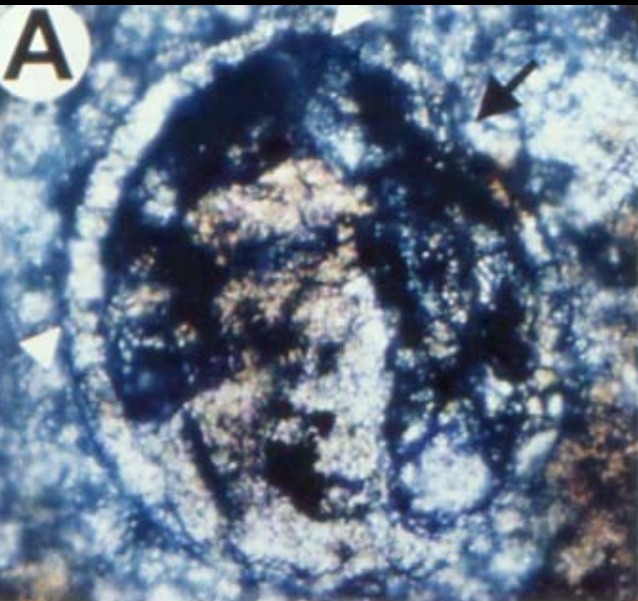


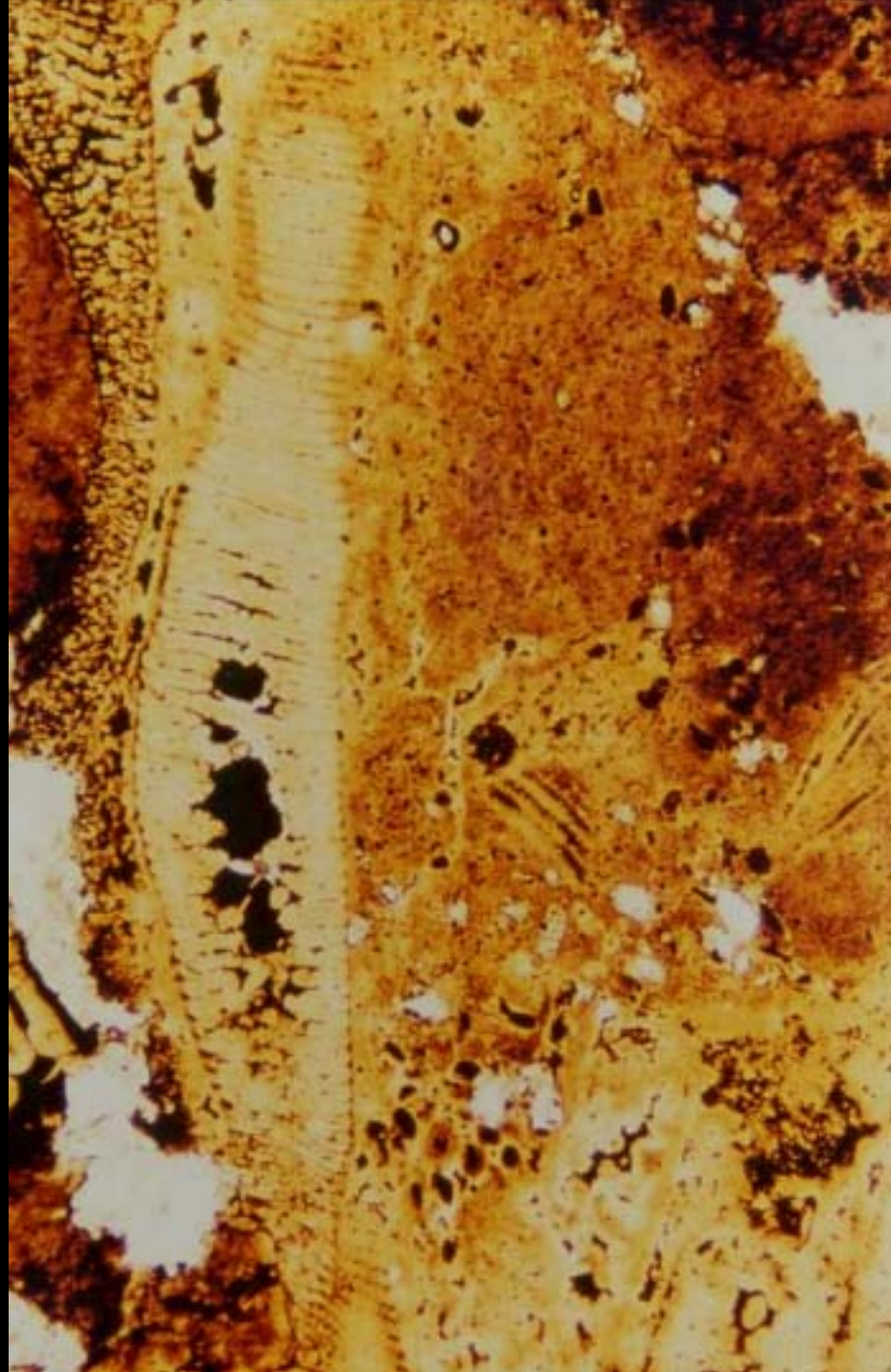
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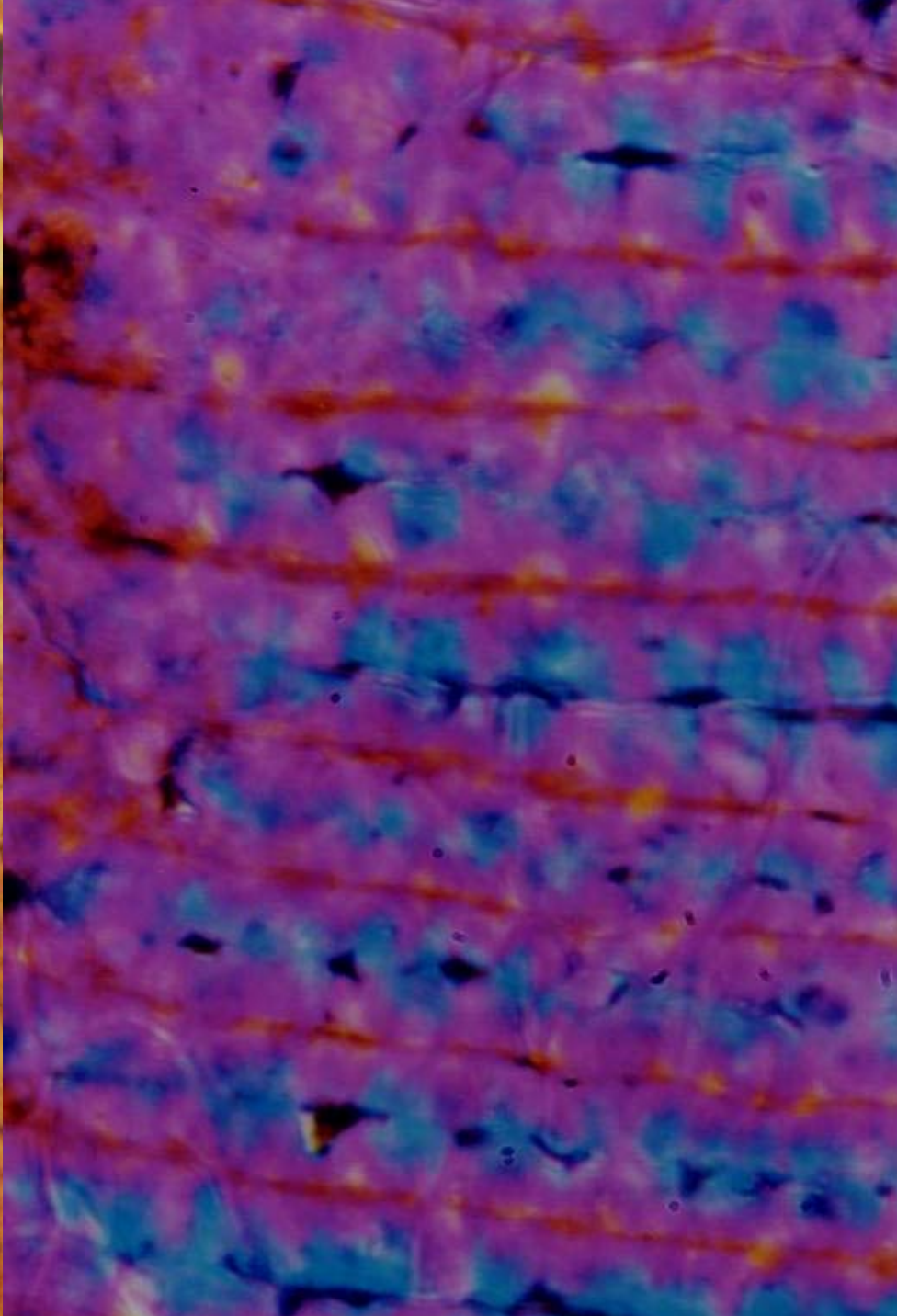
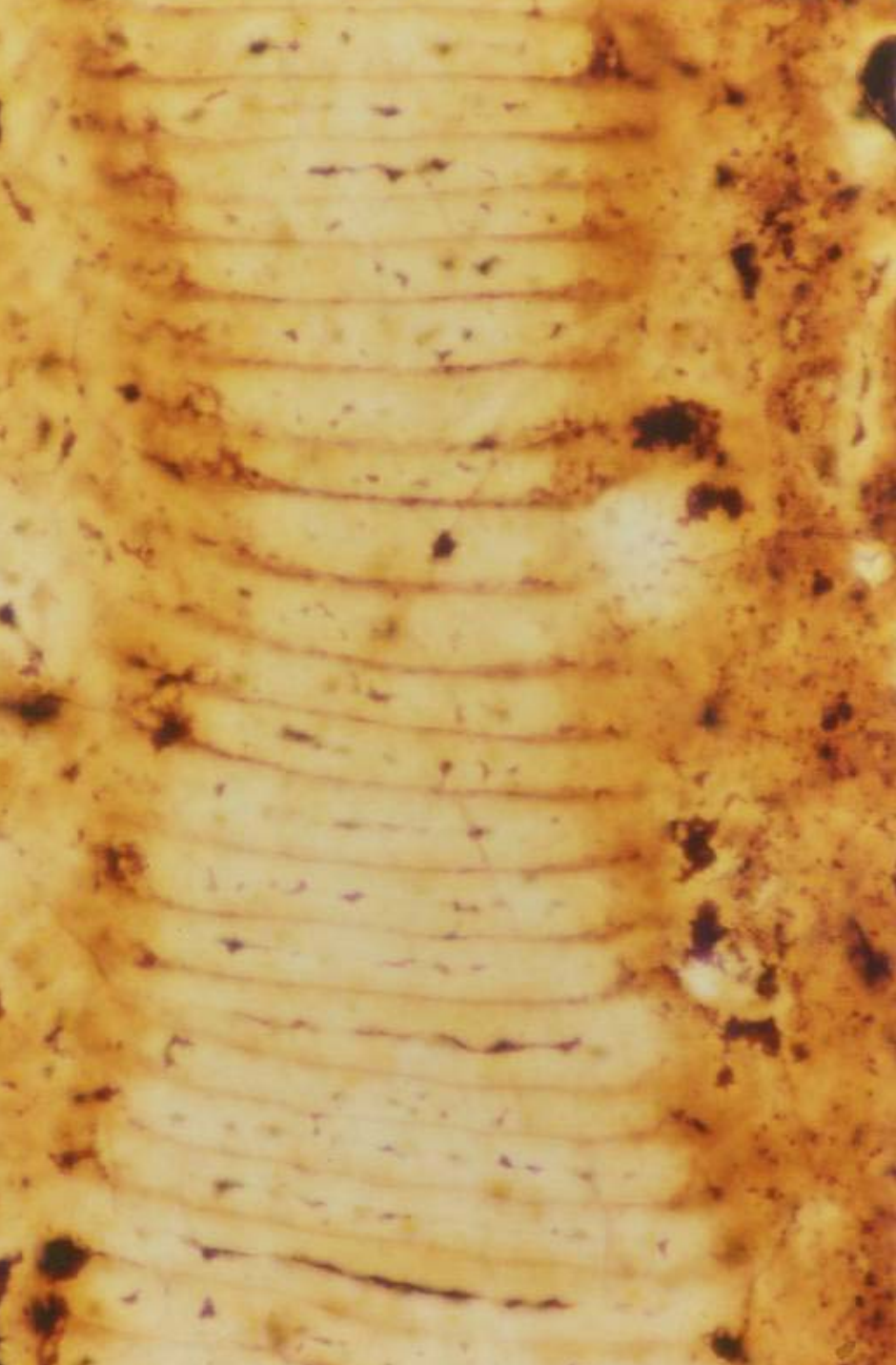


38

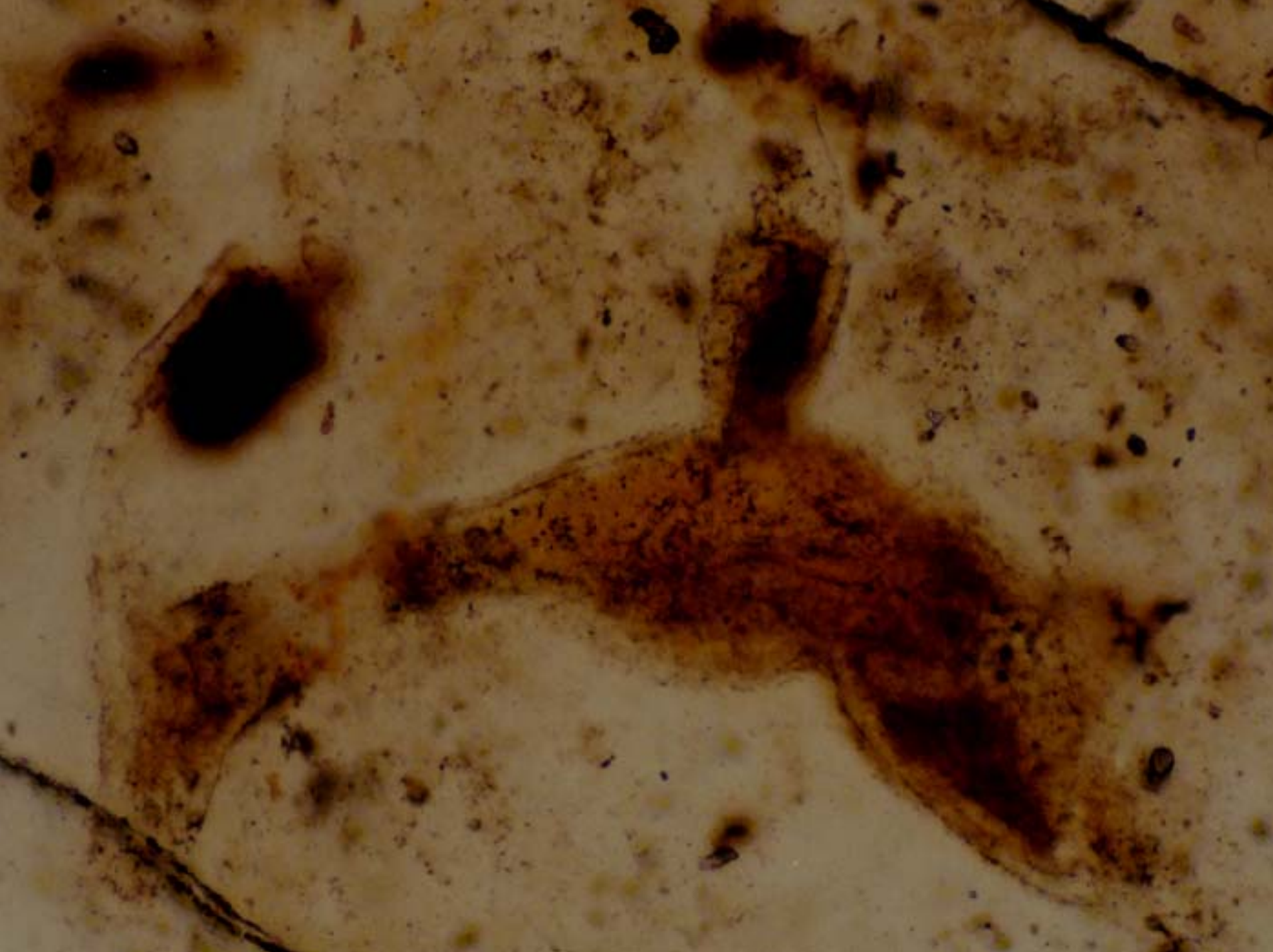


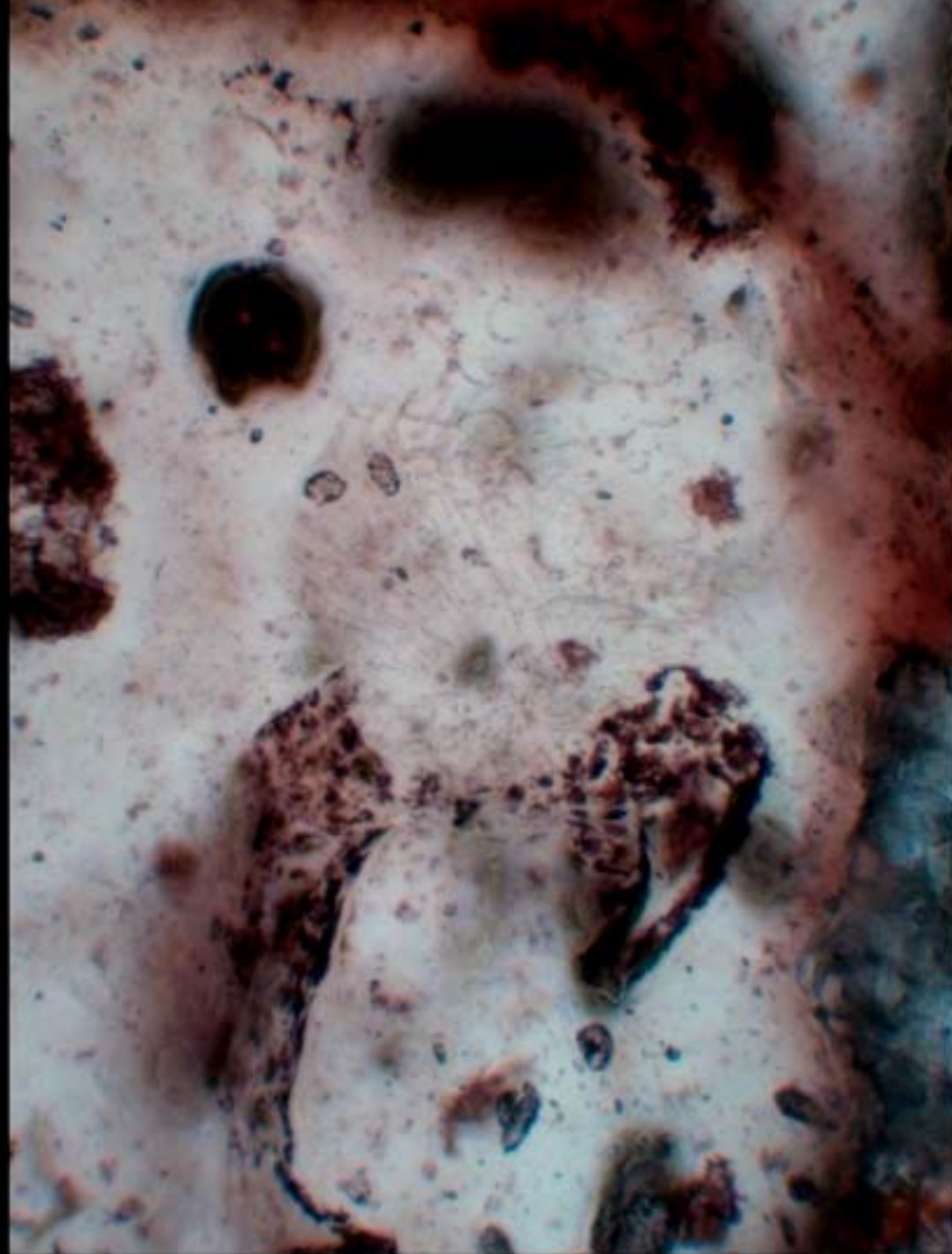




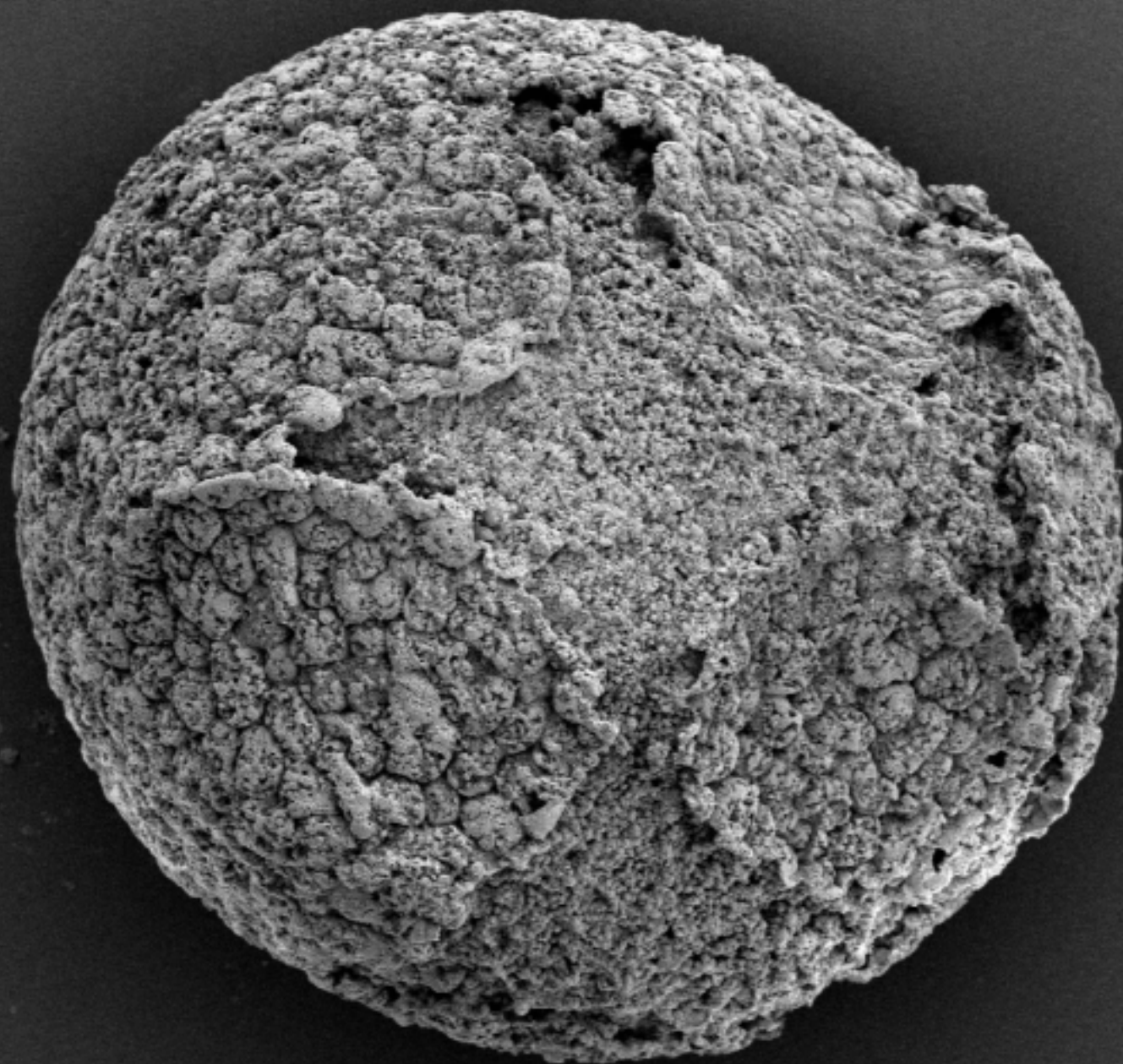






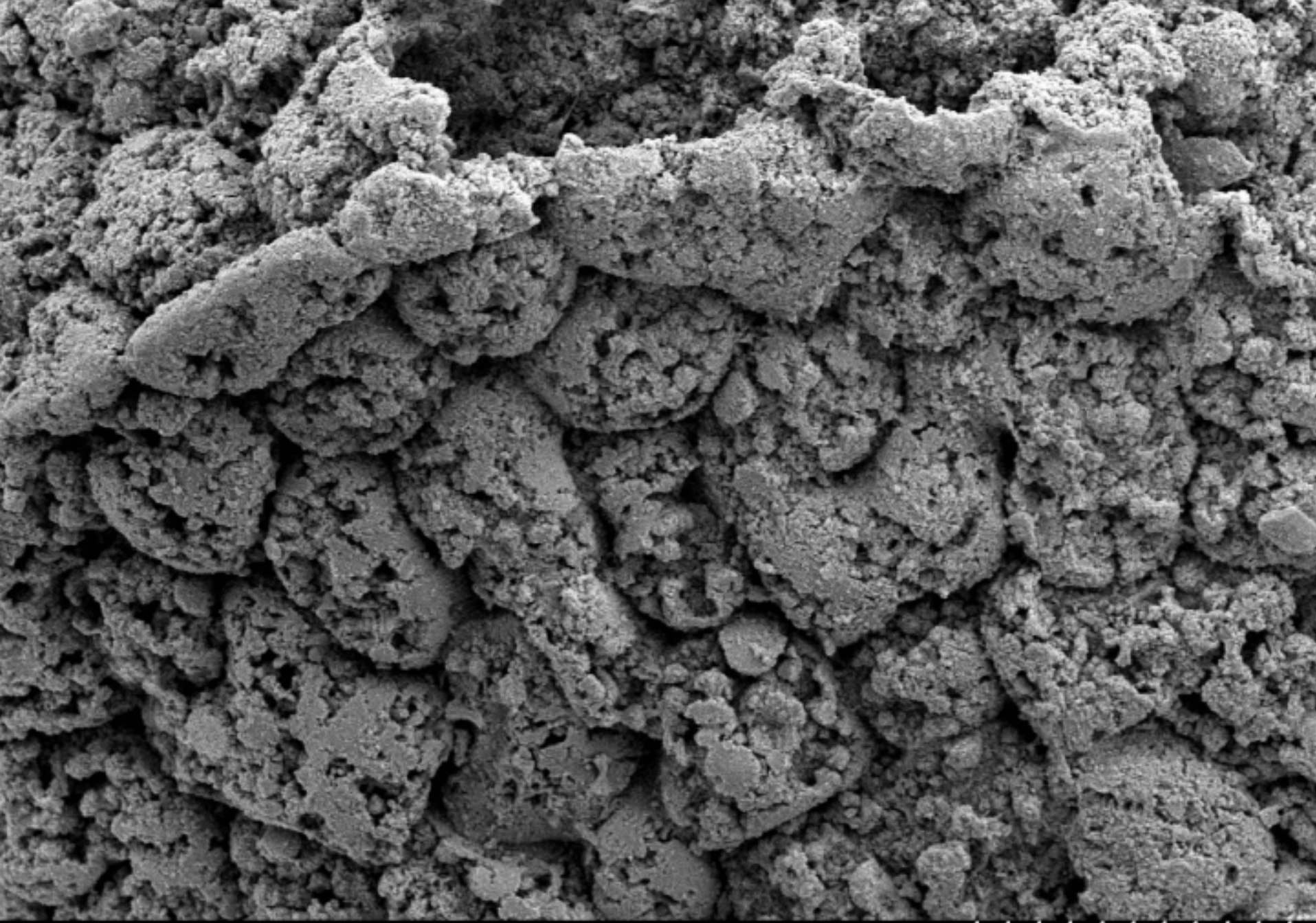






wsb-11 10.0kV x130

400um

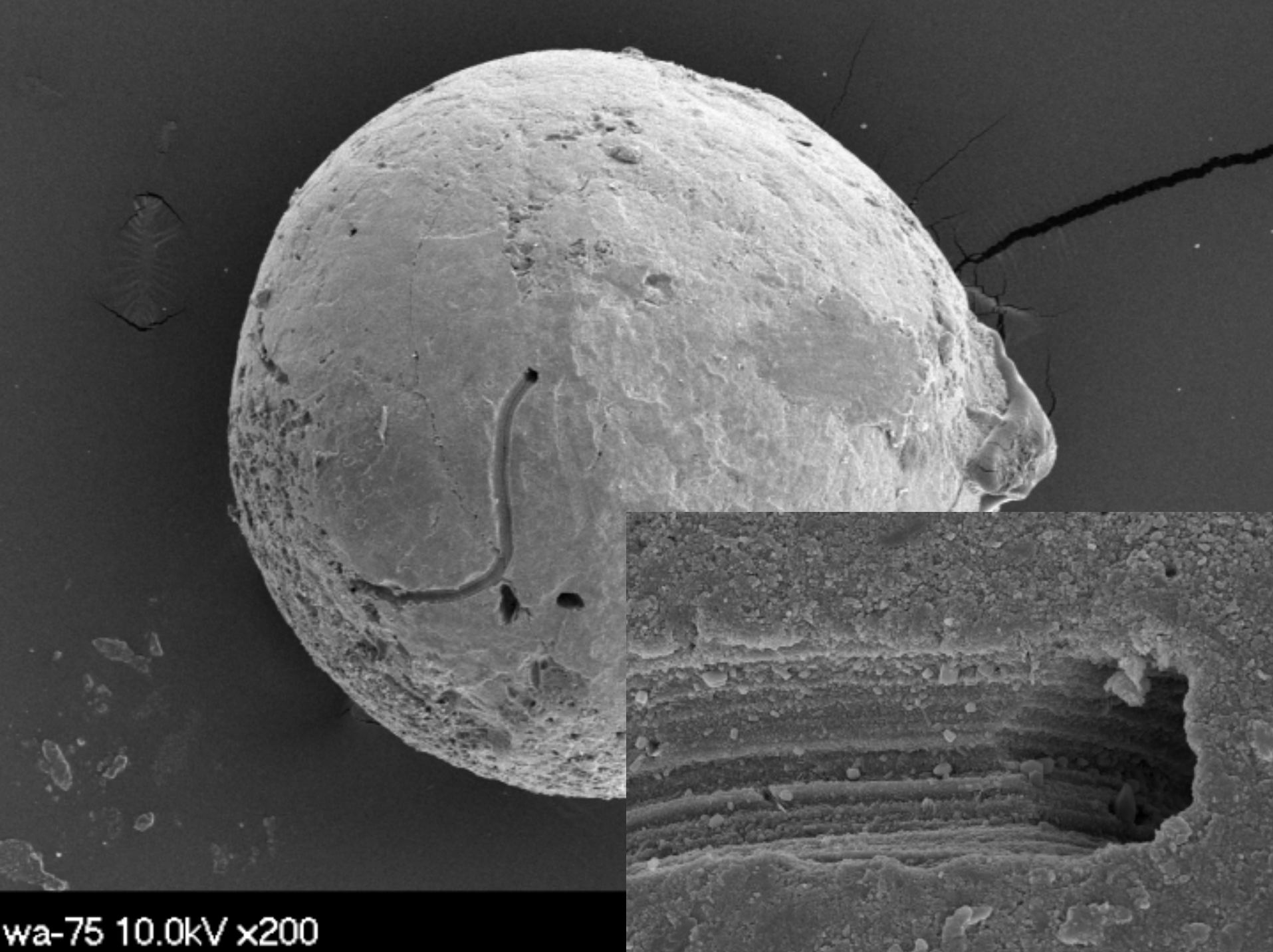


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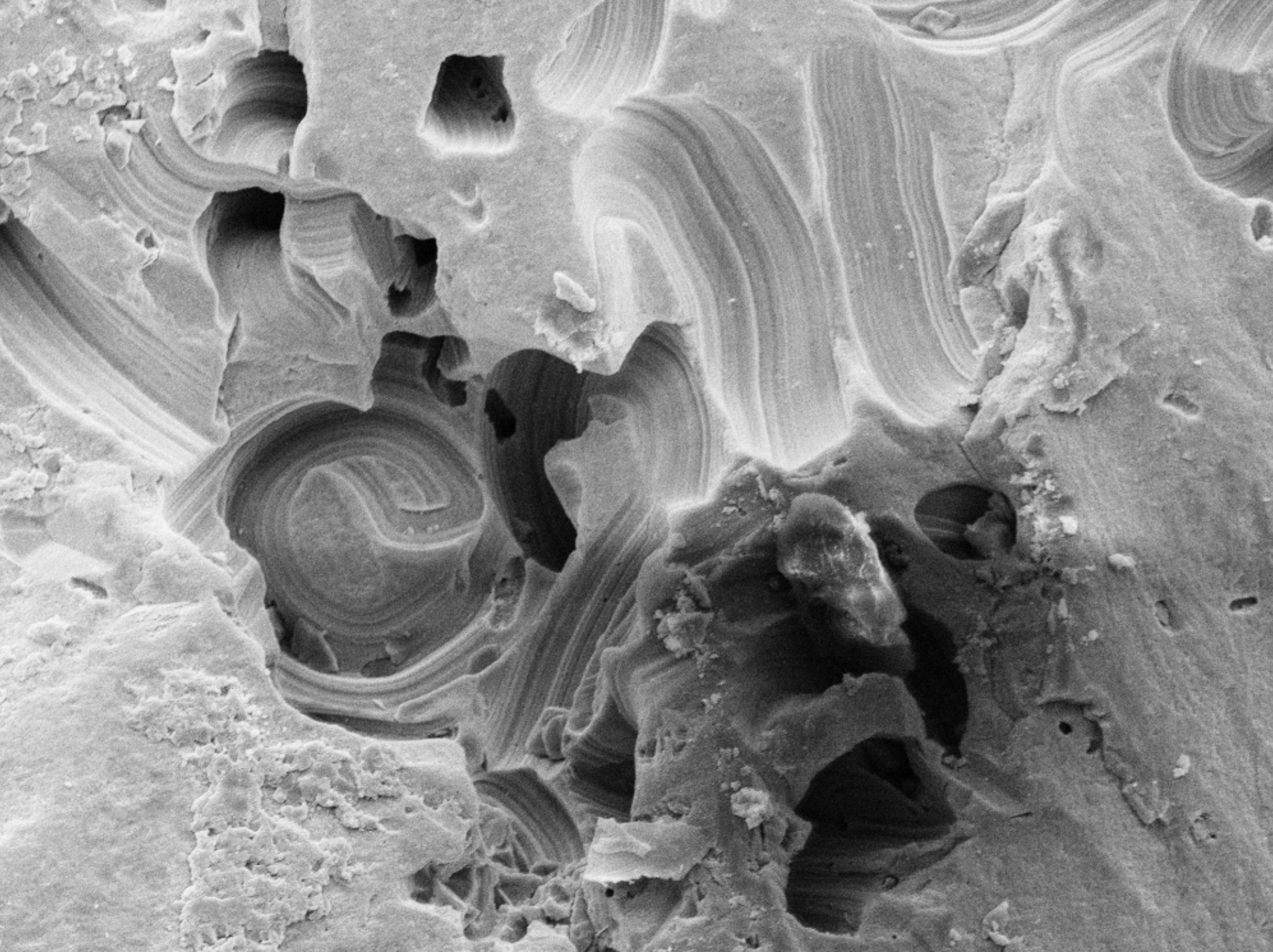
50.0um







wa-75 10.0kV x200

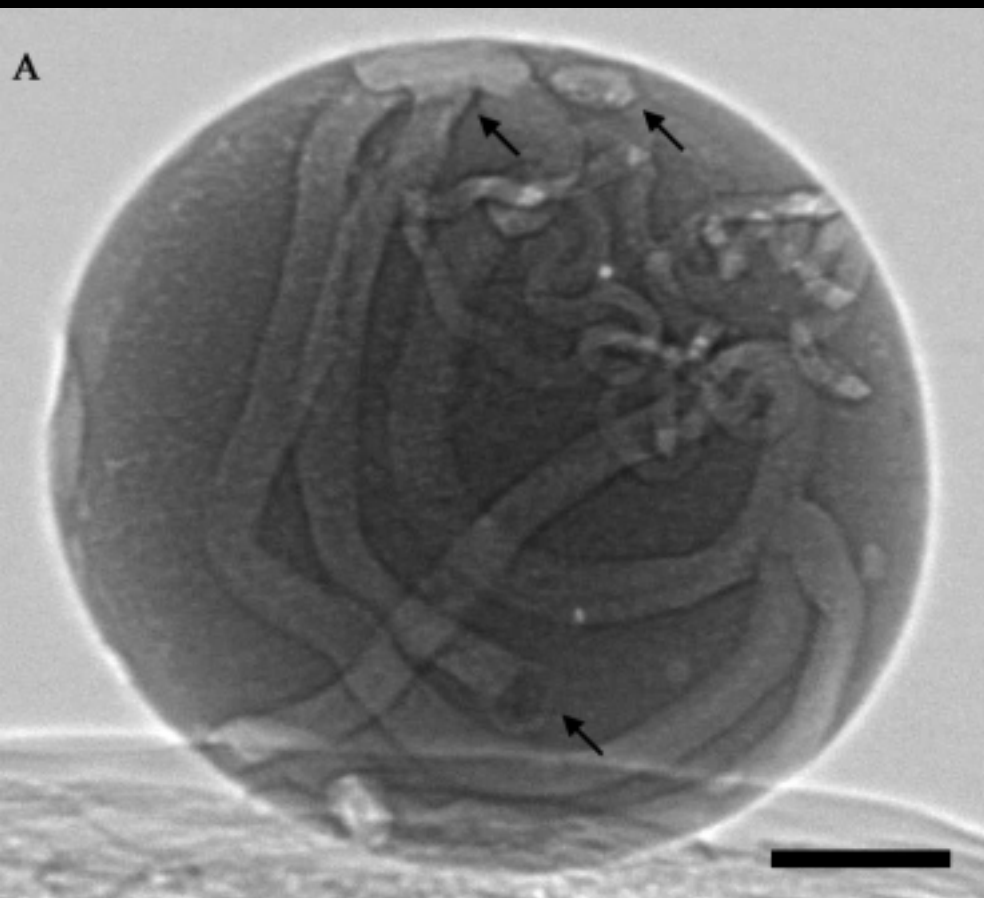




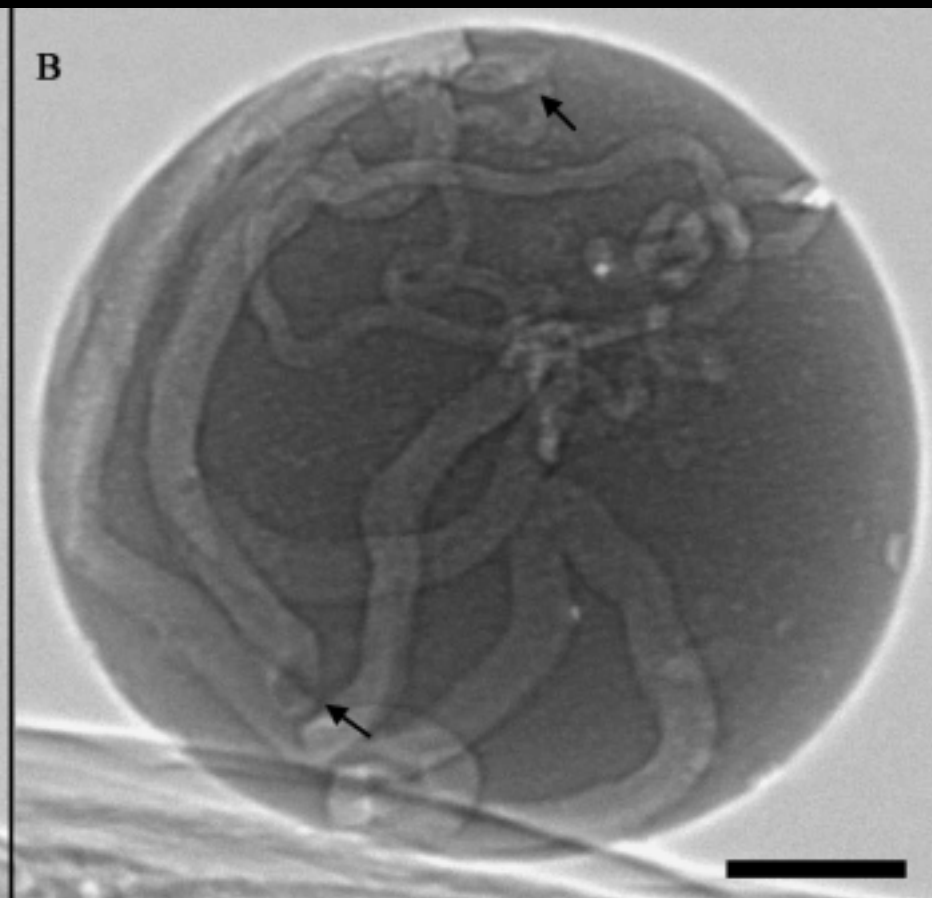
tunnel-09 5.0kV x1.50k

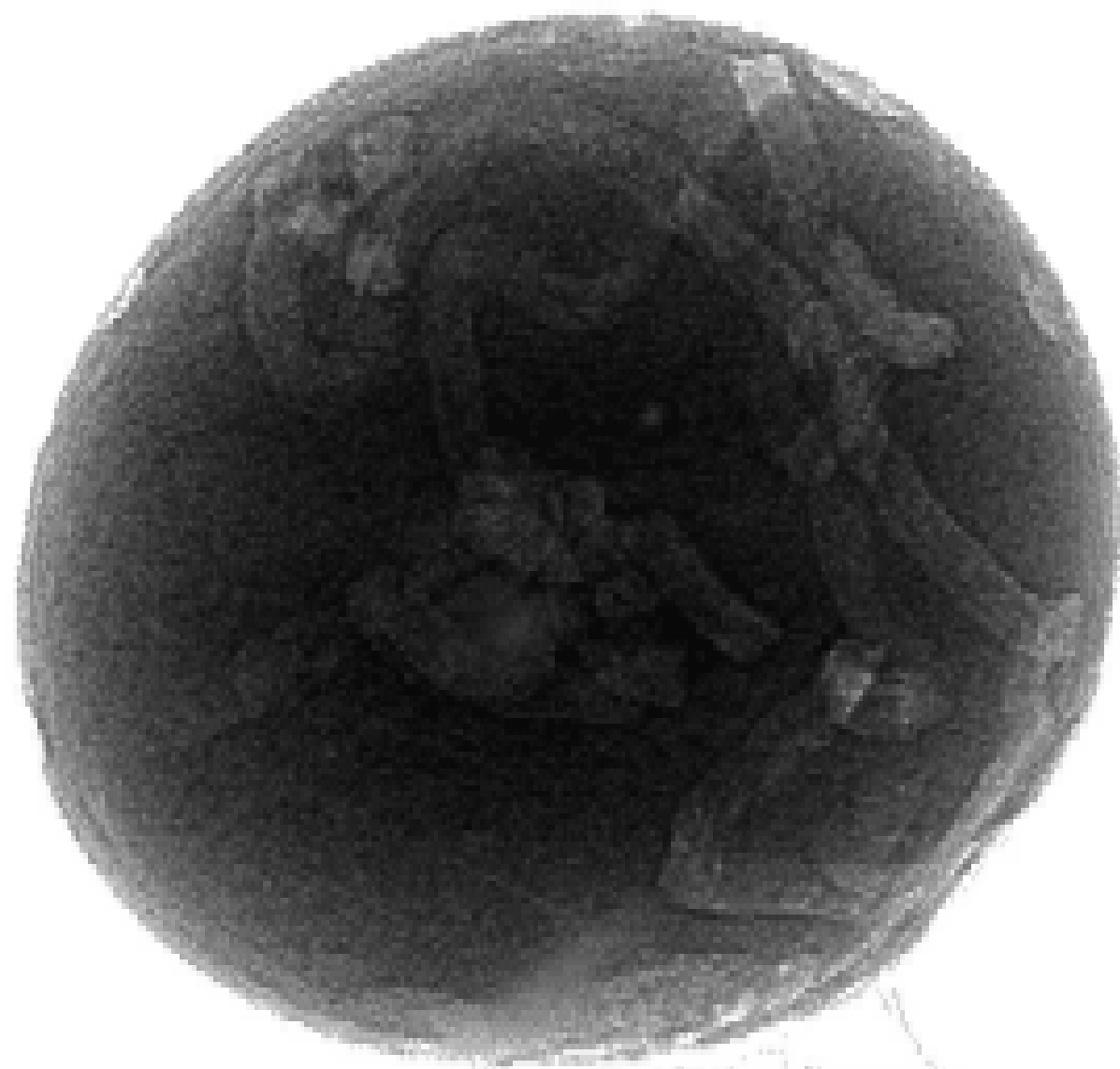
30.0um

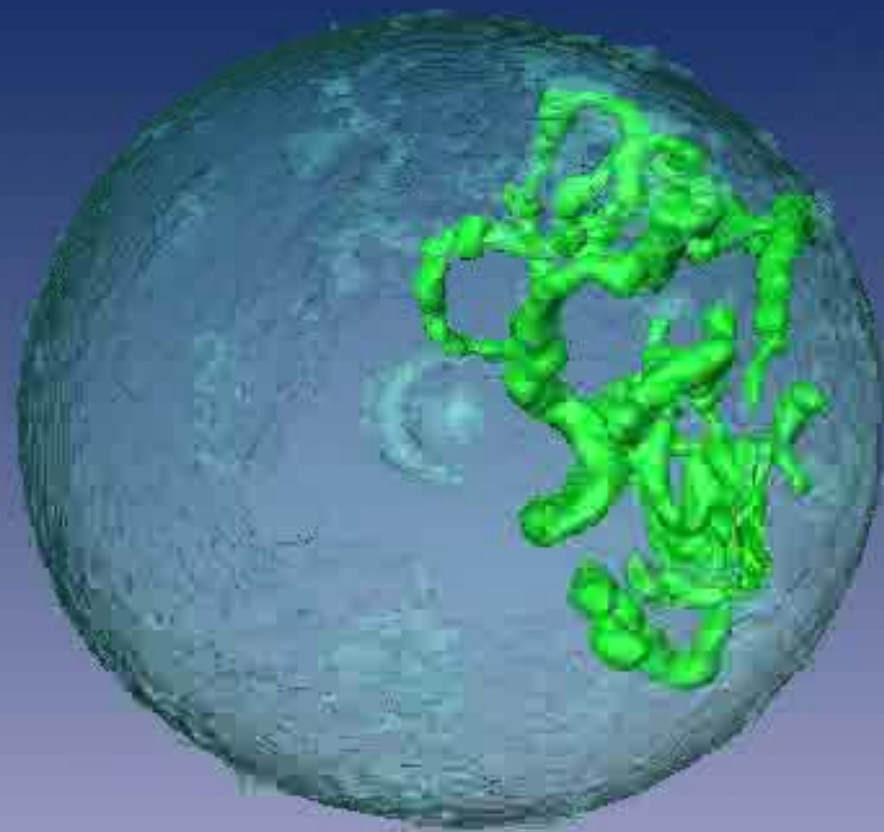
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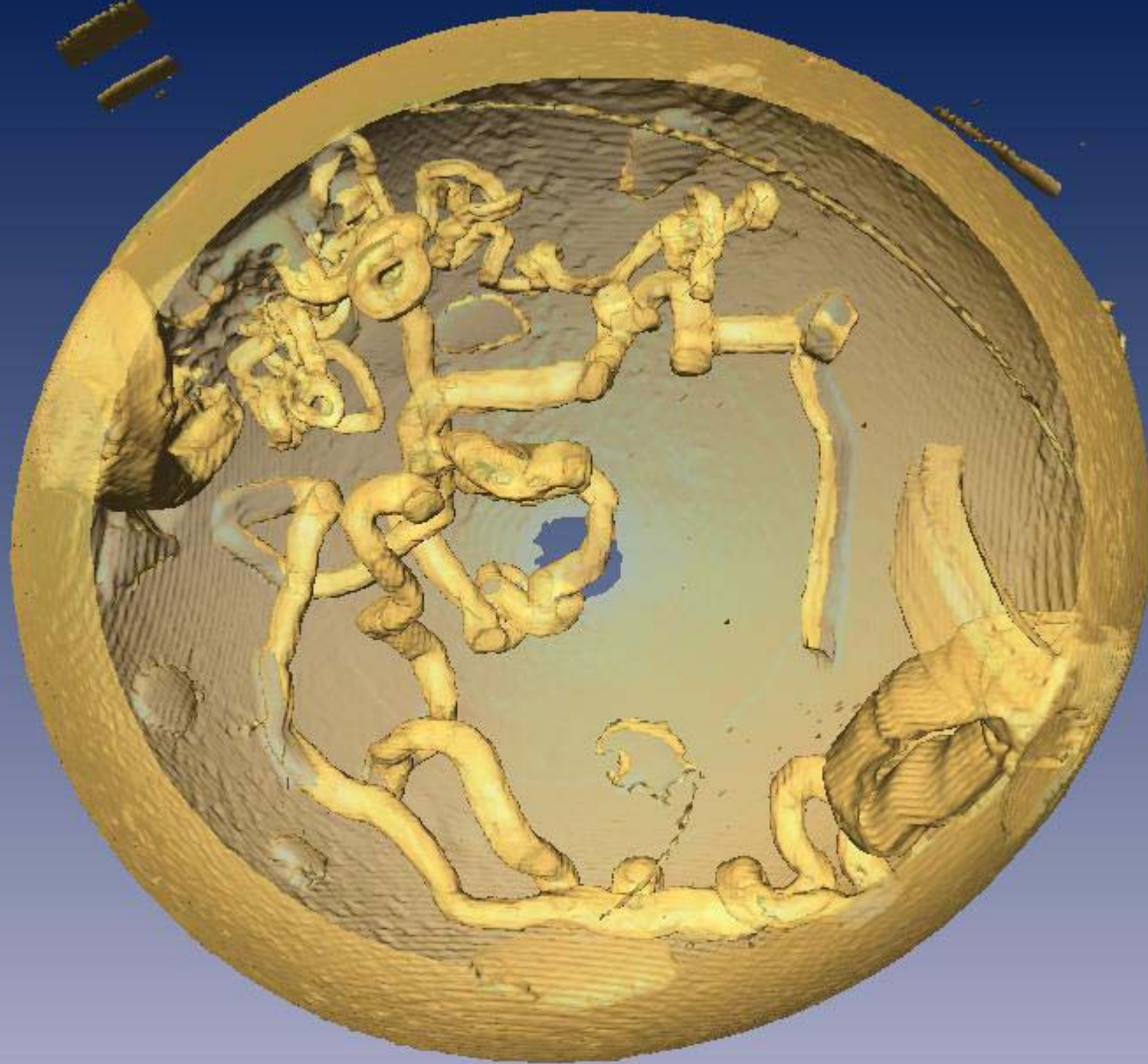


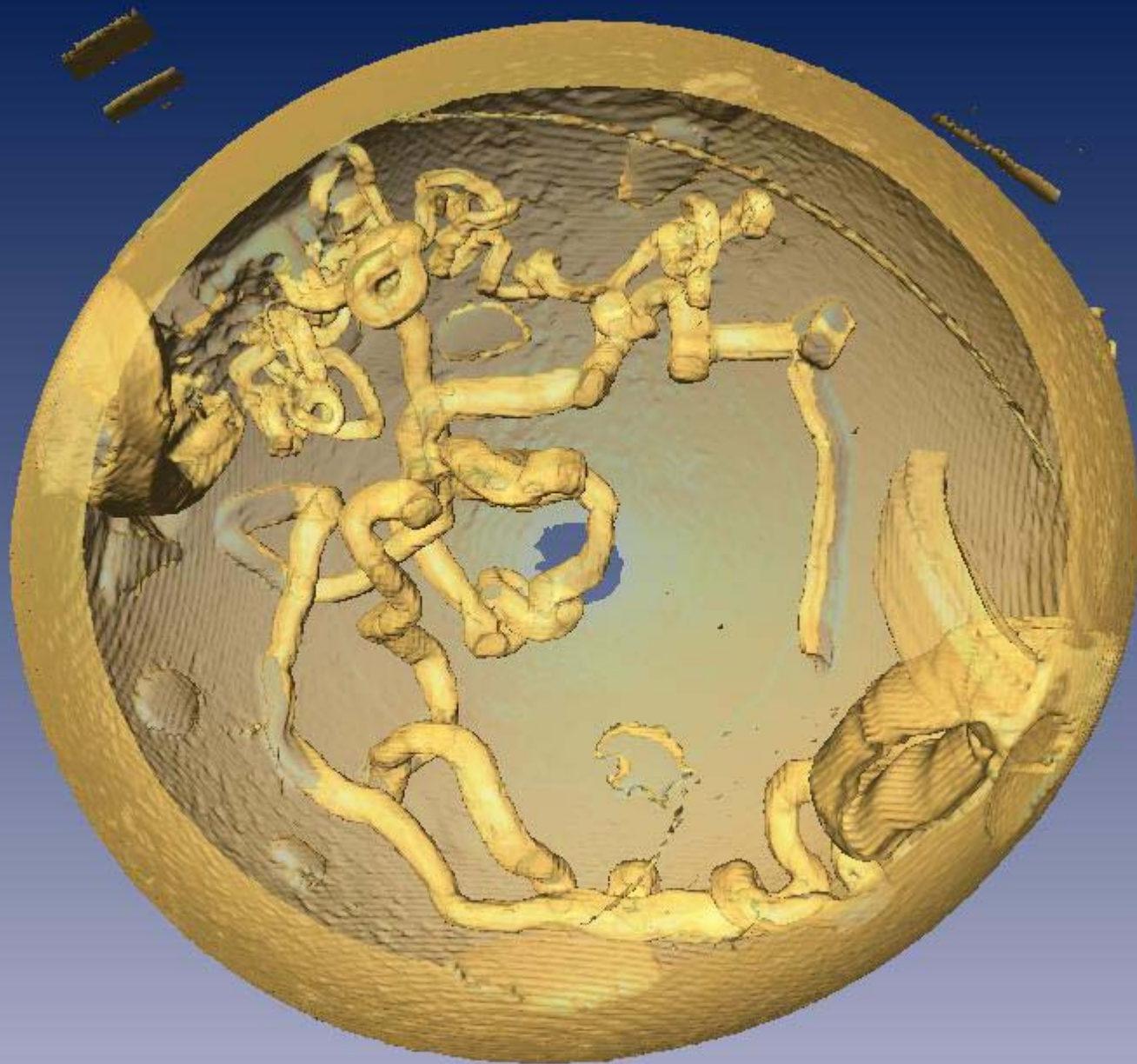
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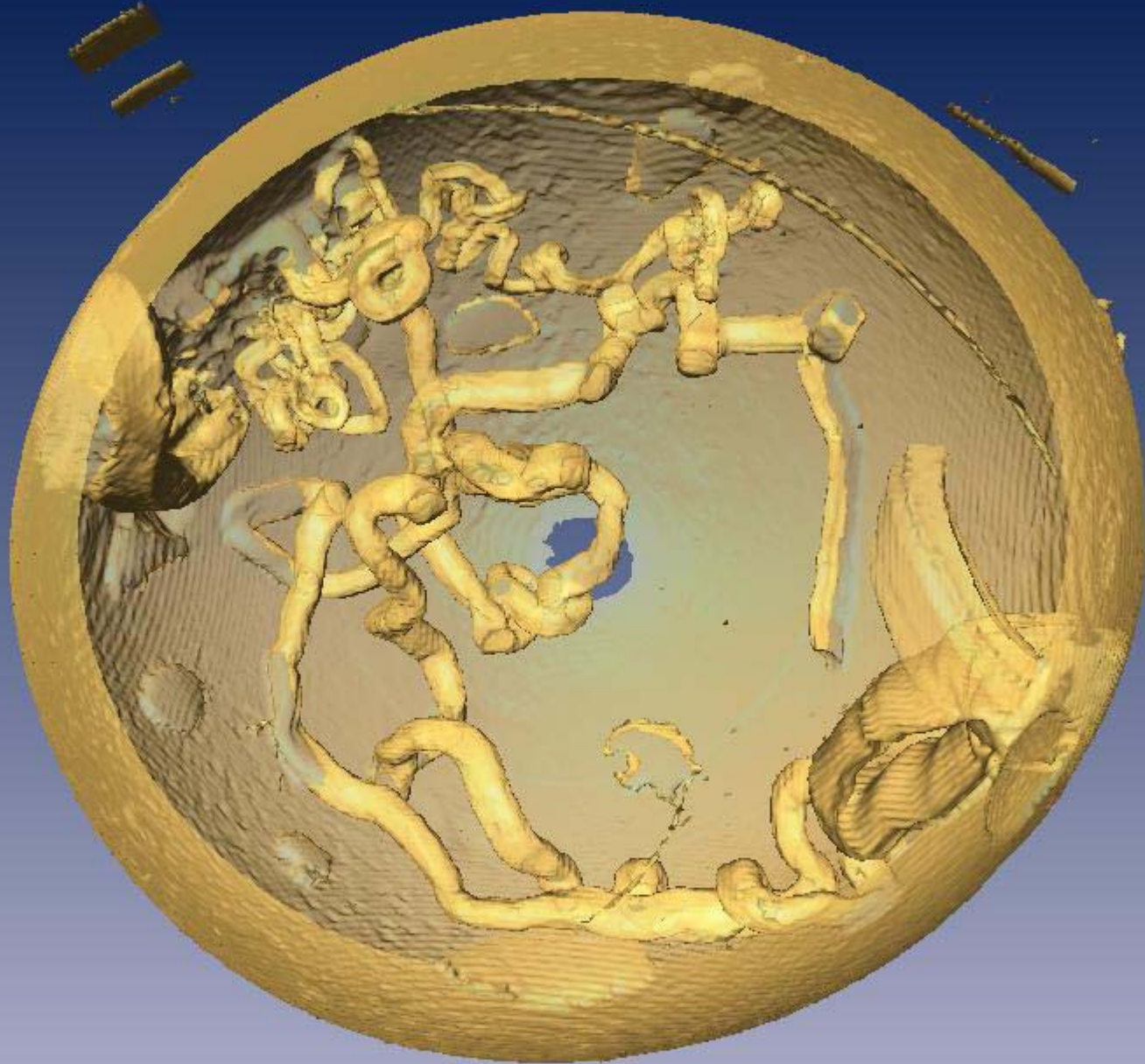


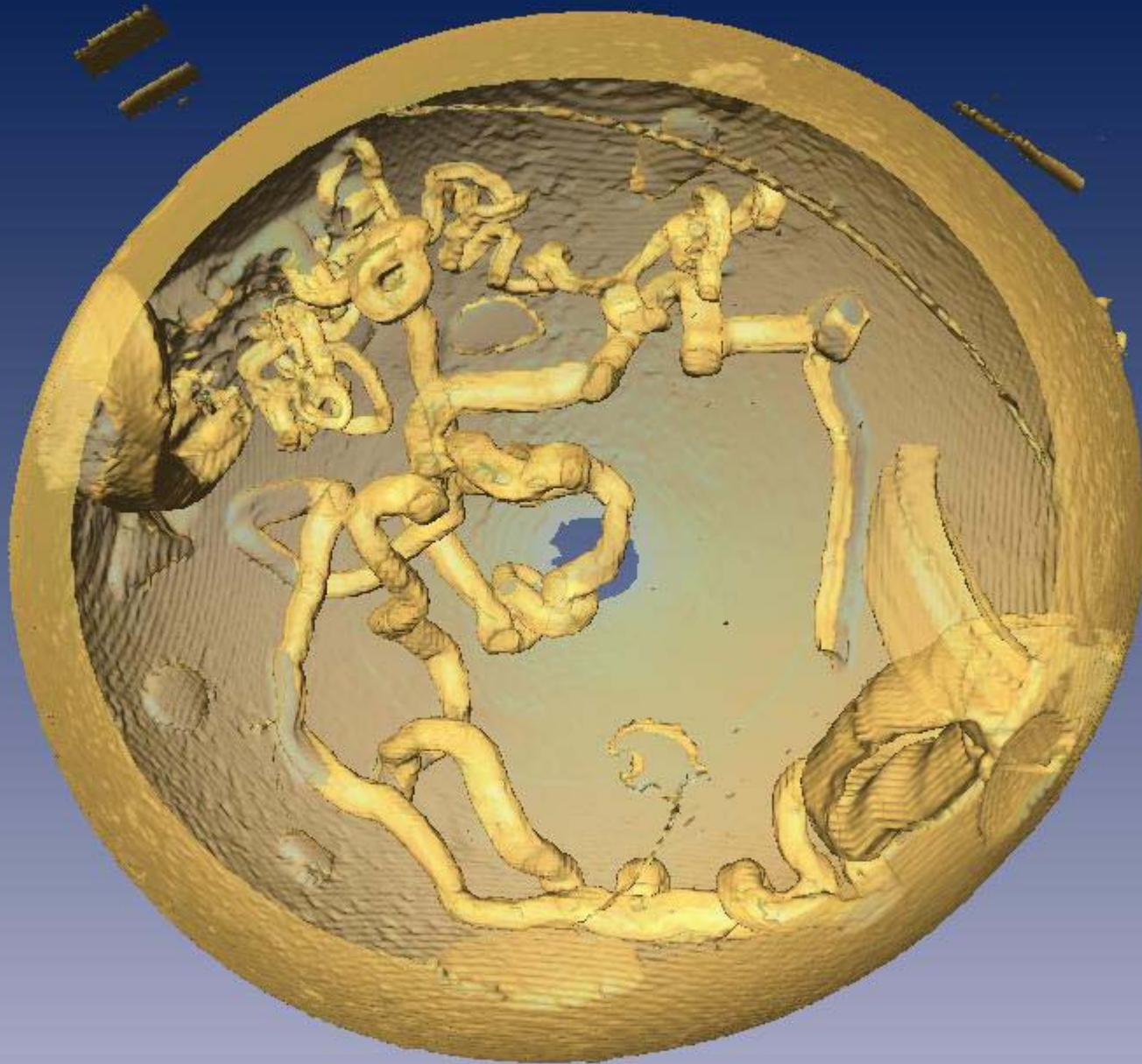


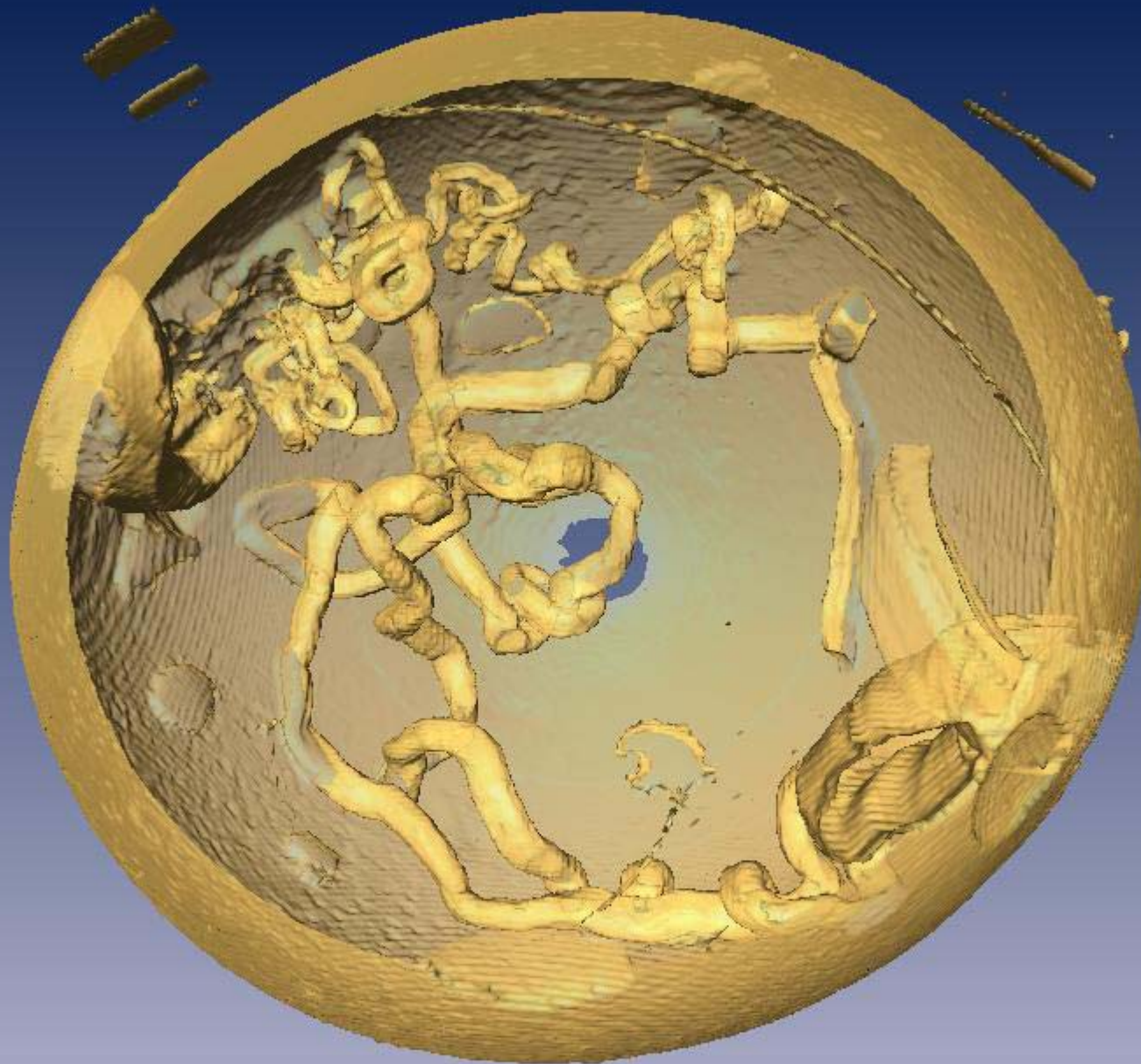


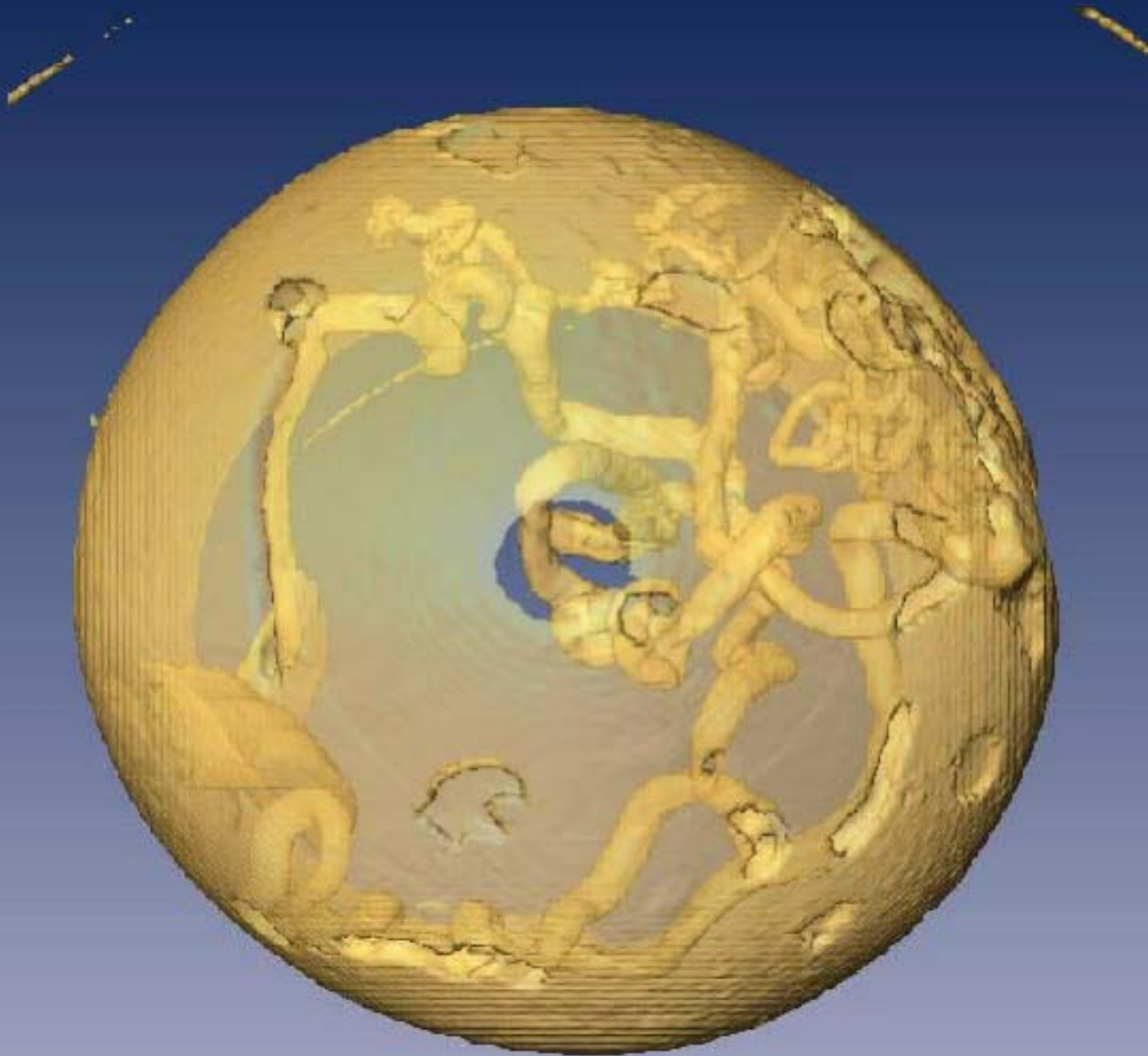


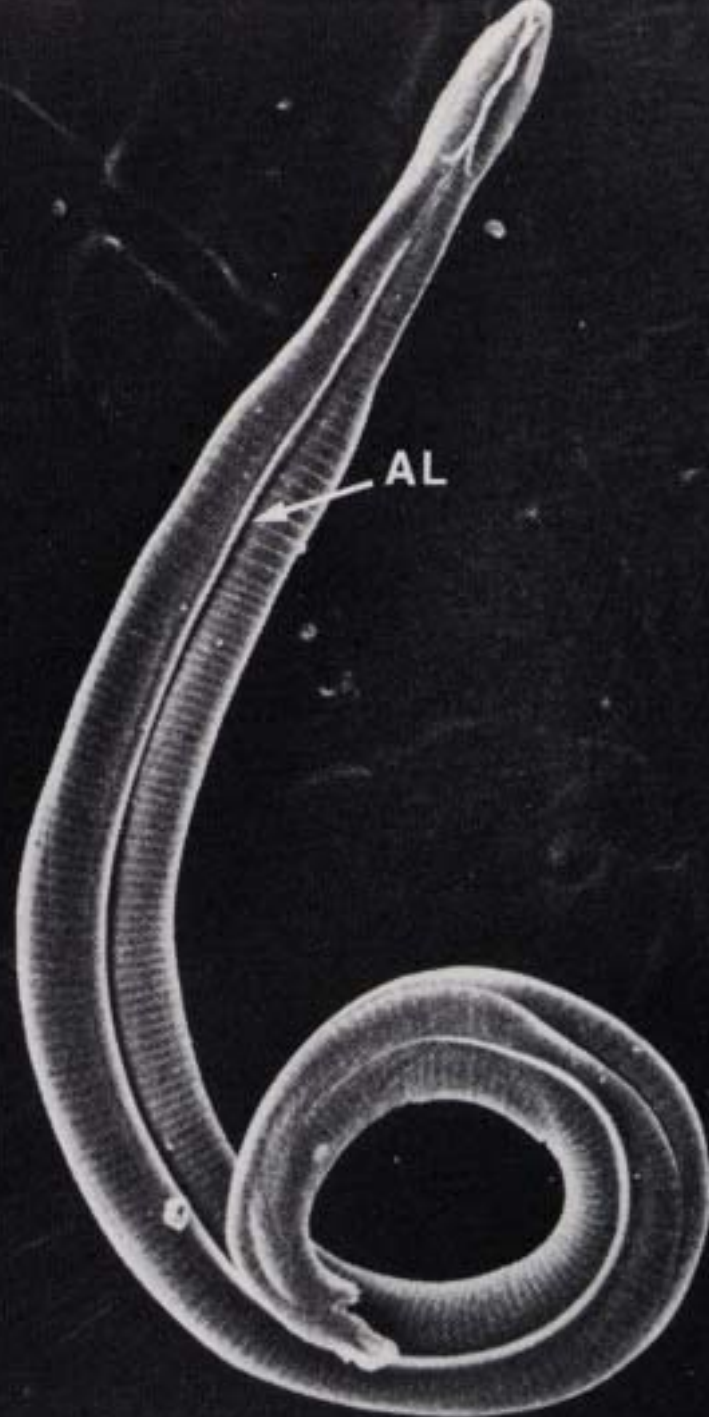








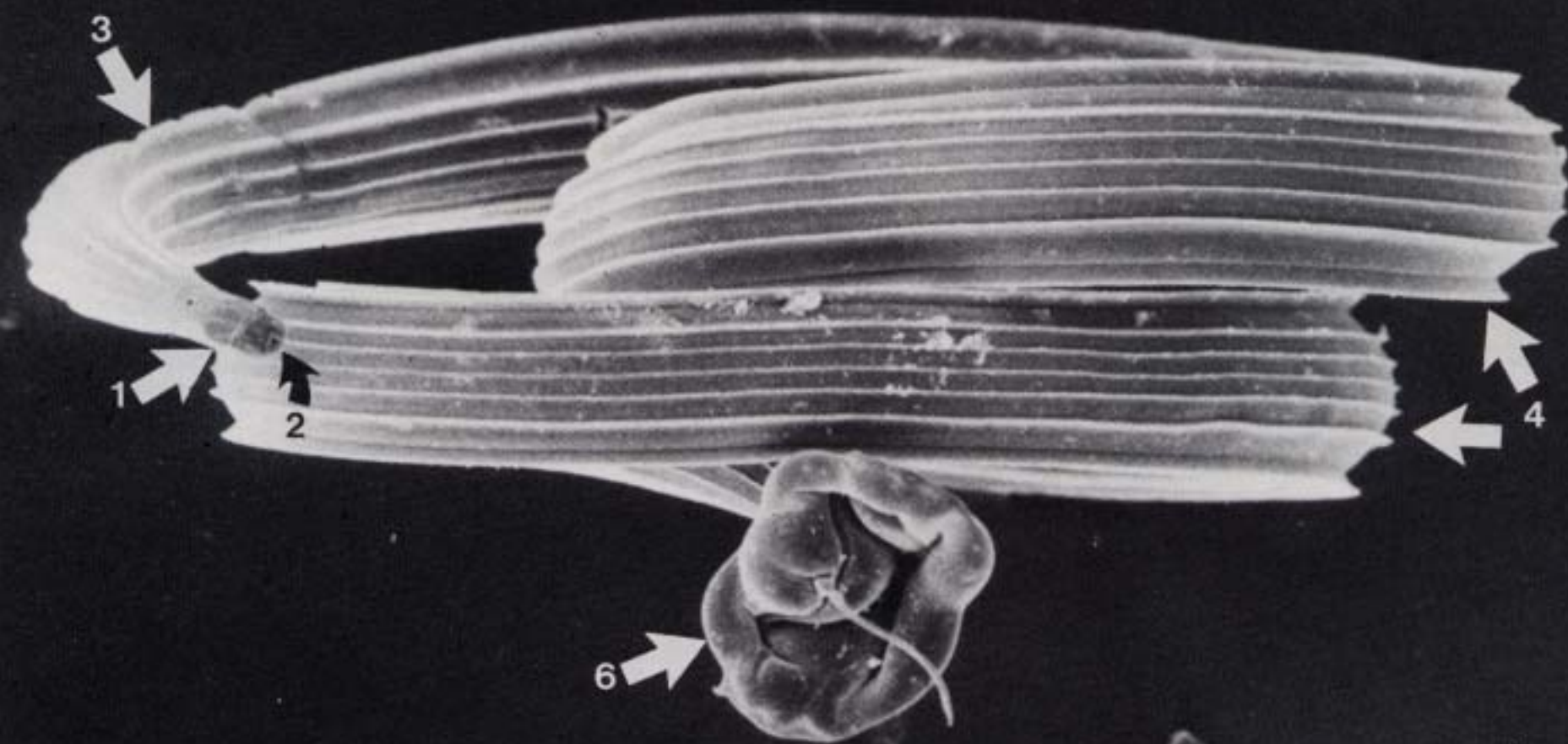




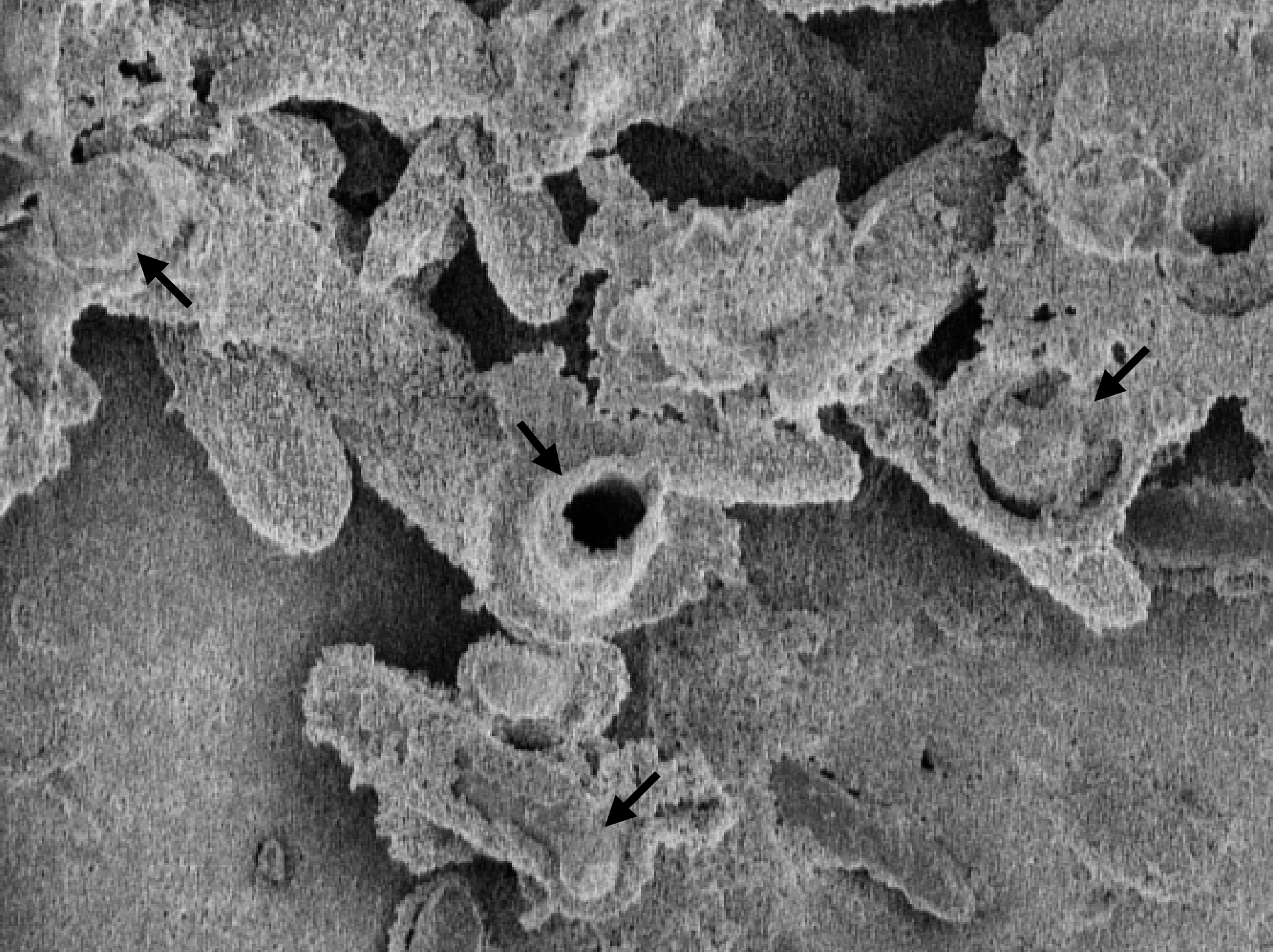


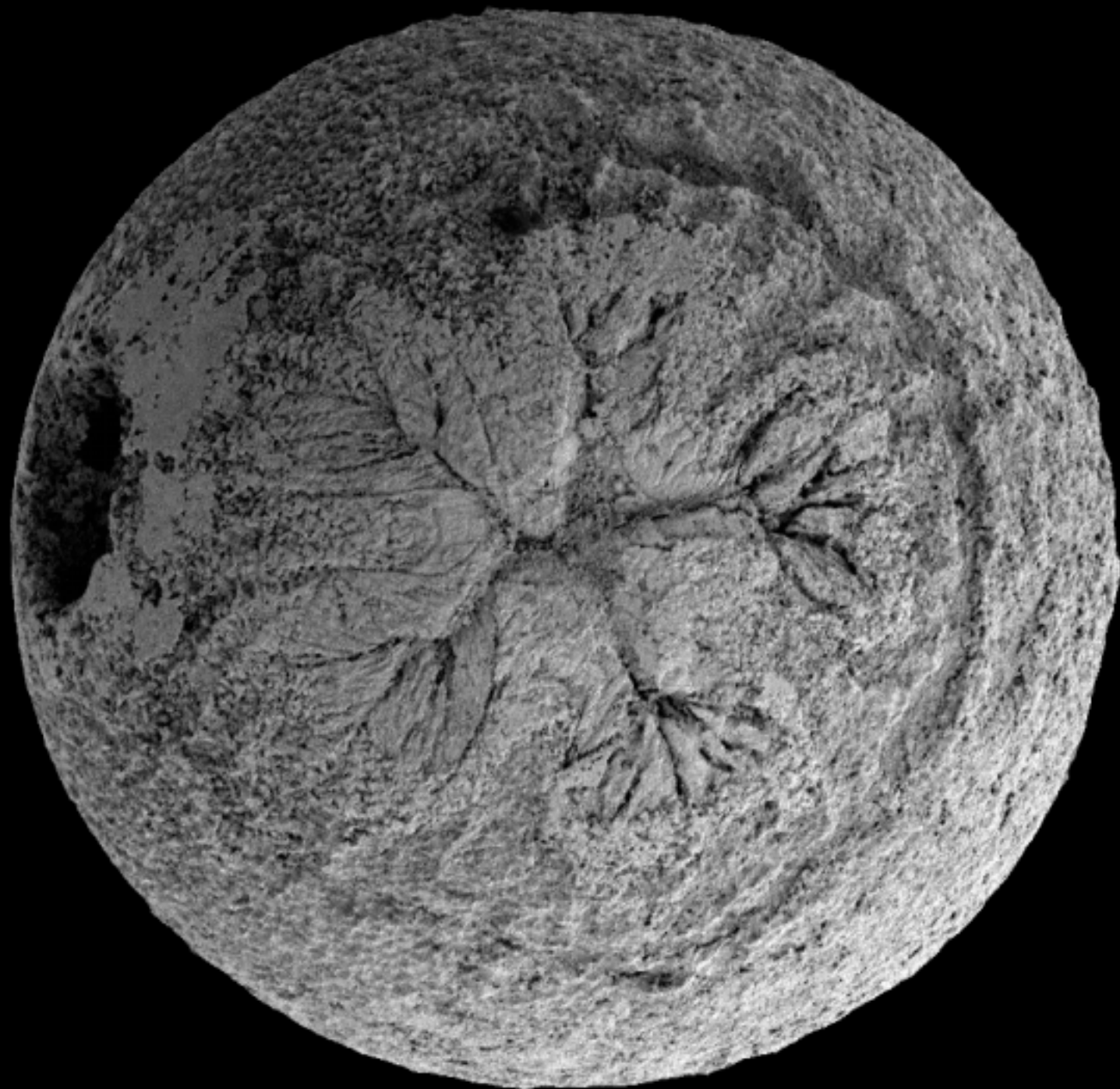
tunnel-09 5.0kV x1.50k

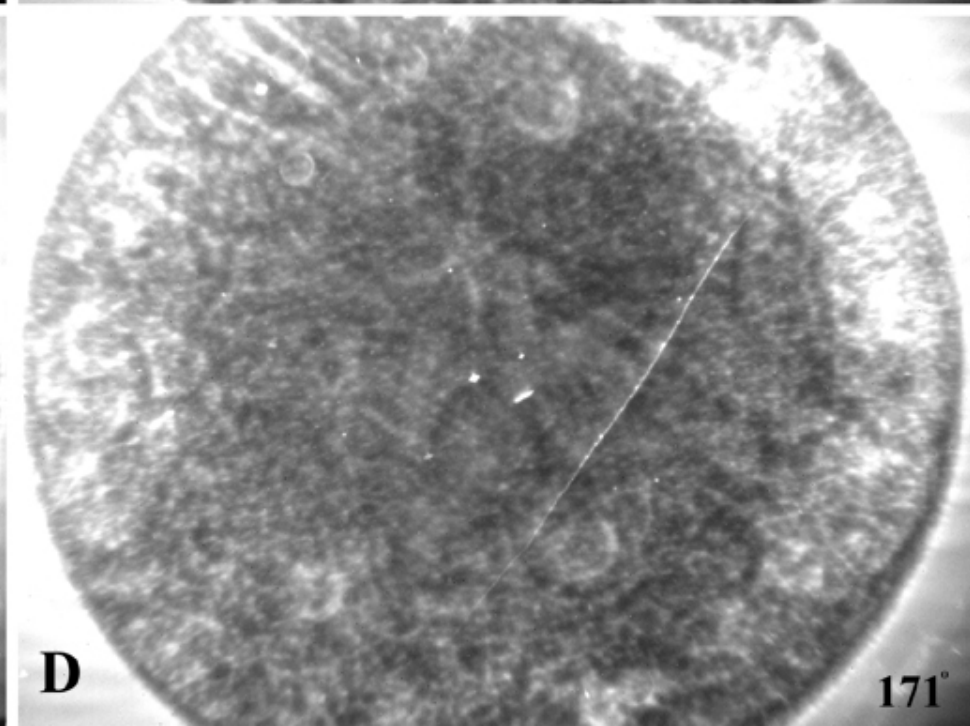
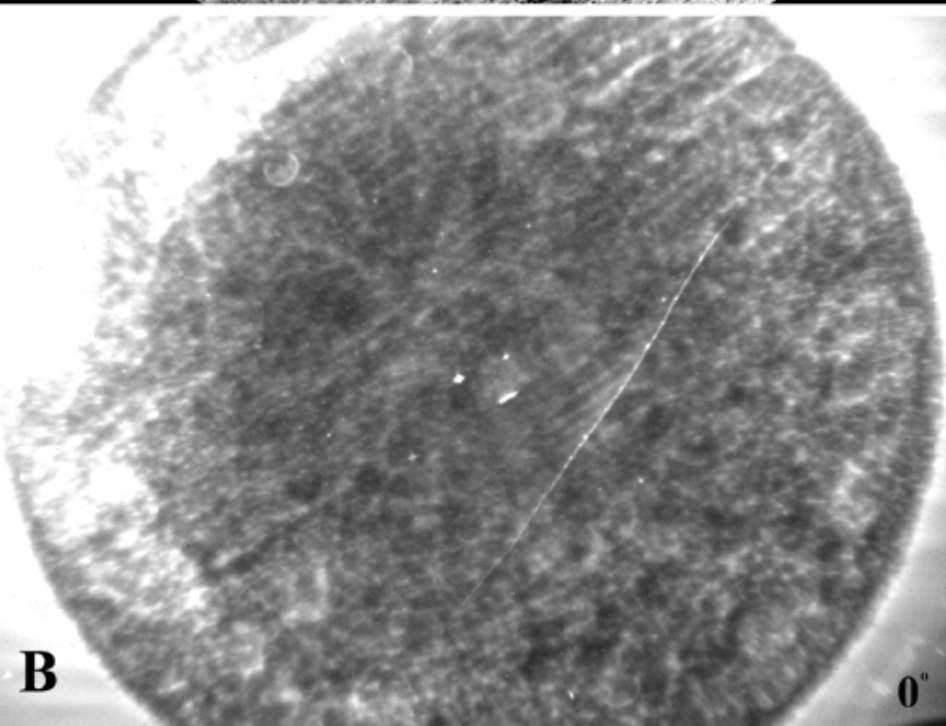
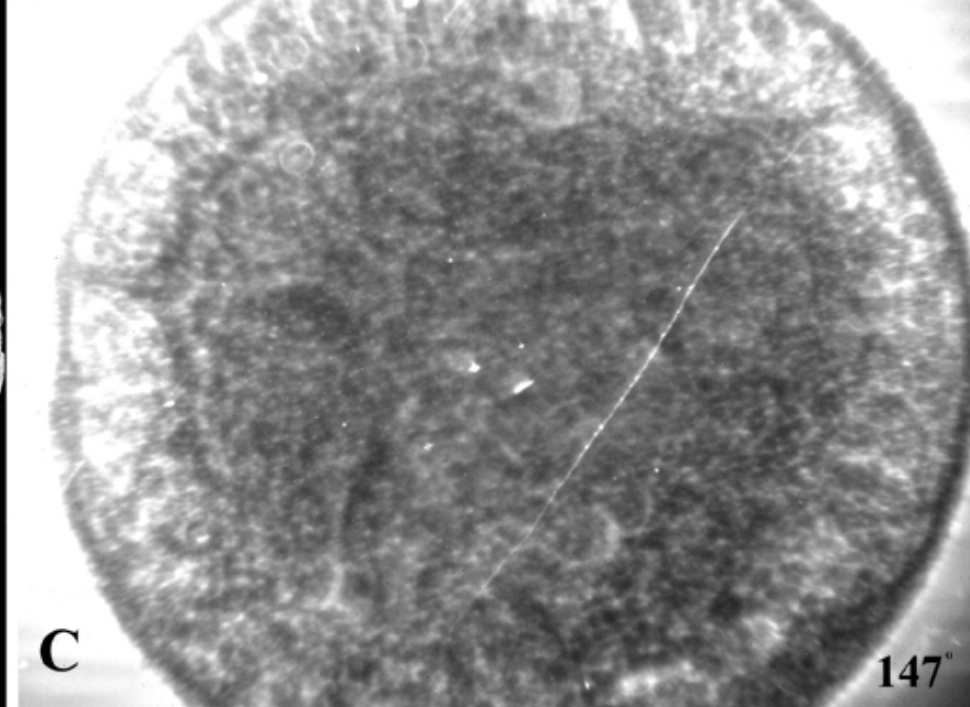
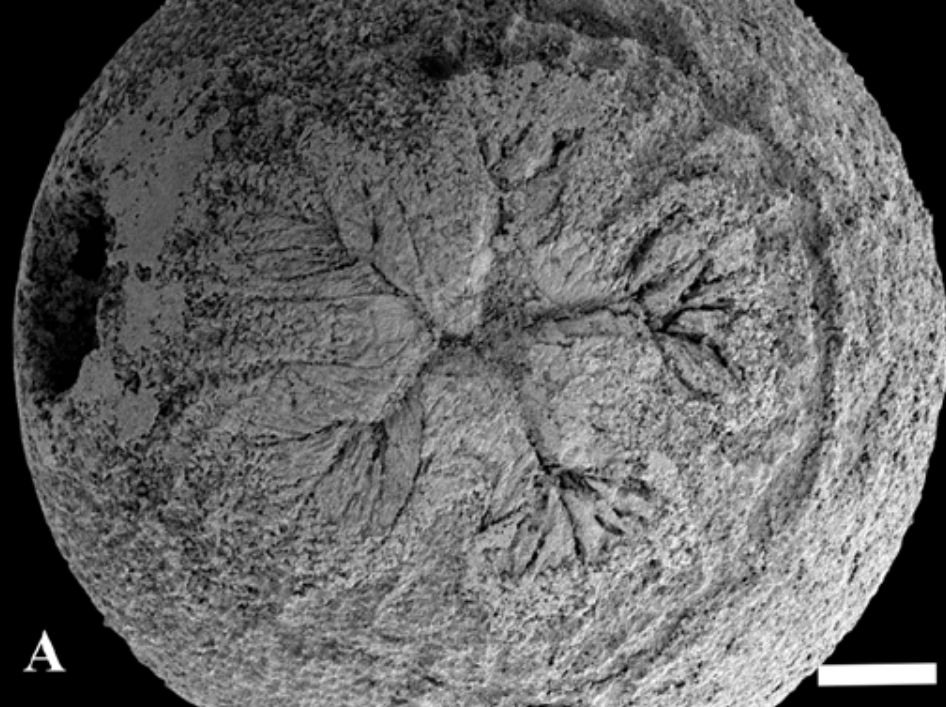
30.0um







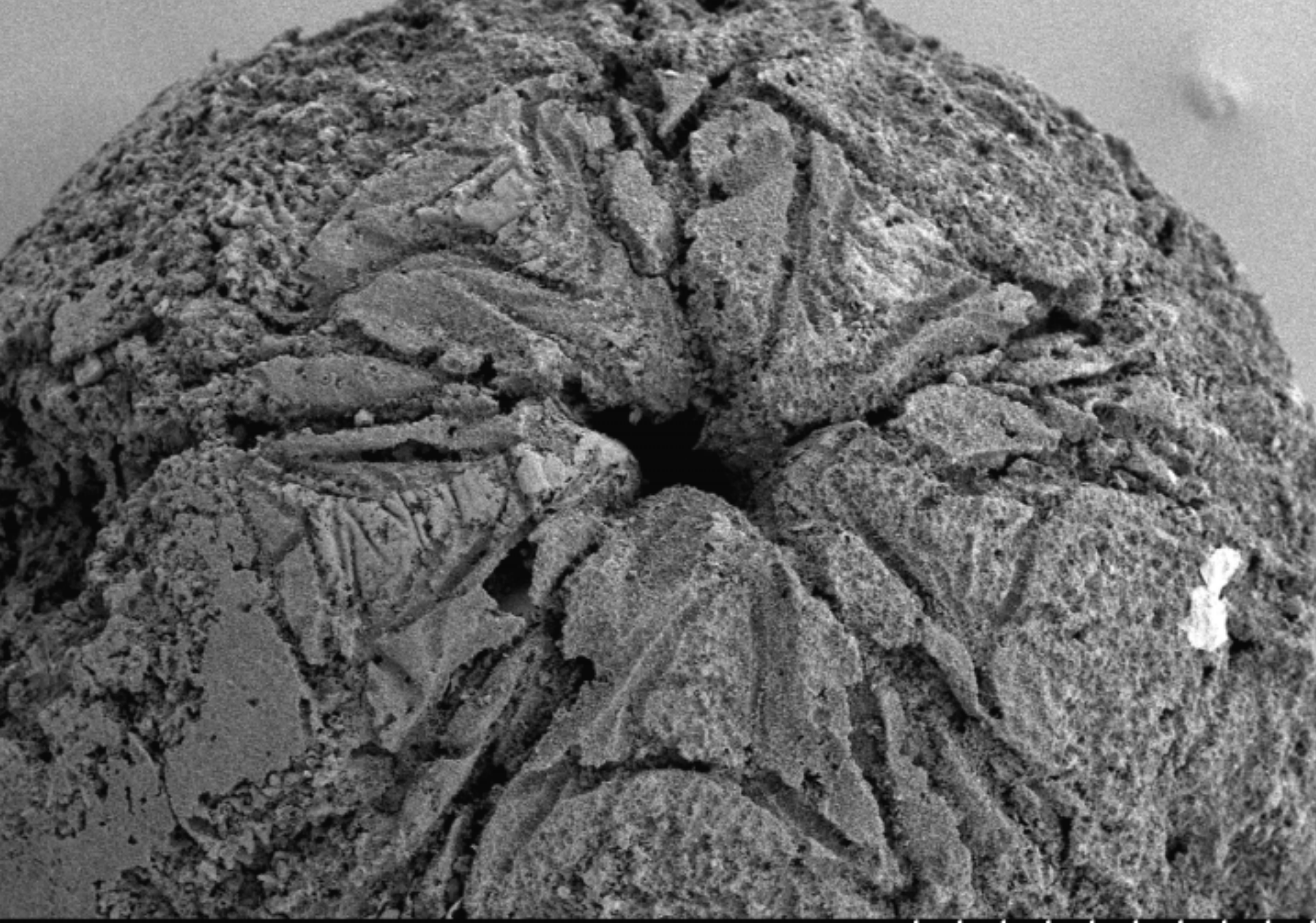






kx009-02 10.0kV x300

100um



kx009-032 3.0kV x200

200um

1. Precambrian sponges with cellular structures. *Science* **279**: 879-882. 1998.
2. Precambrian animal diversity: Putative phosphatized embryos from the Doushantuo Formation of China. *Proc. Natl Acad. Sci., USA* **97**: 4457-4462. 2000.
3. Precambrian animal life: Probable developmental and adult cnidarian forms from Southwest China. *Developmental Biology* **248**: 182-196. 2002.

















YUNNANOZON

A humble 2-in. chordate is the earliest known member of the line that led to humans.

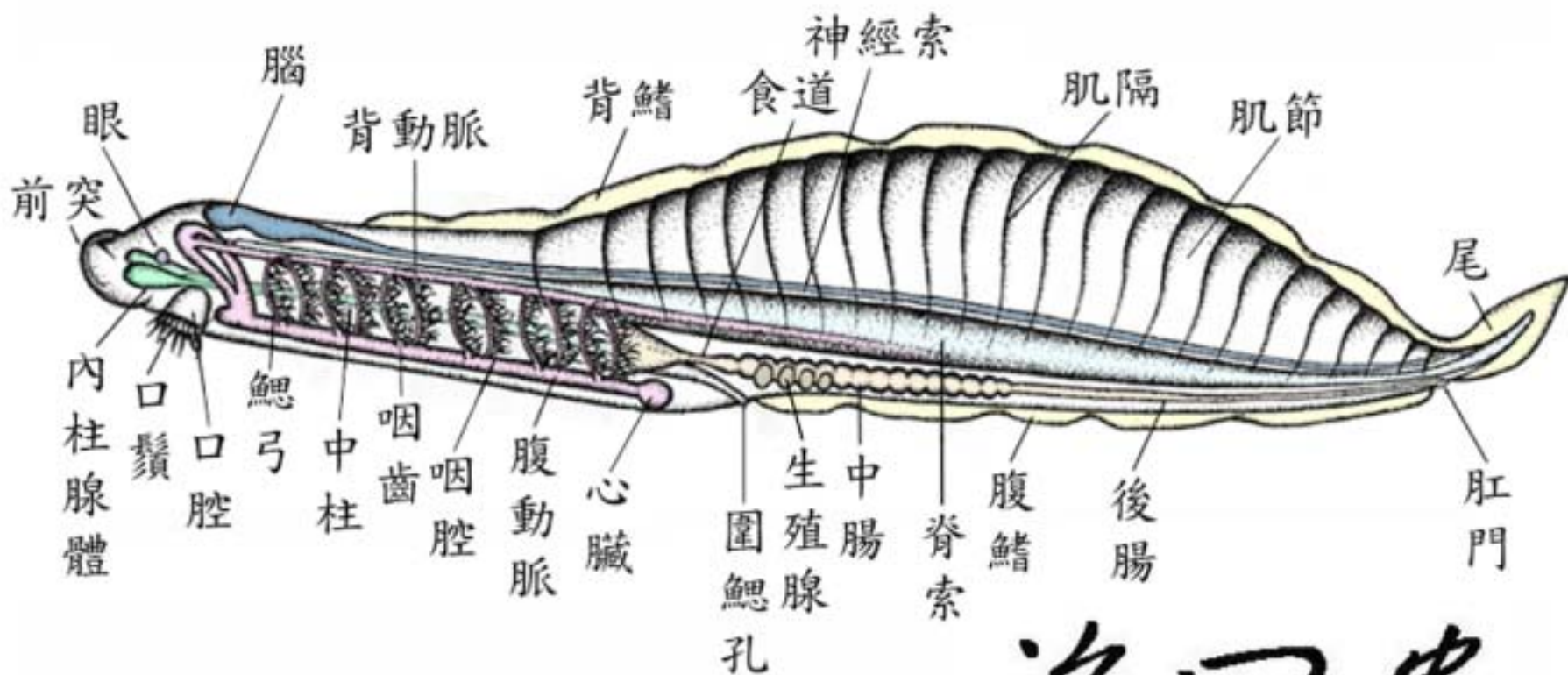








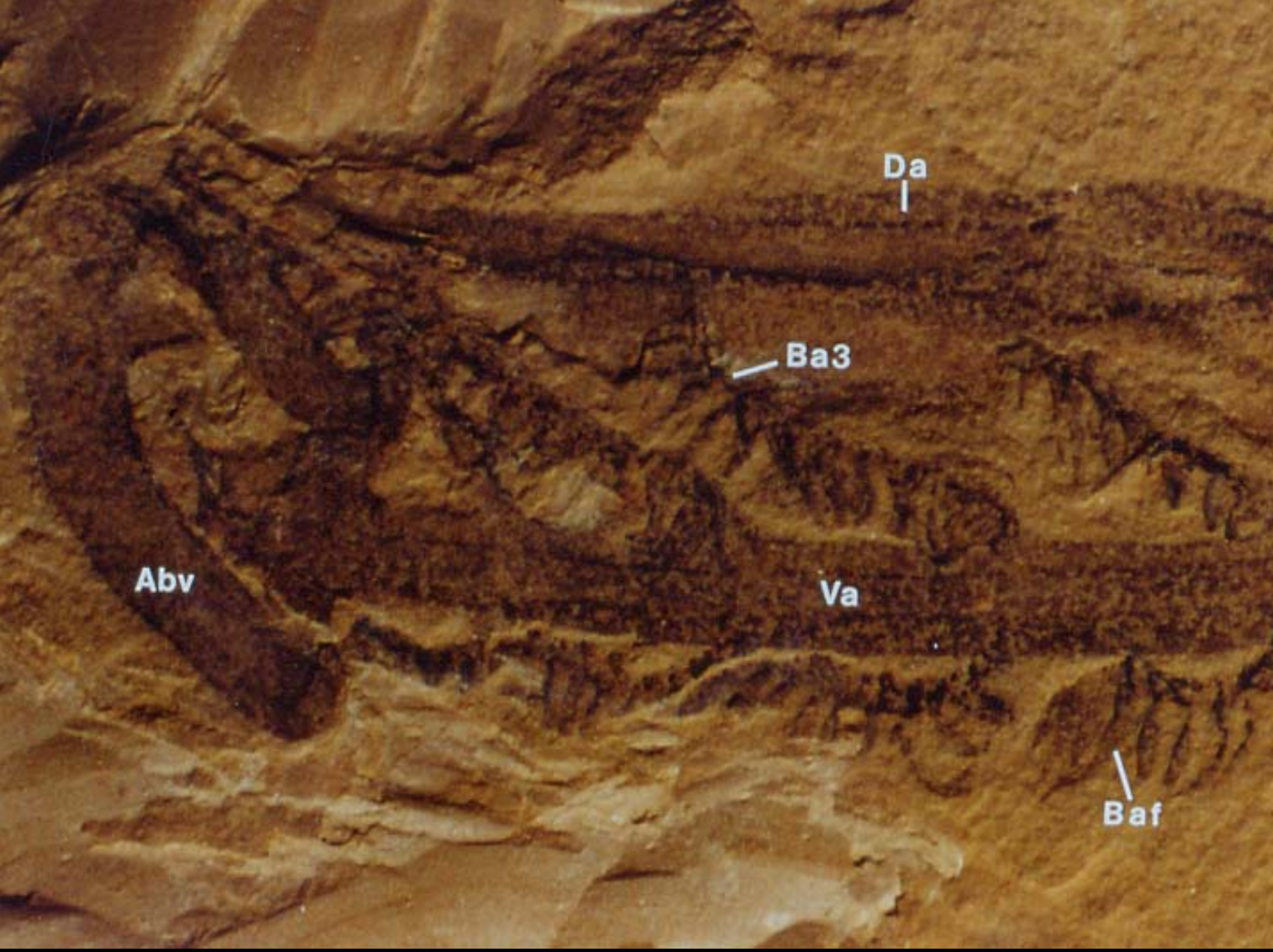
Haikouella lanceolata



海口蟲

雲南 海口





Da
|

Ba3
/

Abv

Va

Baf
/





B
|

NC
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VA

