

GEOCHEMISTRY AND EARTH HISTORY

Homework for Friday

- Use Google Scholar to find a journal article that combines your interests in Geology and Chemistry to tell an interesting/meaningful story....
- What to turn in on Friday
 - A reference to the article
 - A summary paragraph
 - Be ready to share what you learned with the class.

Dynamic change on Earth and Beyond

Matter

Chemistry

Energy/Processes

Metamorphism to diagenesis

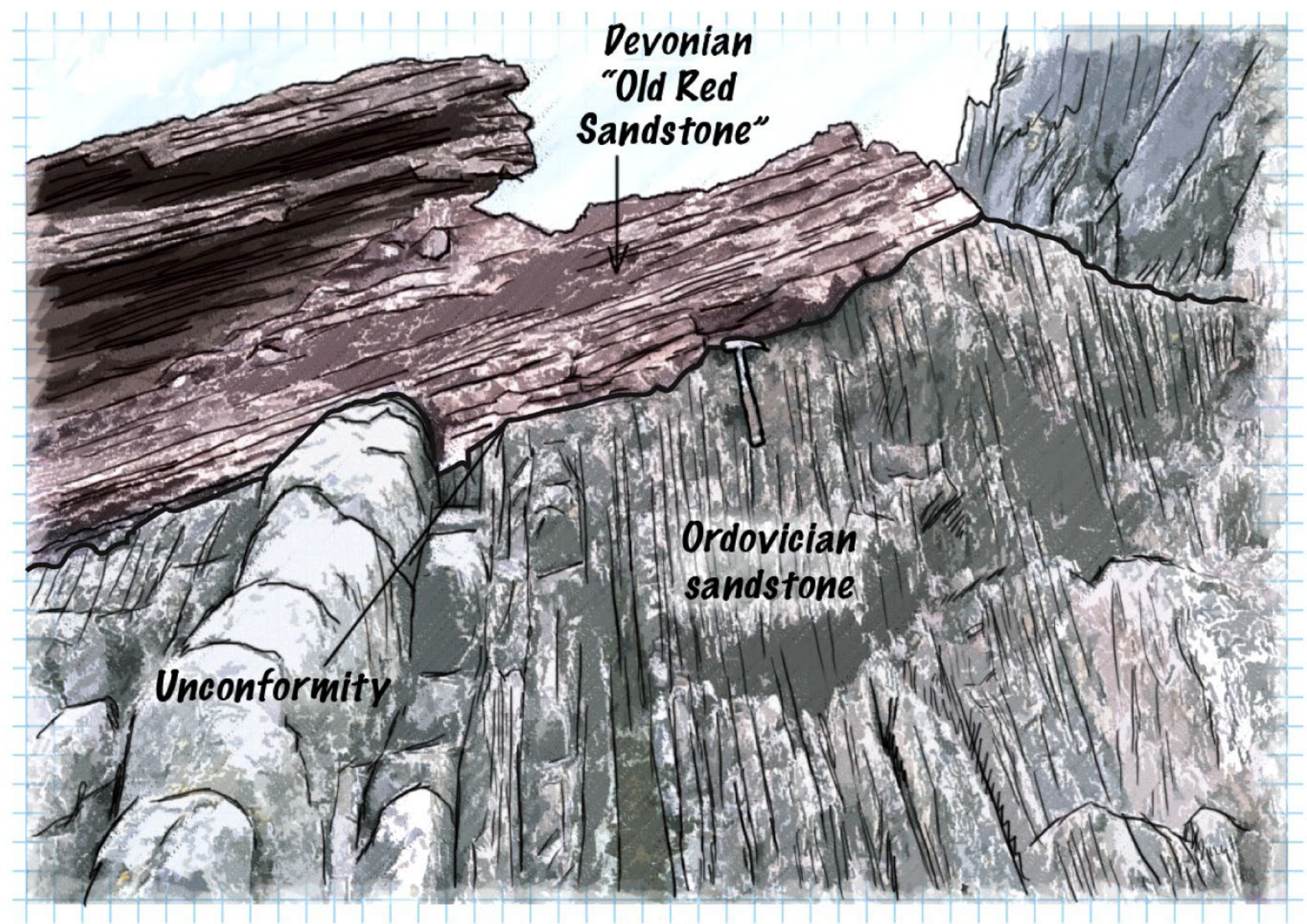
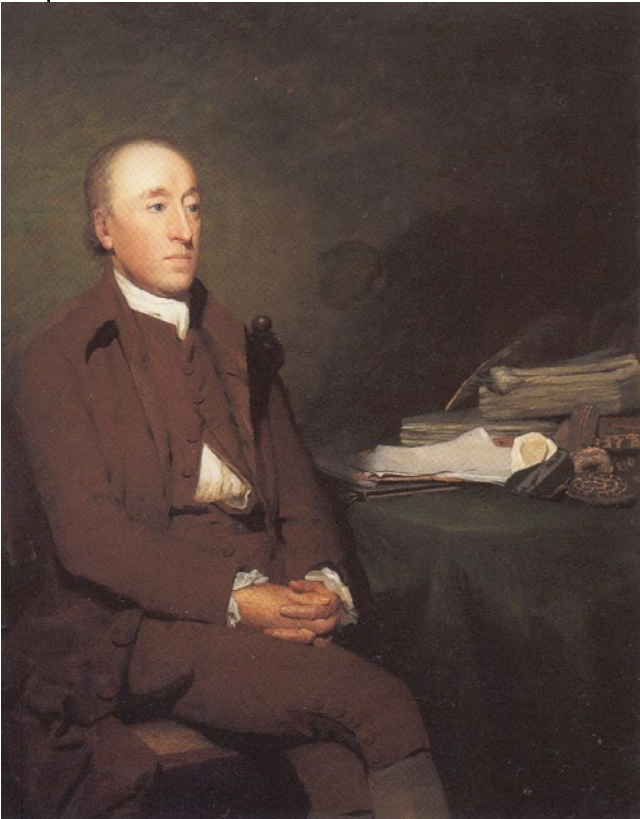
Products

Earth History

Matter – bodies of atoms, elements, minerals

- Air
- Magma – Lava – Minerals to Rocks – Sediments to Soils
- Water – Ice
- Life
- Phase changes and cycles

James Hutton



What a Geologist Sees



The rock record is not continuous!



Absolute Age Dating

Clair Patterson

Mitchellville, Iowa

Some consider him the
most influential
geochemist/geologist of
the century!

SNOWBALL EARTH

Example of Geochemistry

| | | | |
|-----------------------|------------|--------|------|
| Neoproterozoic | Ediacaran | | 541 |
| | Cryogenian | 635 Ma | Ma |
| | Tonian | 720 | 1000 |

- Till vs Tillite
- Iceberg deposited dropstones
 - Even along the Equator

Gaskers 582
584

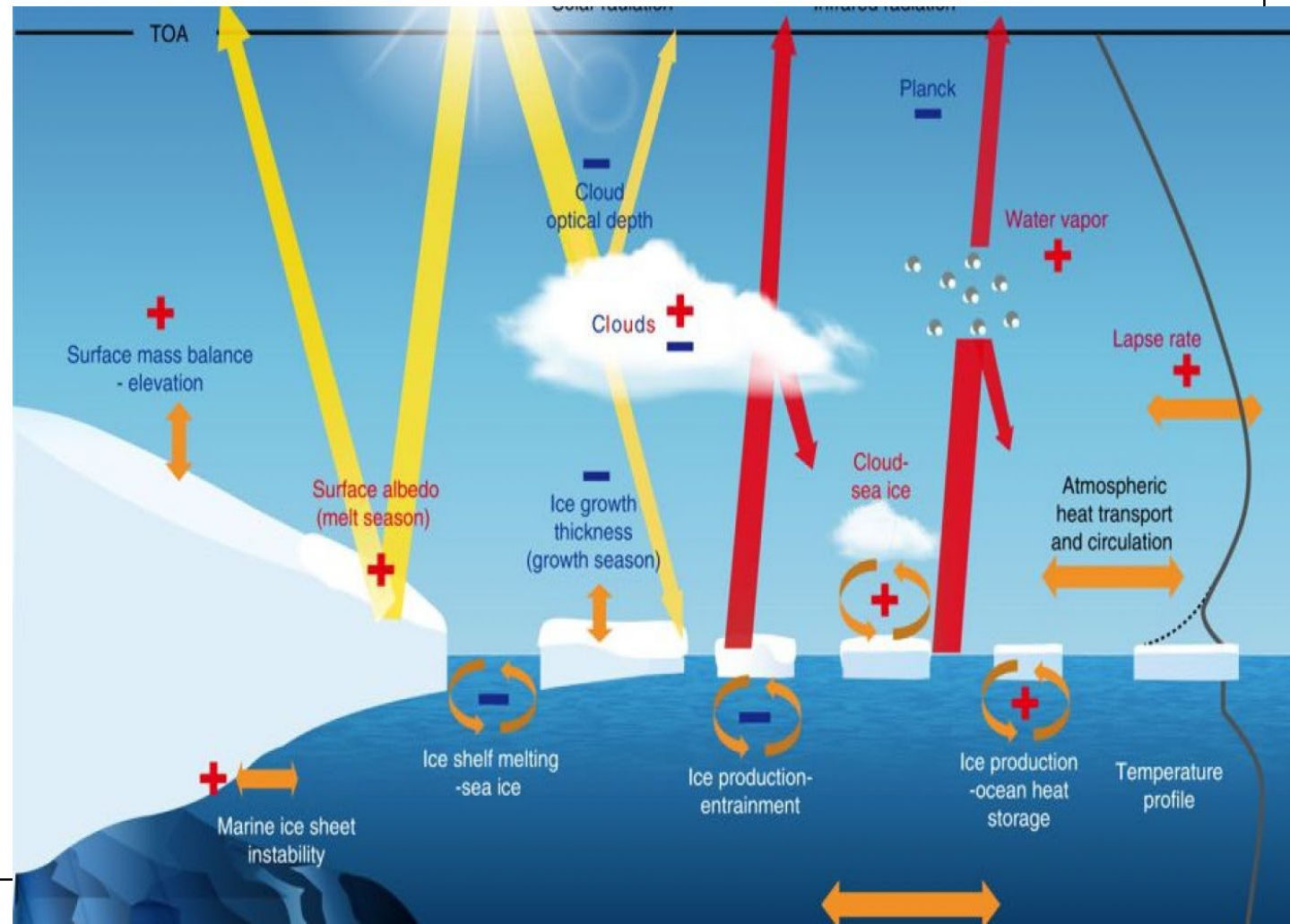
Marinoan 635
650

Sturtian 660
750

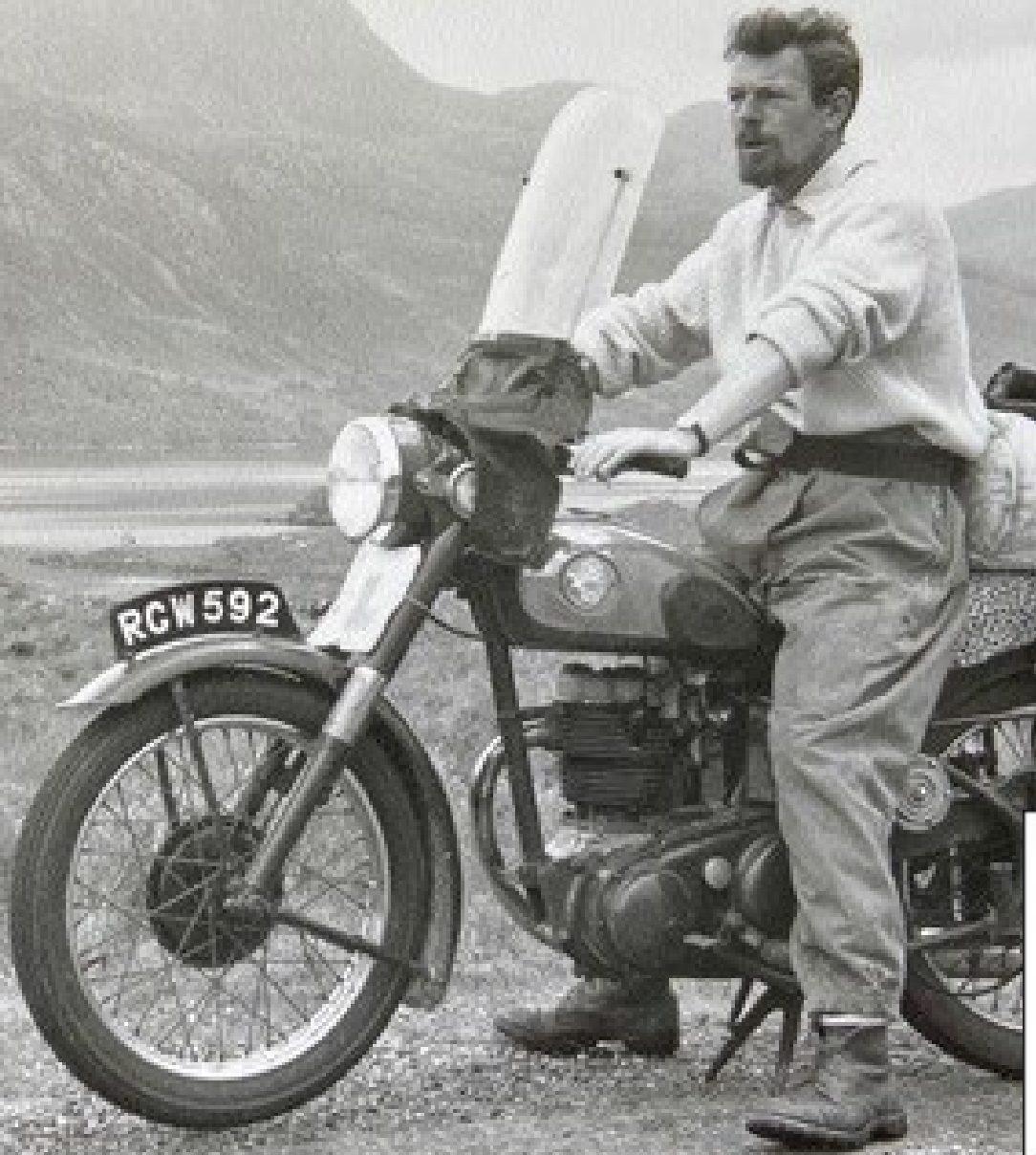


Hypotheses – Potential contributing factors

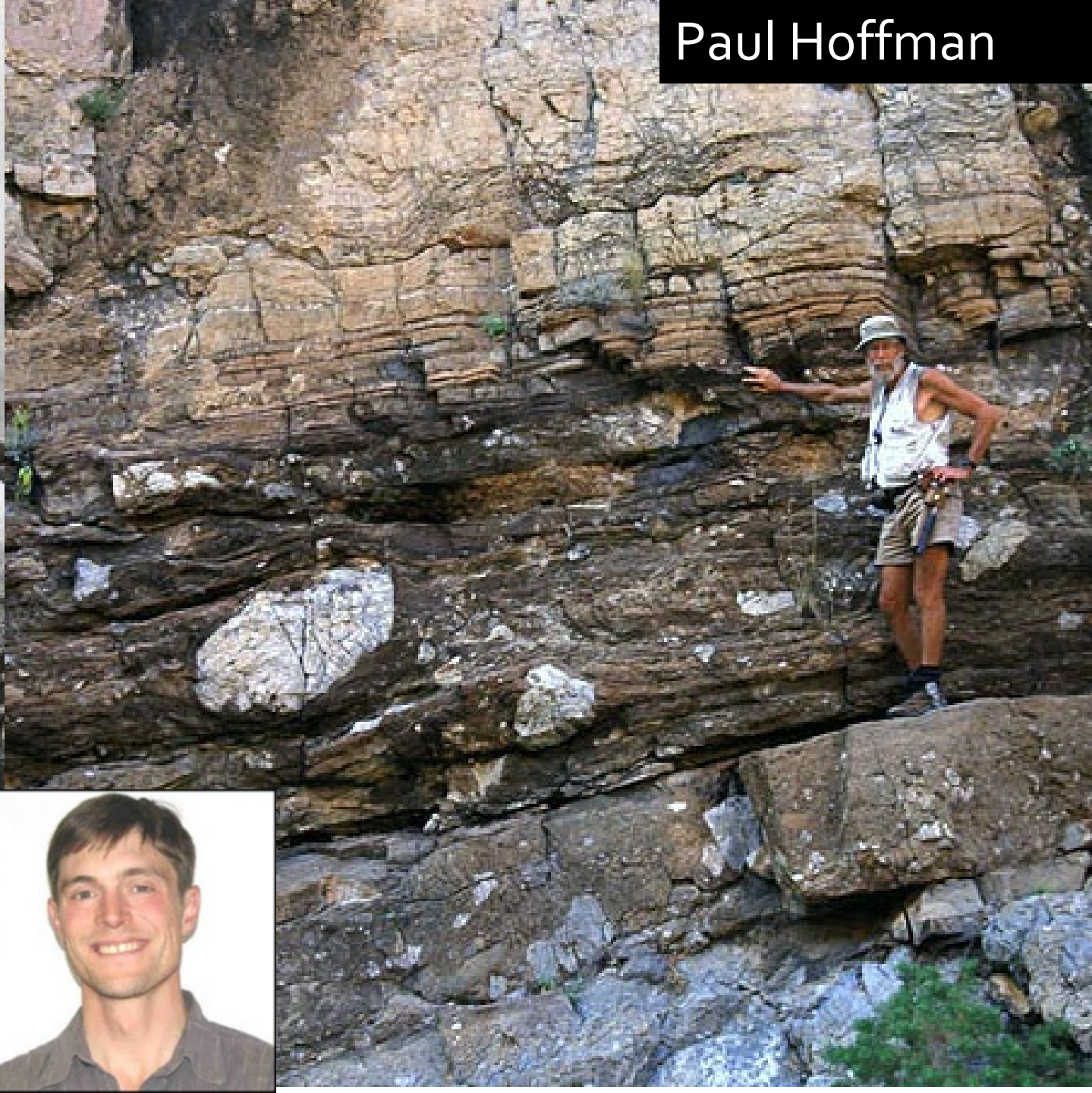
- Winter snow must extend into and through summer
 - Solar radiation was 6% less lower
 - H to He, increased core density
- Neoproterozoic Supercontinent
 - Rodinia, equatorial, easier for intercontinental glacial expansion
- Positive Feedback
 - Glacial albedo

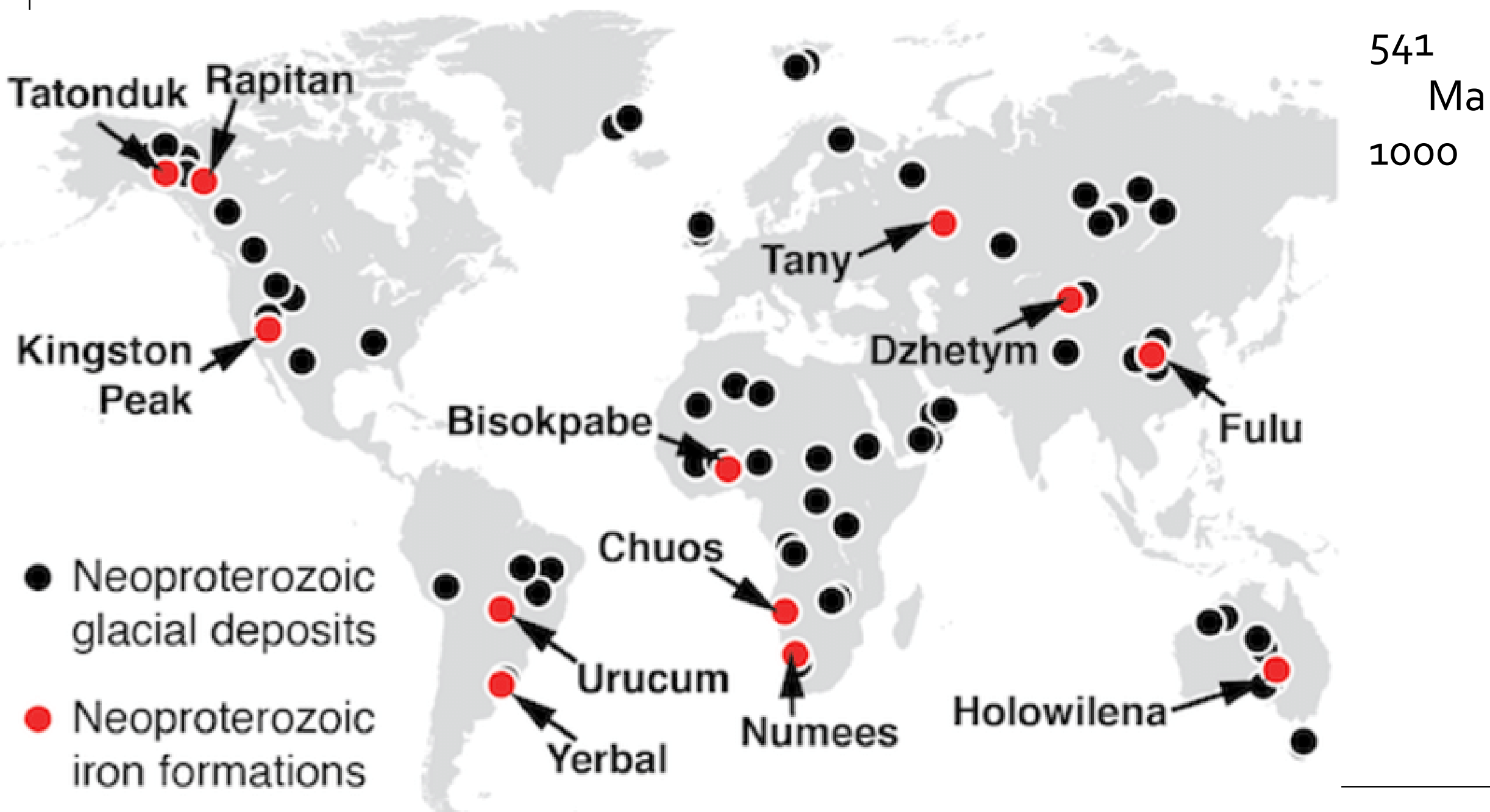


Grant Young



Paul Hoffman





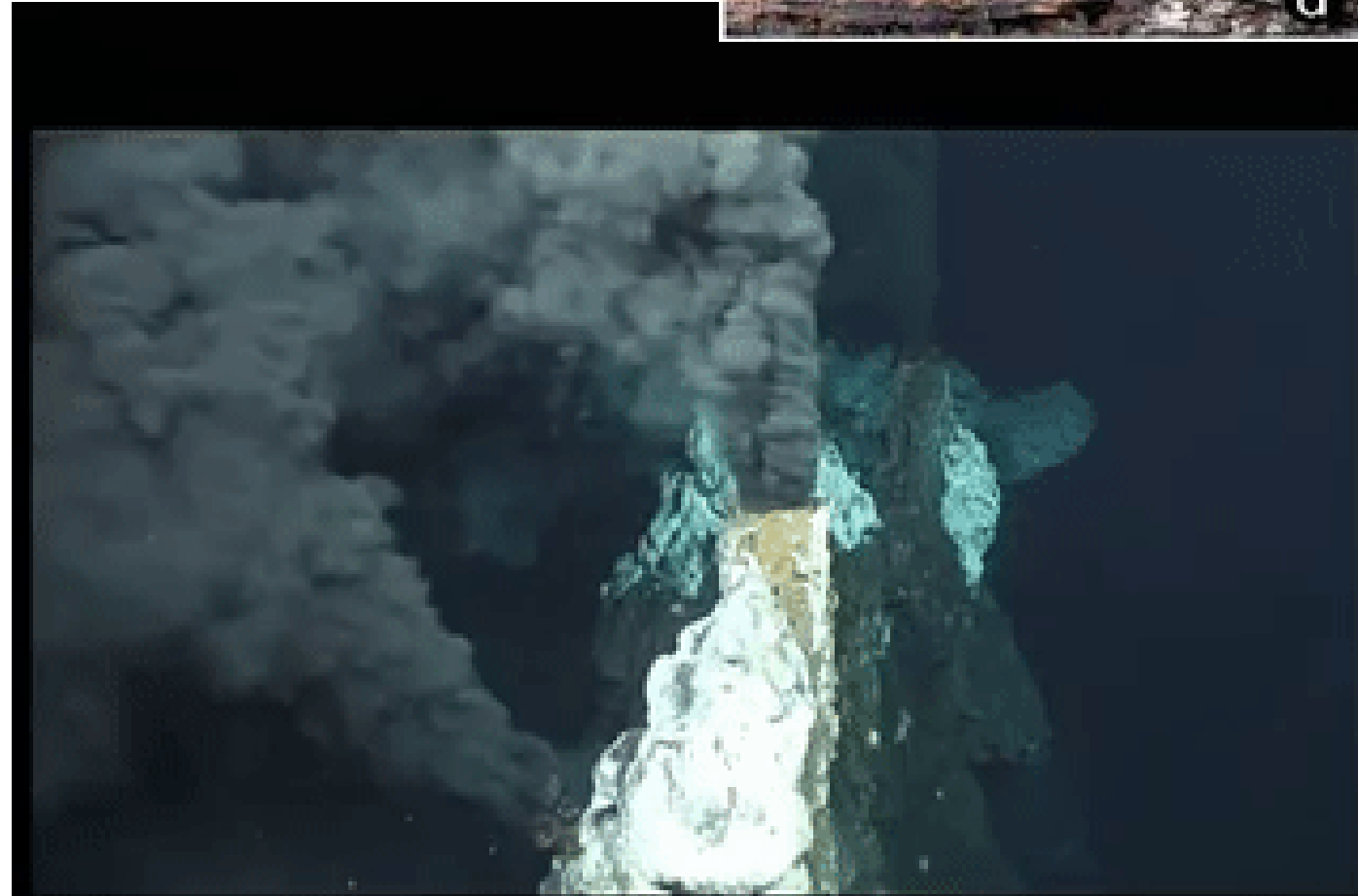
Banded Iron Formations (BIF)

Initial Hypothesis –

- Started again in correlation with glaciations because O_2 concentration was low due to increased ice cover' Similar to Archean Seas...

Current hypothesis

- O_2 isn't the most important factor, Rather BIF are common during increased seafloor hydrothermal activity
- BIFs were developed during glacial retreat, causing sea level to rise



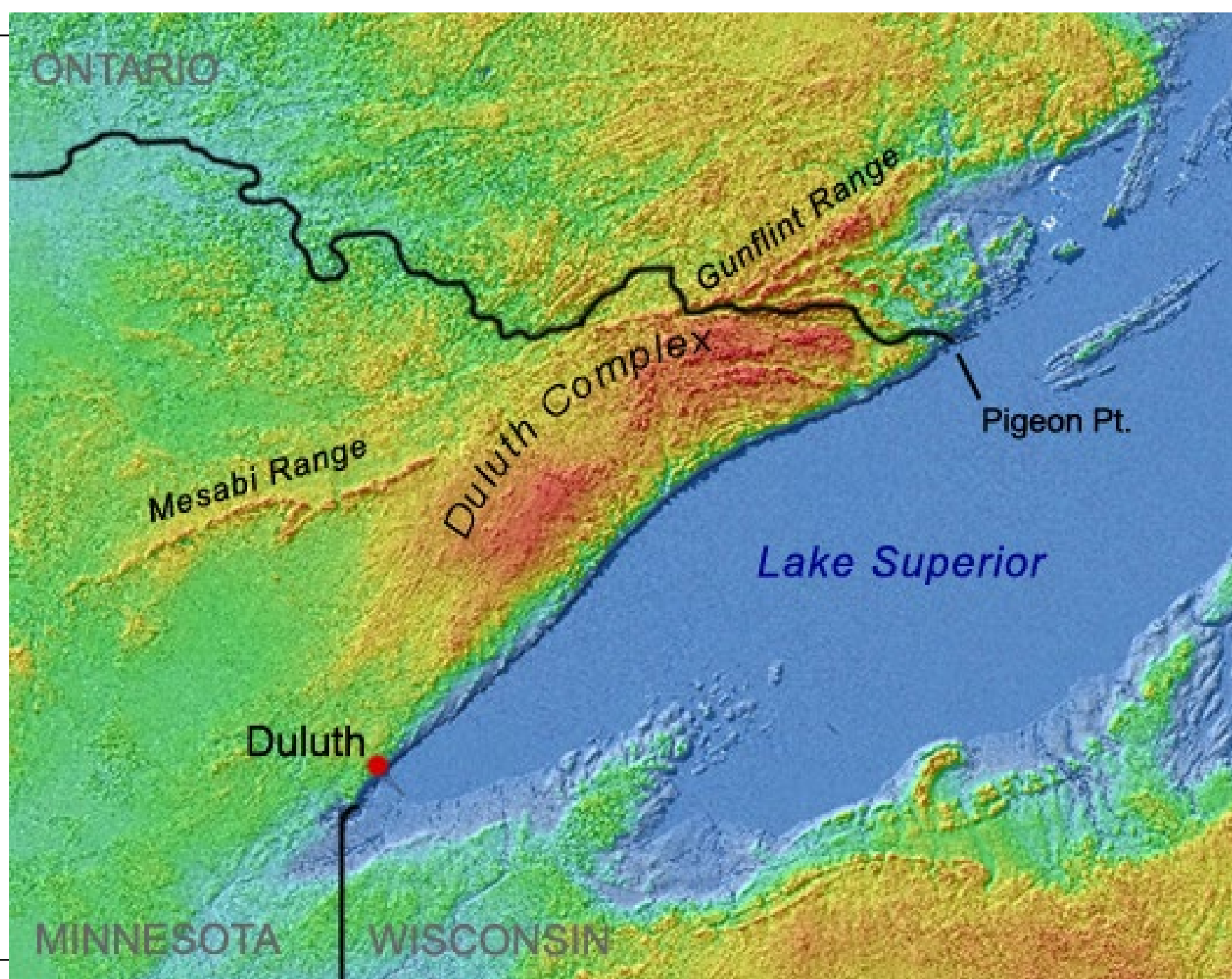
Evidence for...

- If the oceans were frozen, they would become depleted in O_2 because photosynthesis from phytoplankton would end.
- Aerobic bacteria would continue until all dissolved O_2 would be used.

Against...

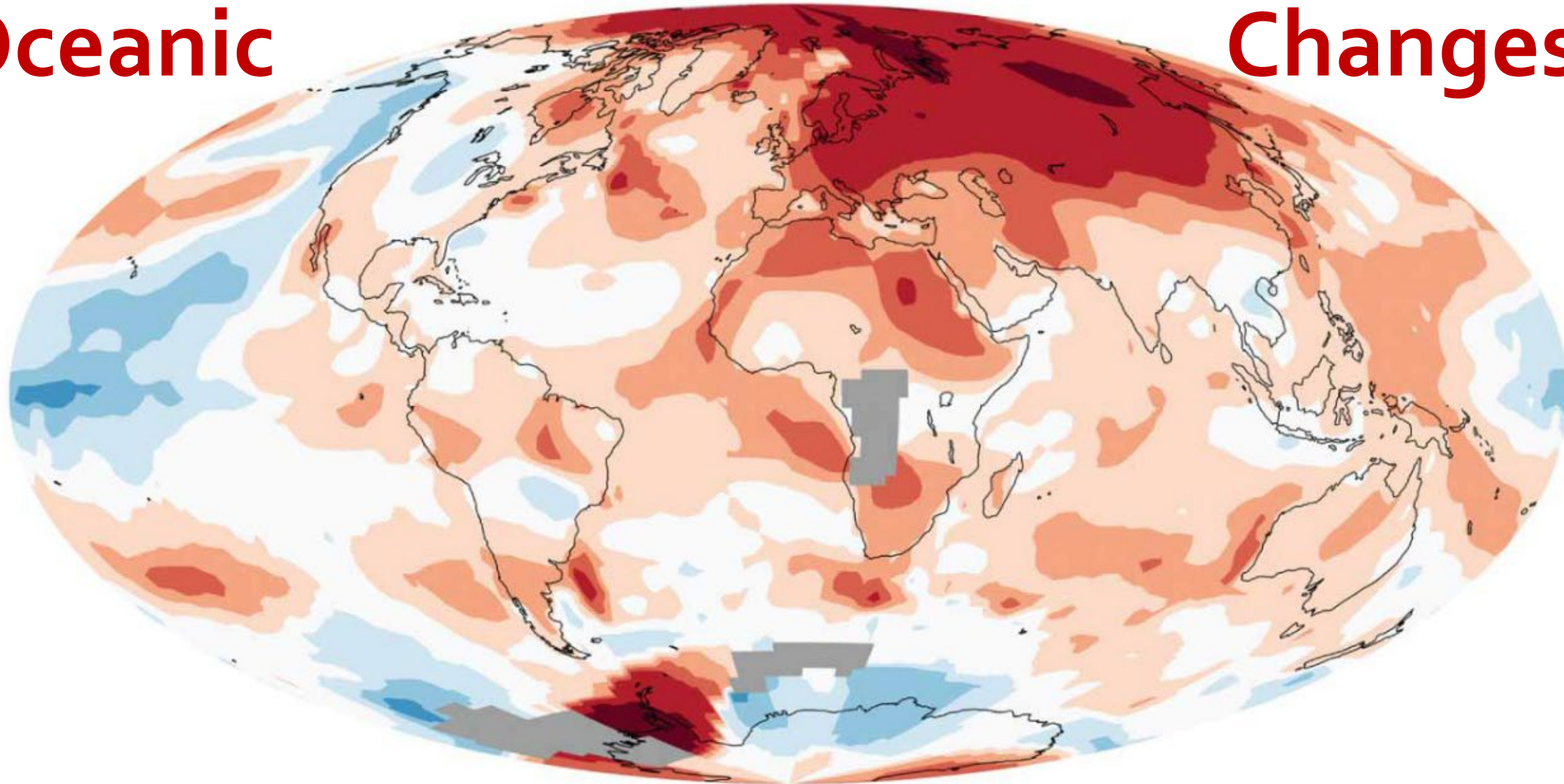
- There are no oceanic Mass Extinctions during the Neoproterozoic
- There is evidence of dropstones in both Sturtian and Marinoan Tillites.

Geochemistry & Geophysics



Oceanic

Changes



2008 Surface Temperature Anomaly (degrees Celsius)



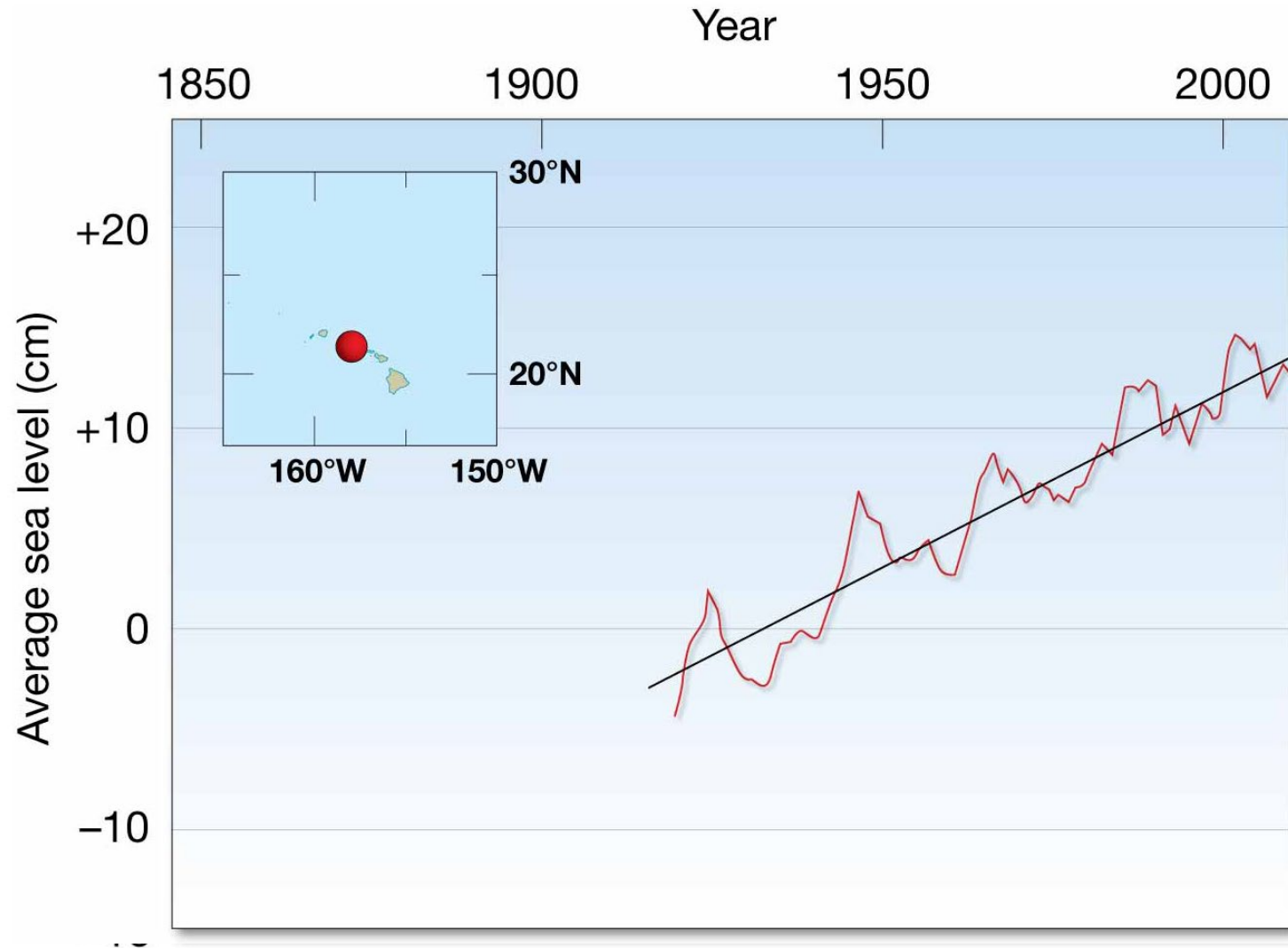
Melting polar ice

- Accelerating
- Arctic Amplification
 - Warming leads to less ice
 - Less ice leads to more warming
 - Positive feedback loop

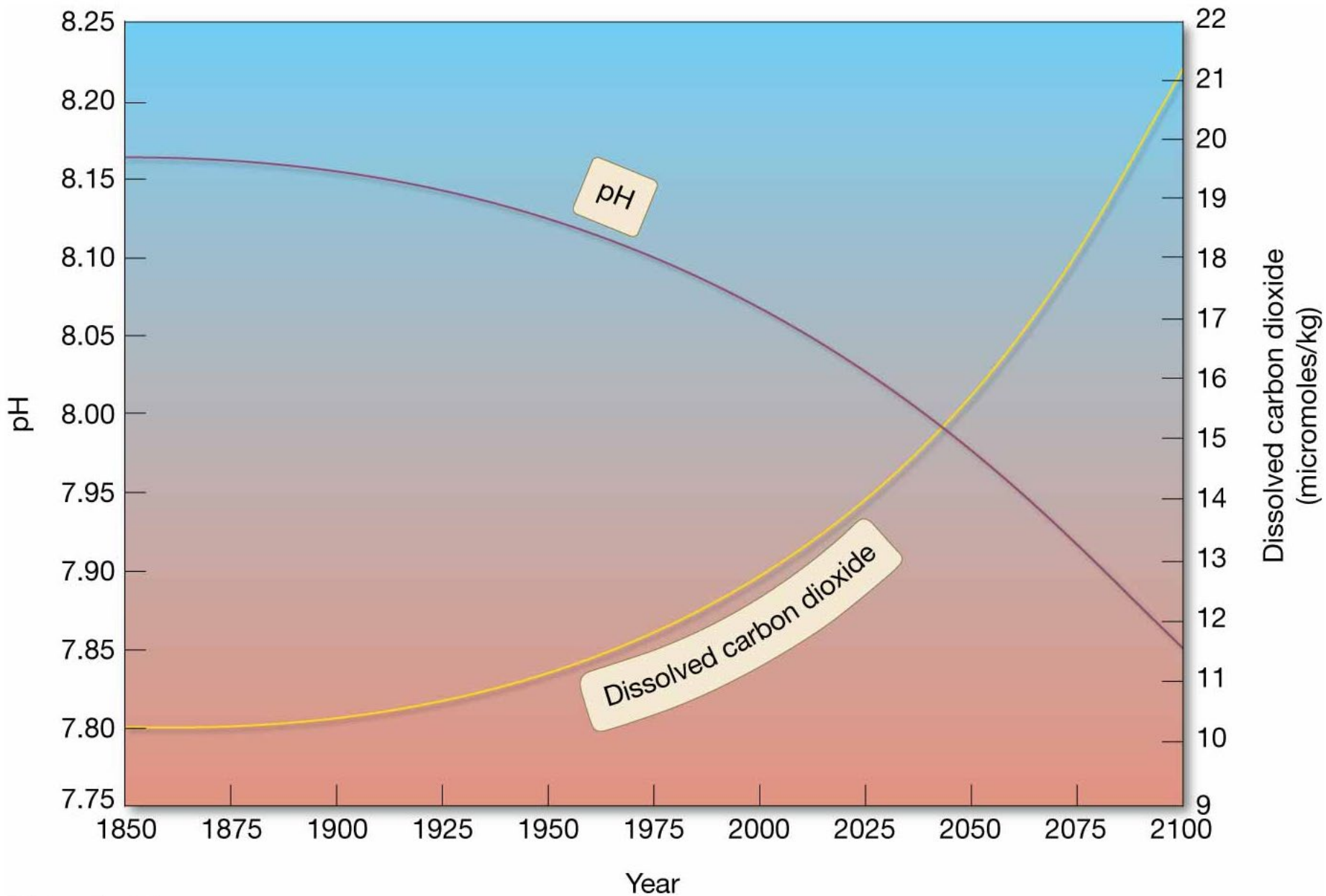


Sea level rise

- Thermal expansion
 - Expansion of surface water
 - Expansion of deep water
- Increased water availability
 - Melting of Antarctic and Greenland ice sheets
 - Melting of Terrestrial glaciers

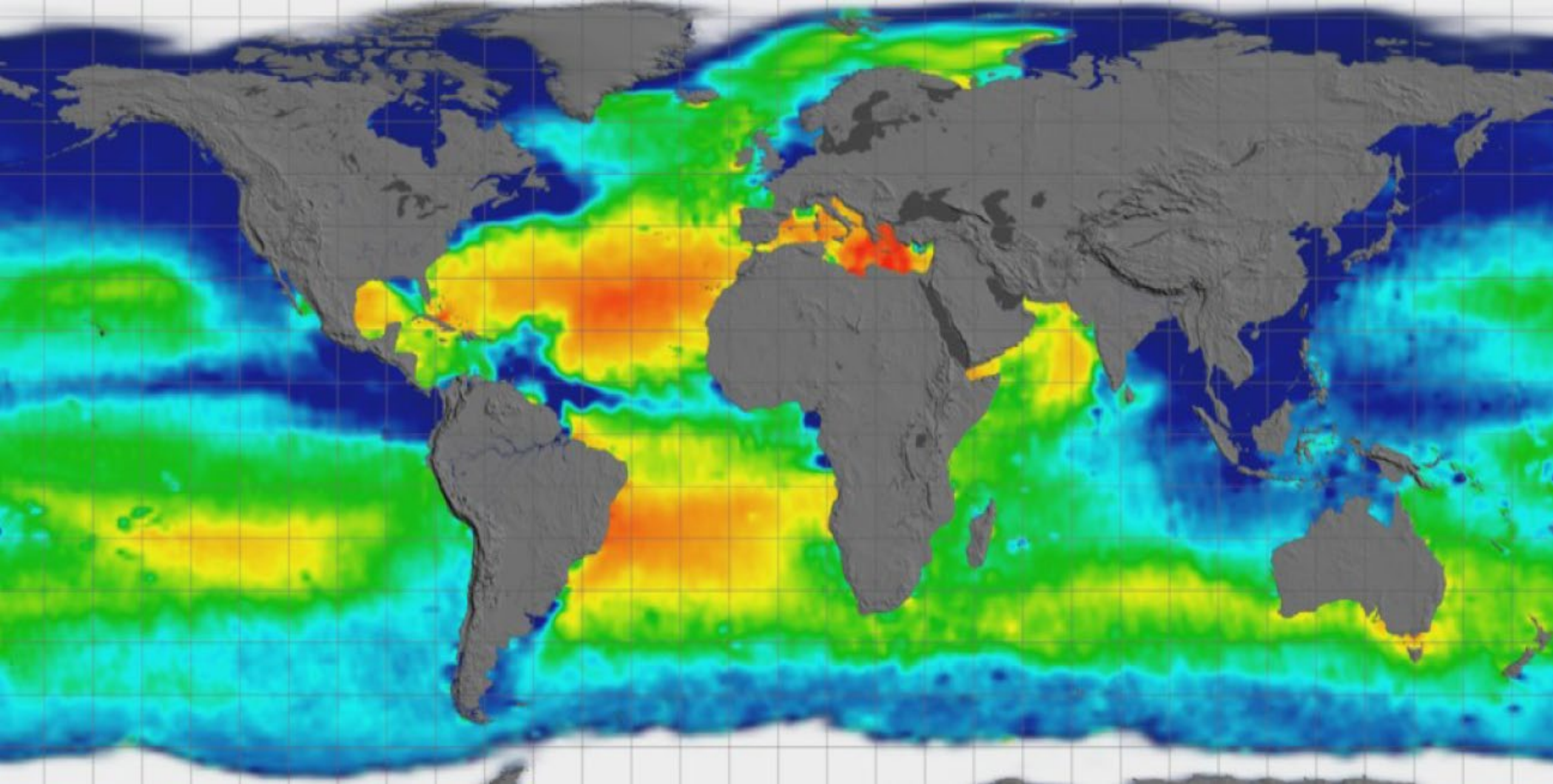


OCEAN ACIDIFICATION



atmosphere





<https://salinity.oceansciences.org/highlightso3.htm>

Changes in Deep Ocean Currents and storage

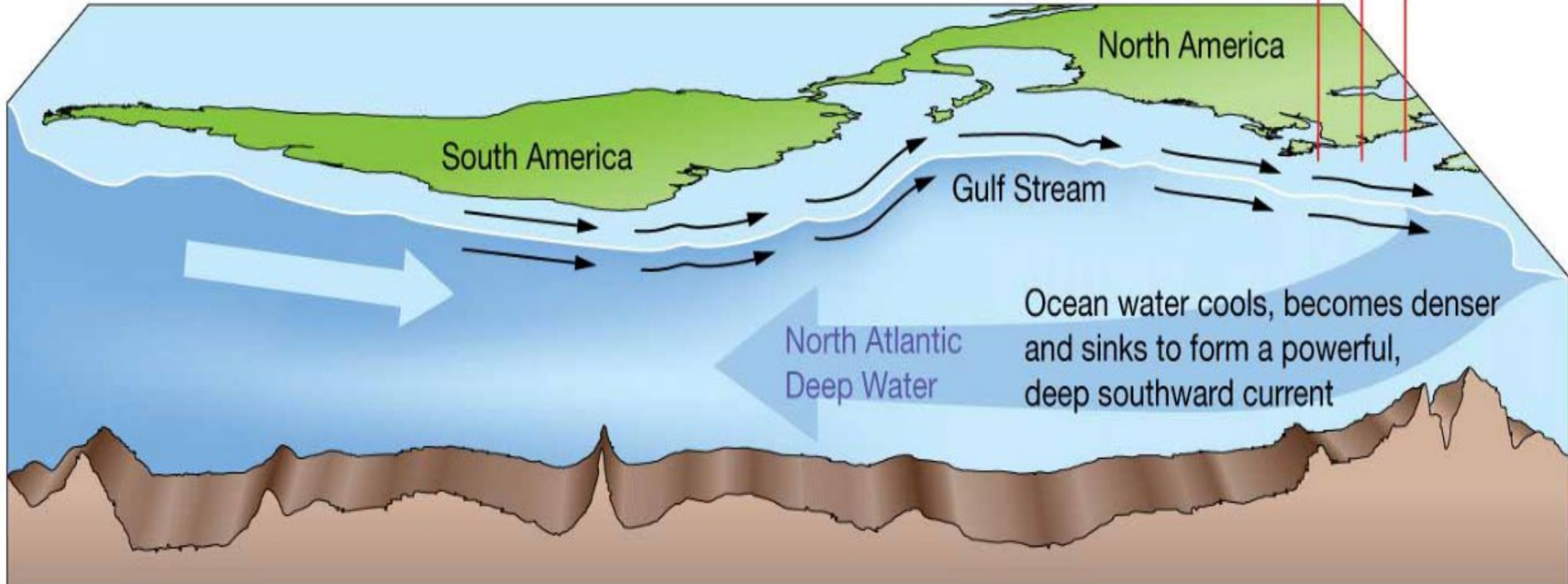
Reduced Reservoir Capacity

to

Reversal ?

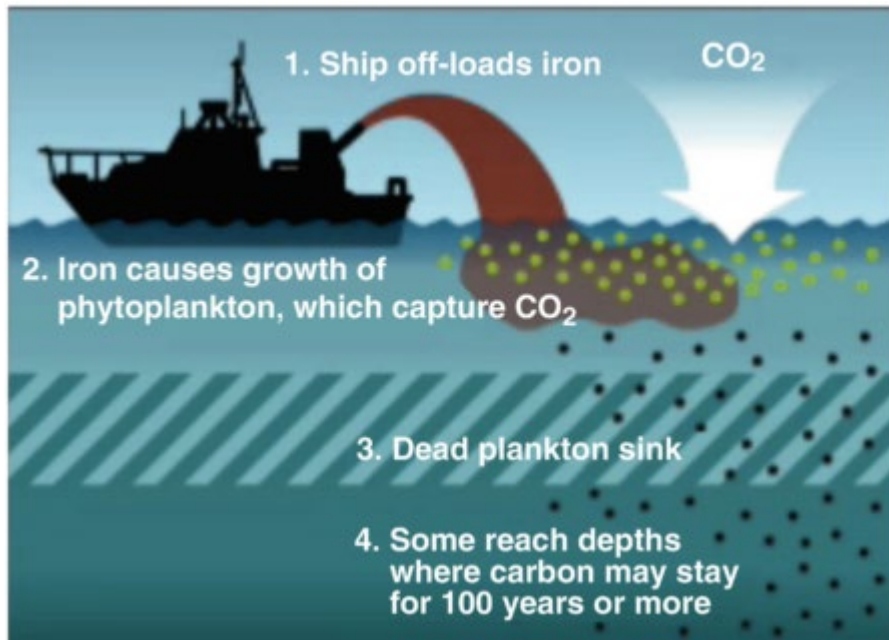
Ocean releases large amount of heat to atmosphere

North Atlantic Ocean Circulation



GeoEngineering

- Carbon Dioxide Sequestration
- Iron Hypothesis



- Good ideas?

<https://grist.org/energy/a-midwest-pipeline-promises-to-return-carbon-dioxide-to-the-ground/>

NORTH DAKOTA IS A GREAT PLACE FOR CCUS

CARBON CAPTURE, UTILIZATION, AND STORAGE (CCUS) ADDRESSES AN ENVIRONMENTAL CHALLENGE, AND NORTH DAKOTA IS A GREAT PLACE TO DO IT.

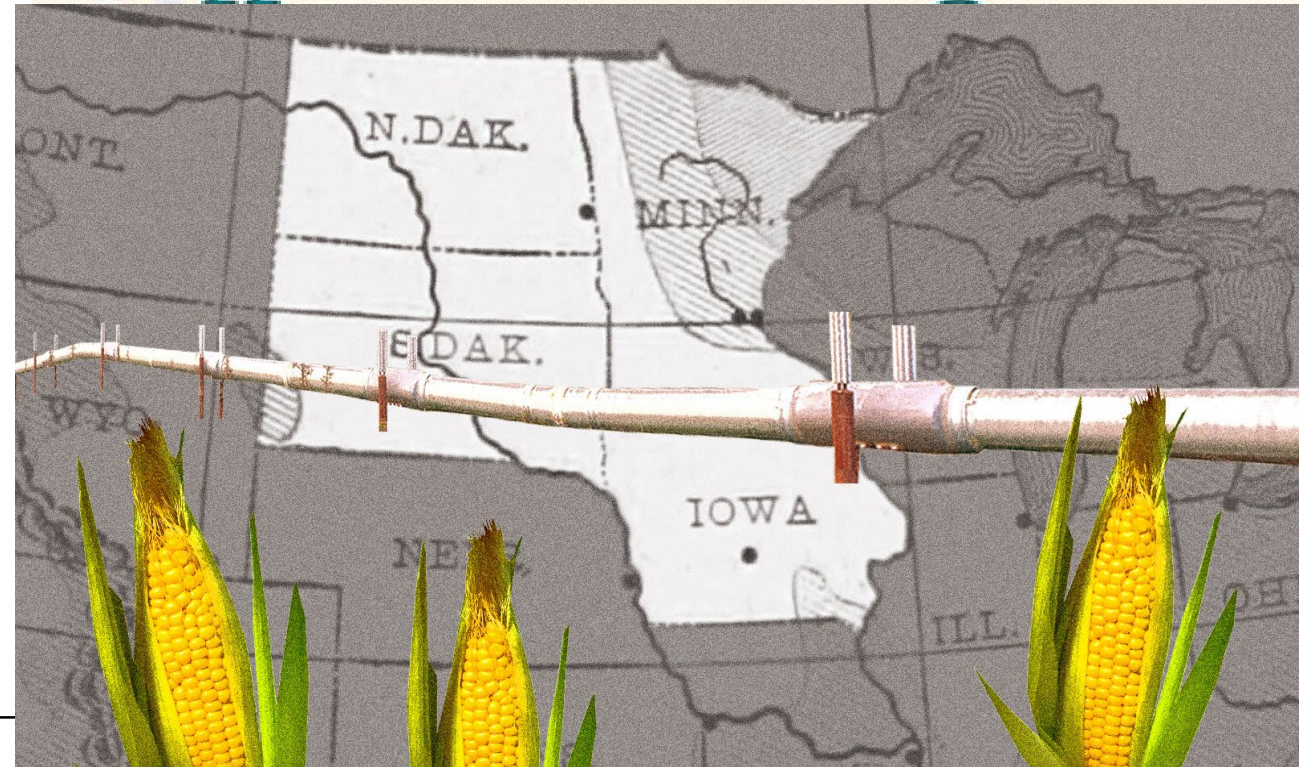
Scientists are concerned that increased greenhouse gases from human activities are contributing to climate change.

Carbon dioxide from North Dakota's energy development and consumption is one of those greenhouse gases.

CCUS reduces CO_2 emissions from large, stationary sources.

WHAT IS CCUS?

Carbon capture, utilization, and storage is a method of significantly reducing CO_2 emissions to the atmosphere.

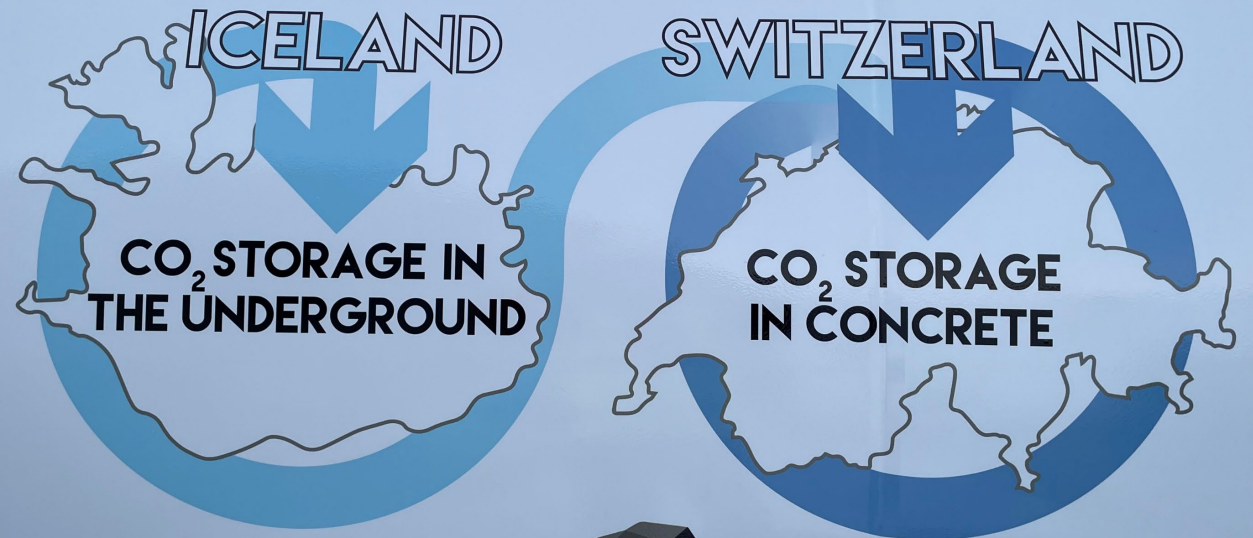




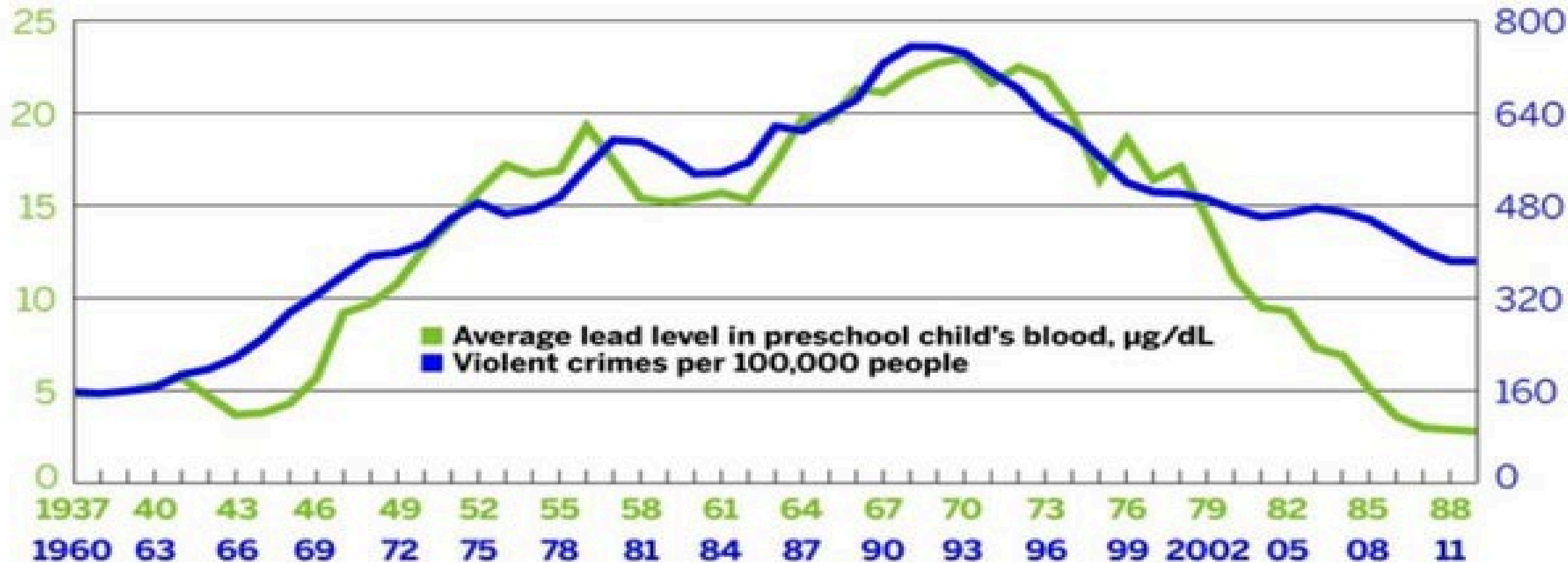
[Empty box for caption text]



EXPLORING CO₂ MANAGEMENT SOLUTIONS



DEMO UP  CARMA

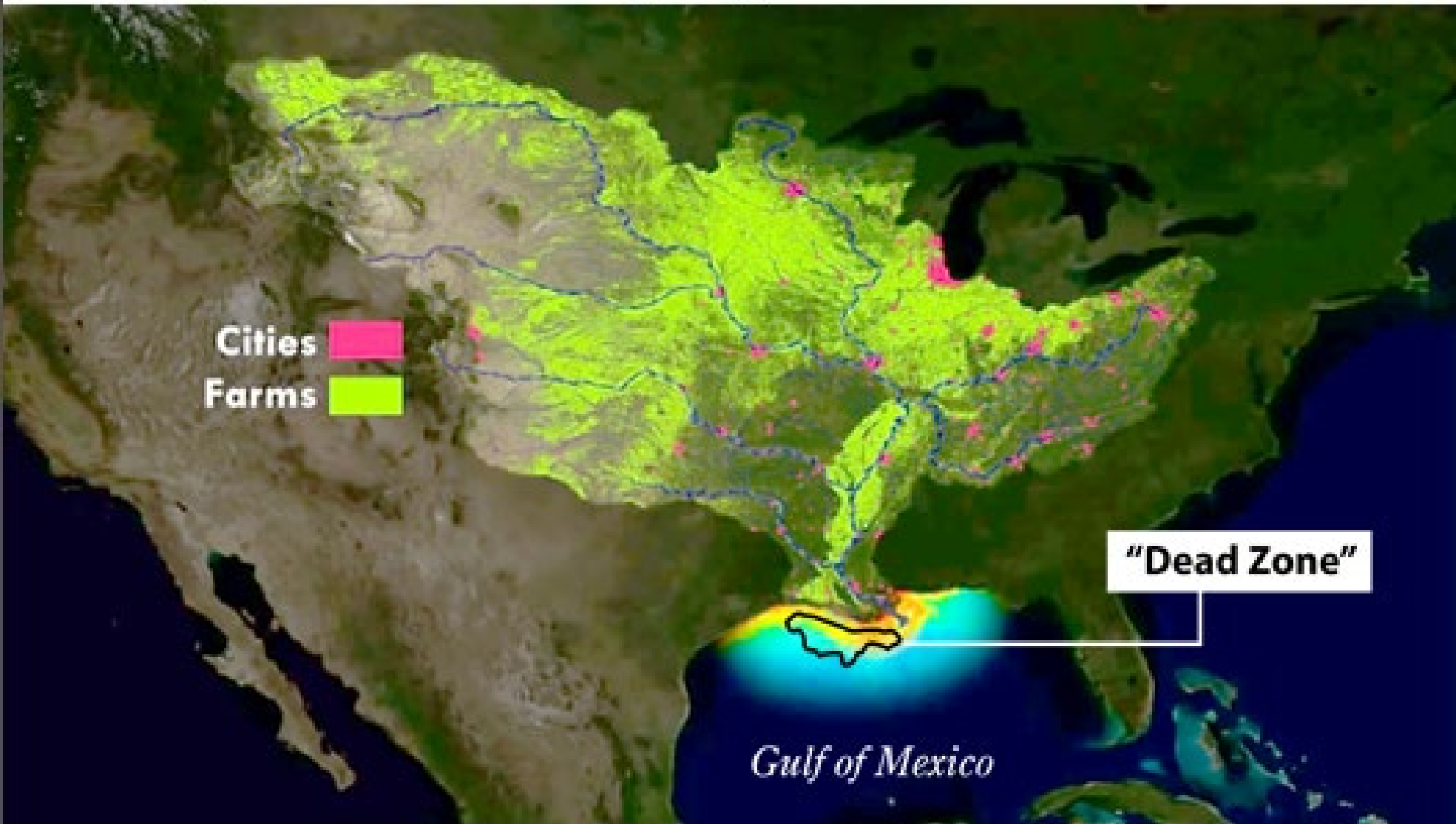


A timeline of lead reduction

| | | | | | |
|--|---|---|--|---|---|
| <p>1970 CDC sets acceptable blood-lead level of 40 µg/dL</p> | <p>1973 EPA mandates a phaseout of leaded gasoline</p> | <p>1978 CPSC bans residential lead paint</p> | <p>1991 CDC sets acceptable blood-lead level of 10 µg/dL</p> | <p>1996 EPA eliminates lead from all U.S. motor fuel</p> | <p>2012 CDC describes blood-lead level of >5 µg/dL as elevated</p> |
|--|---|---|--|---|---|

Gulf 'Dead Zone' Chokes Marine Life

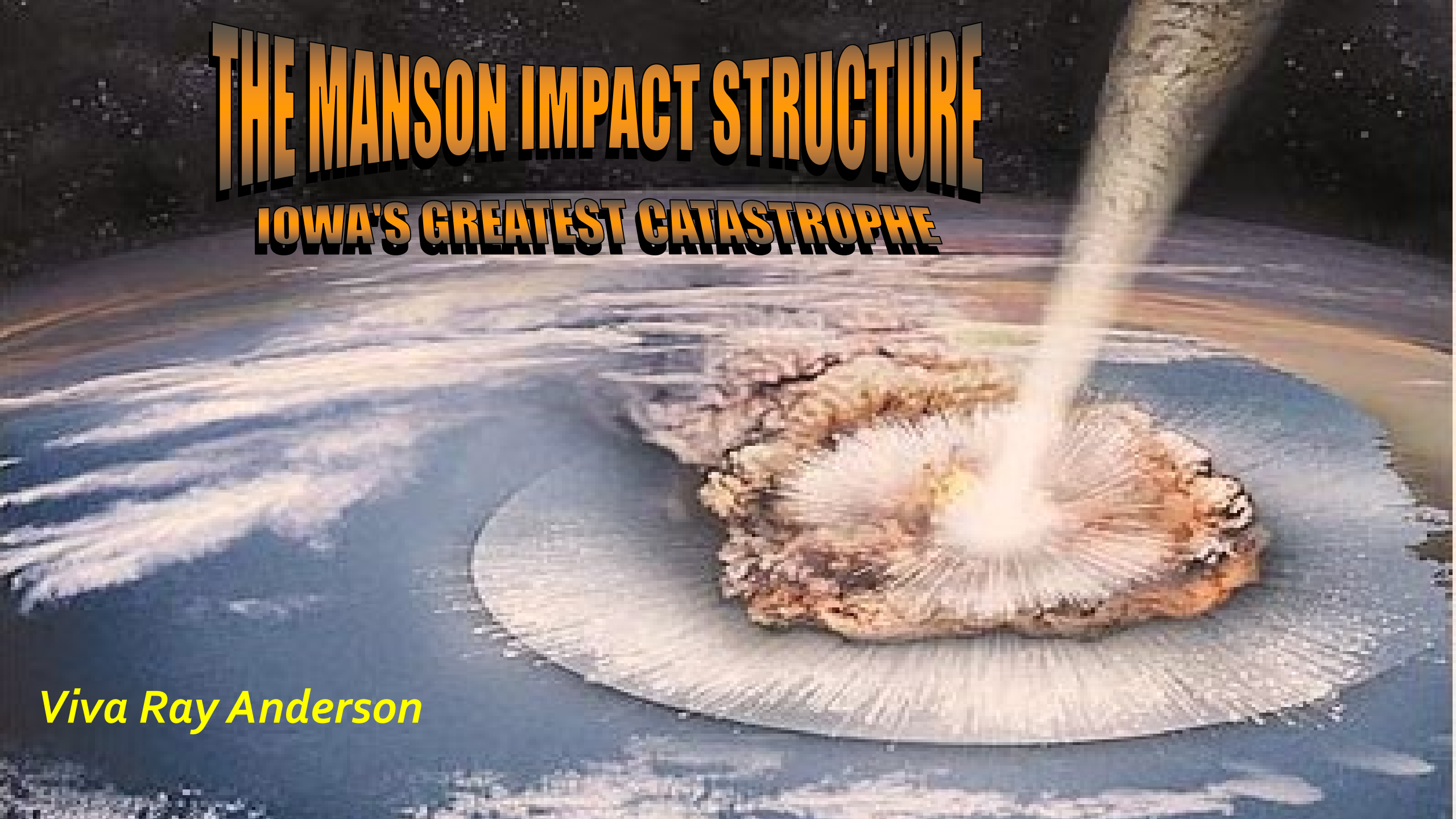
The Gulf of Mexico at the Mississippi River Delta experiences a seasonal *hypoxia*, or "dead zone," where there is not enough oxygen in the water to sustain marine life.



THE MANSON IMPACT STRUCTURE

IOWA'S GREATEST CATASTROPHE

Viva Ray Anderson



MINNESOTA

BEDROCK GEOLOGIC MAP OF IOWA

1:500,000

Iowa Geological and Water Survey
Open File Map OFM-2010-01
March 2010

Prepared and Compiled by
Brian J. Wilkie, Raymond R. Anderson and John P. Pope
Iowa Geological and Water Survey, Iowa City, Iowa

Iowa Geological and Water Survey
Richard D. Liden, State Geologist
Iowa Department of Natural Resources
Richard Leopold, Director

ACKNOWLEDGEMENTS

Recognized for significant contributions to the map's production: Bill J. Bralier, James D. Childers, Steve A. Lamberson, Robert M. McKay, Huanuo P. Liu, and Thomas E. Marshall.
Supported in part with funding from the U.S. Geological Survey's National Cooperative Geologic Mapping Program.

SOUTH DAKOTA

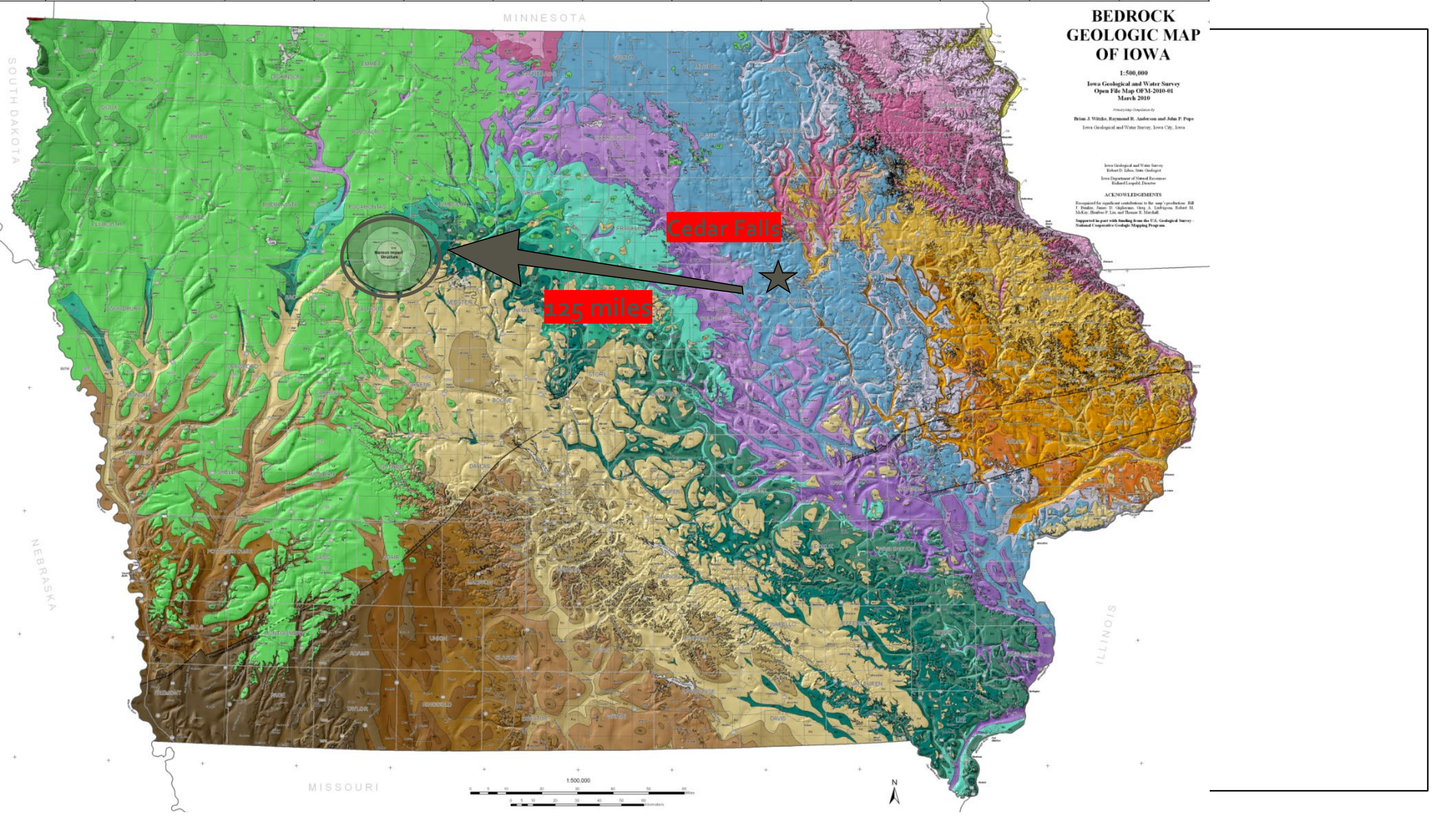
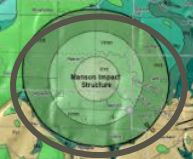
NEBRASKA

ILLINOIS

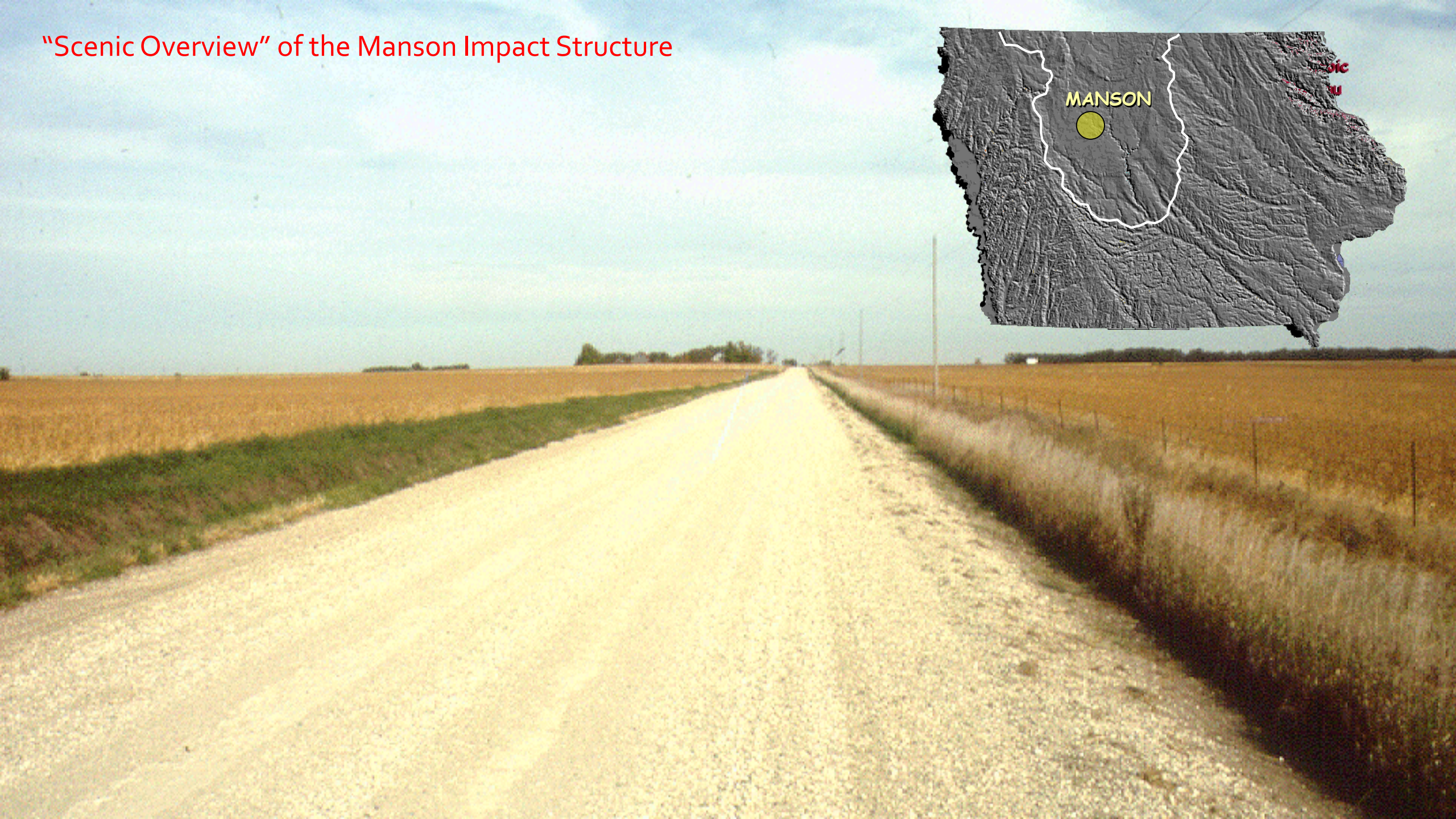
MISSOURI

Cedar Falls

125 miles



"Scenic Overview" of the Manson Impact Structure



Iowa Geological Survey Annual Report Volume 33 1928

The facies of the cuttings also is abnormal, especially in the appearance of conglomerate and in the large amount of arkosic material. In some aspects they are strikingly similar to those of the De Witt well below the Saint Peter sandstone, and to similar sections at Maquoketa and Preston, which the writer has interpreted as the fill of deep erosion channels cut in rocks of the Prairie du Chien during the interval preceding the deposit of the Saint Peter sandstone.

The exceptional character and thickness of the shales and arkose of the Manson well are explainable by a like hypothesis—the fill with continental deposits, and finally with marine sediments also, of a valley of erosion. The depth of the valley, 300 feet deeper than that of the Mississippi in northeastern Iowa, is notable. The arkosic material of the fill suggests that the headwaters of the river worked in the igneous rocks of the states bordering Iowa on the north.

The deposits themselves, so far as the cuttings reveal them, do not appear to offer conclusive evidence as to their age, whether they were laid at the close of the long erosion interval preceding the deposit of the Pennsylvanian or of that preceding the Cretaceous. The fact that Manson is located less than 5 miles west of the provisional eastern border of the Cretaceous would preclude the expectation of finding there any great thickness of normal marine sedimentary deposits of Cretaceous age, but not the fill of a deep pre-Cretaceous valley.

DEEP WELLS OF IOWA (A Supplementary Report)

by

W.H. NORTON

WITH A CHAPTER ON

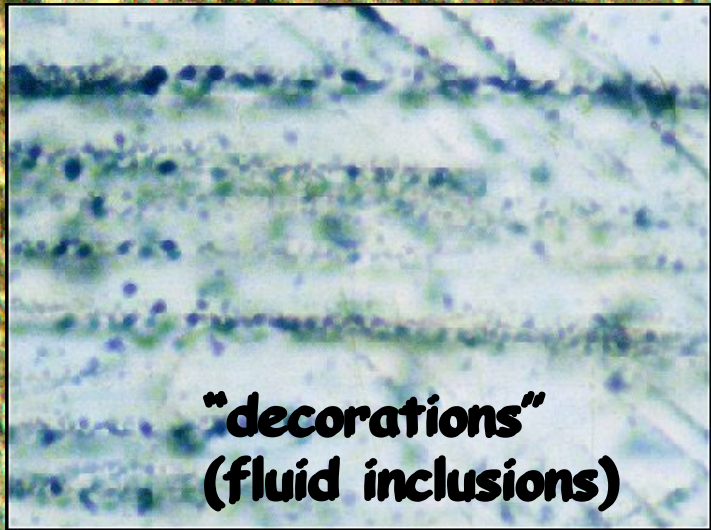
Well Water Recessions in Iowa

by

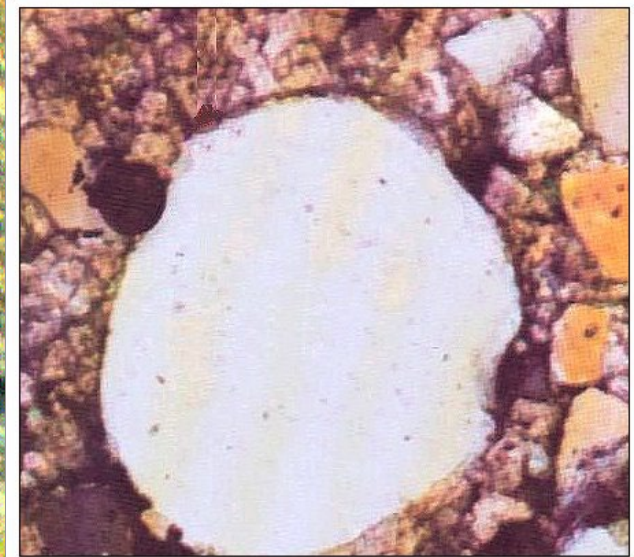
James H. Lees

WITH A TABLE OF IOWA TOWNS GIVING

Municipal Water Supplies



**"decorations"
(fluid inclusions)**



PDFs in
Quartz Grains

Manson 1-A core

1 mm



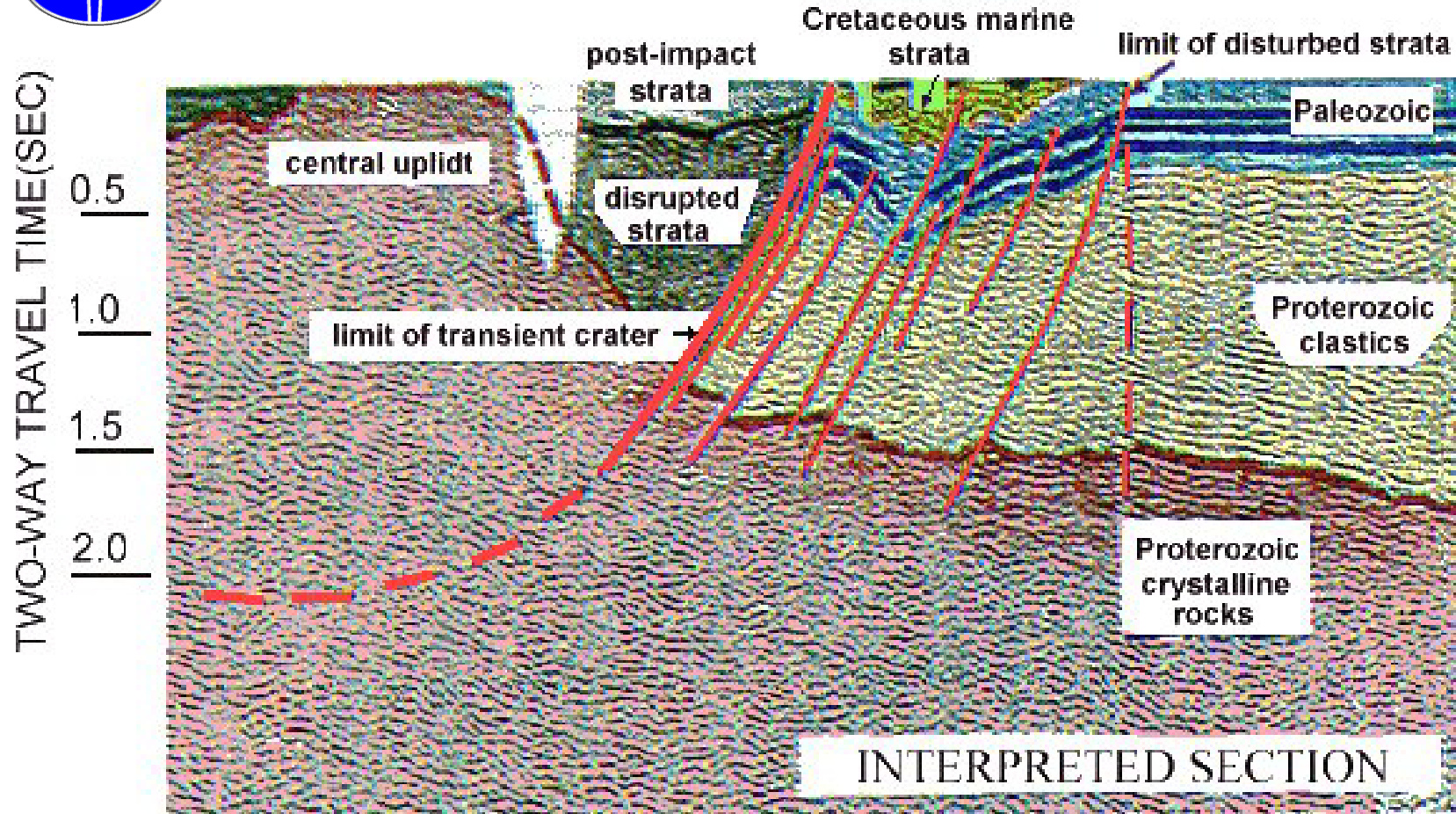


1980

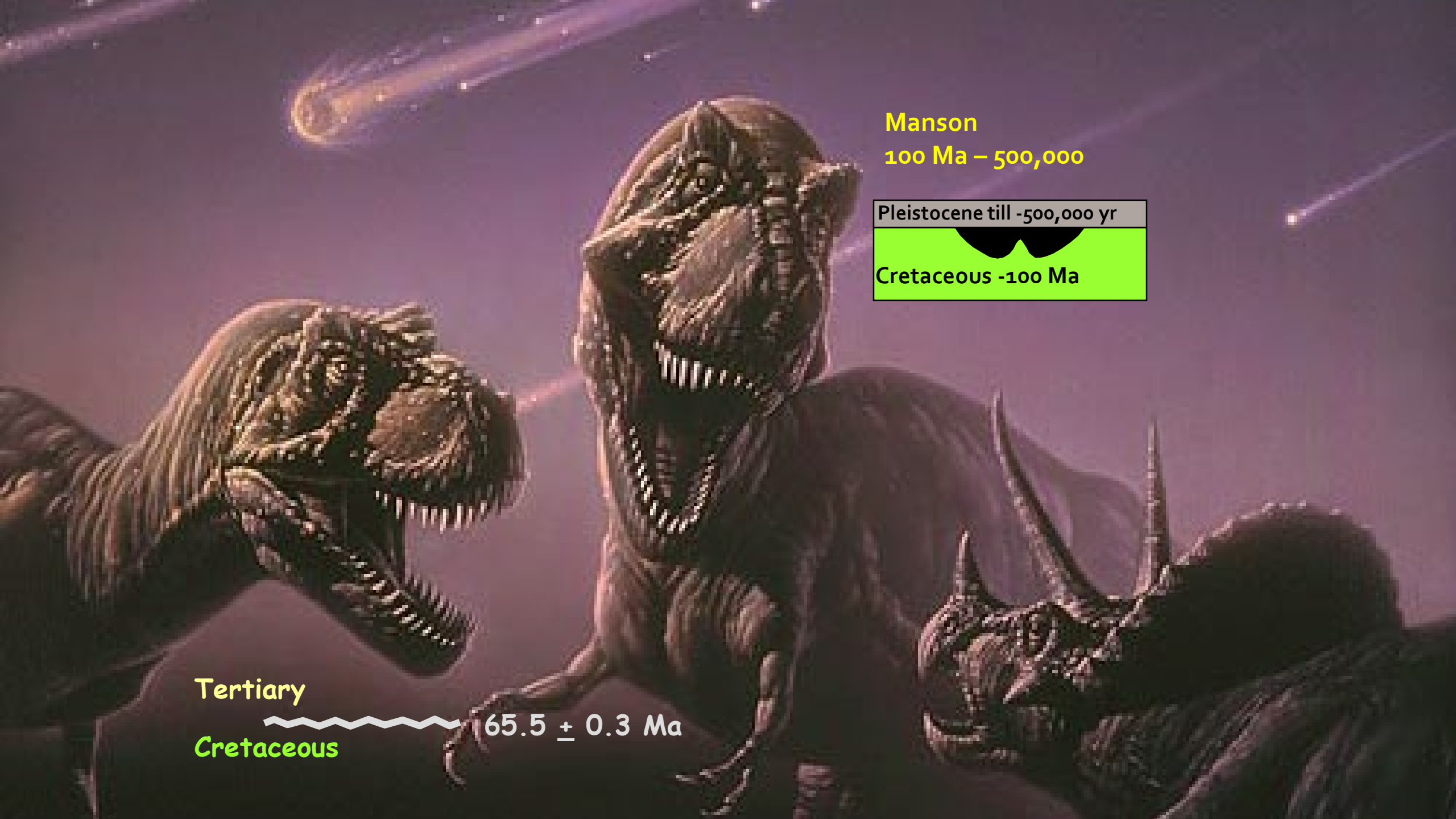
The late Luis Alvarez, a physicist, and his geologist son, Walter, examine a clue to the dinosaurs' demise.



REFLECTION SEISMIC PROFILE



Seismic data courtesy of Amoco Production Co.



Manson
100 Ma – 500,000



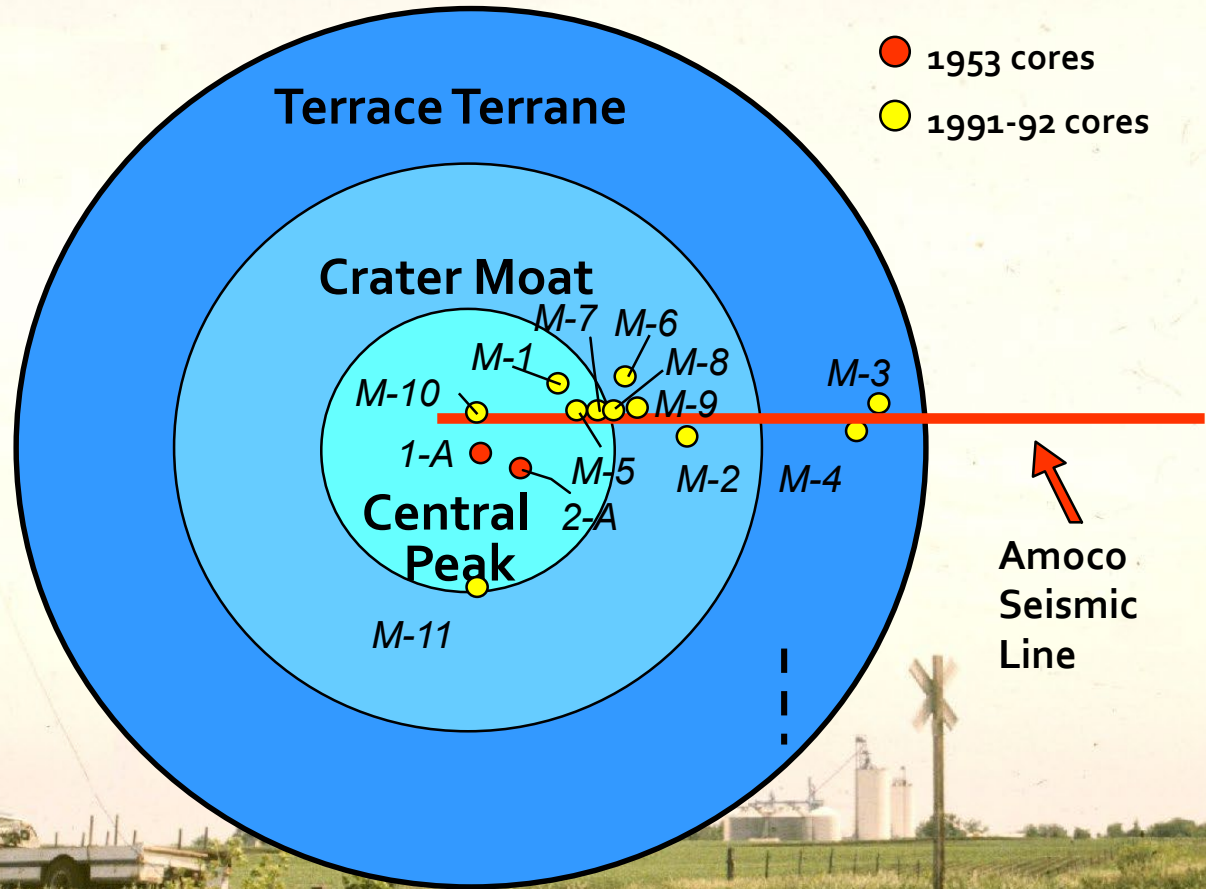
Tertiary
Cretaceous
65.5 ± 0.3 Ma

Manson Drilling

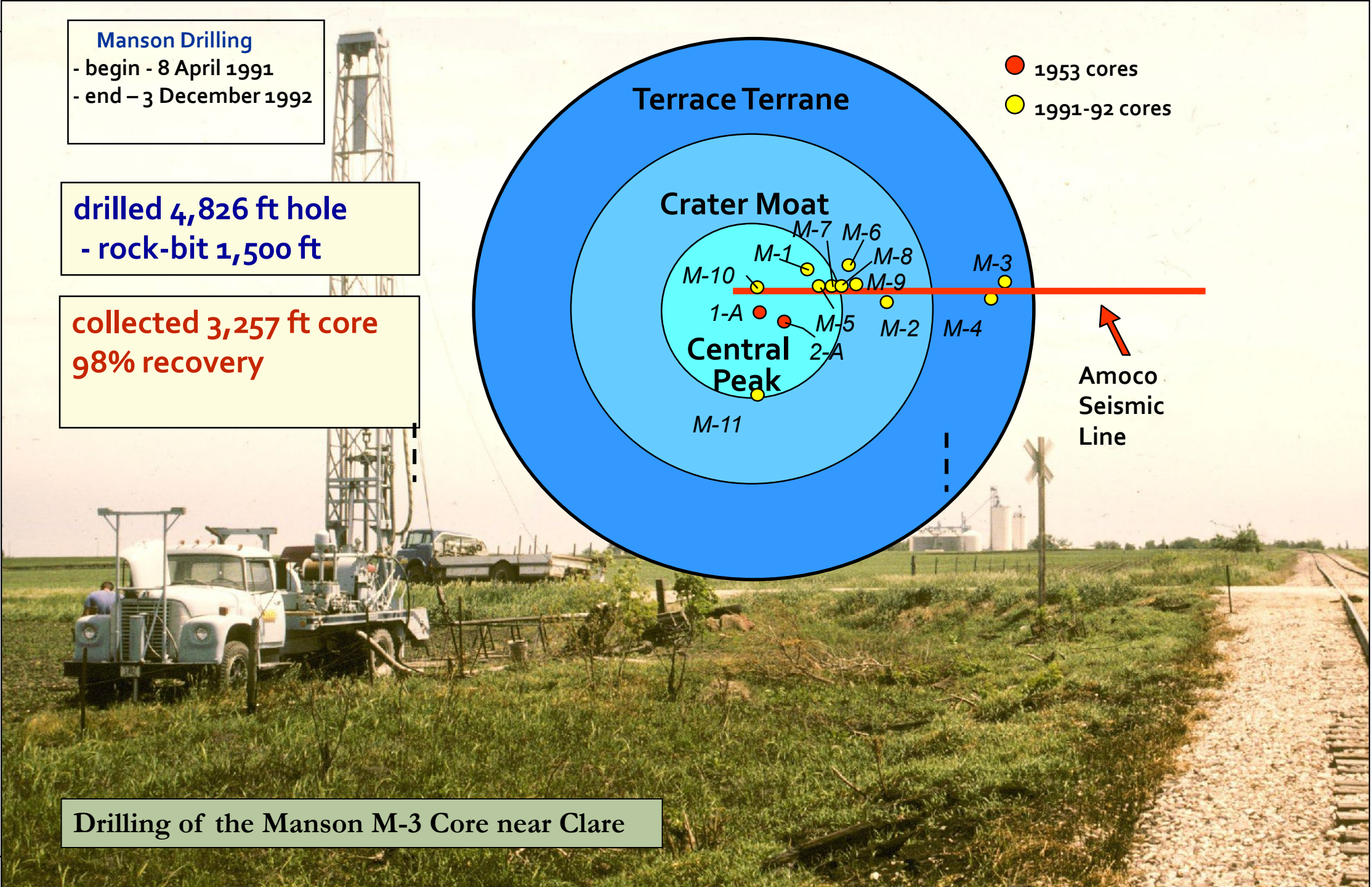
- begin - 8 April 1991
- end - 3 December 1992

drilled 4,826 ft hole
- rock-bit 1,500 ft

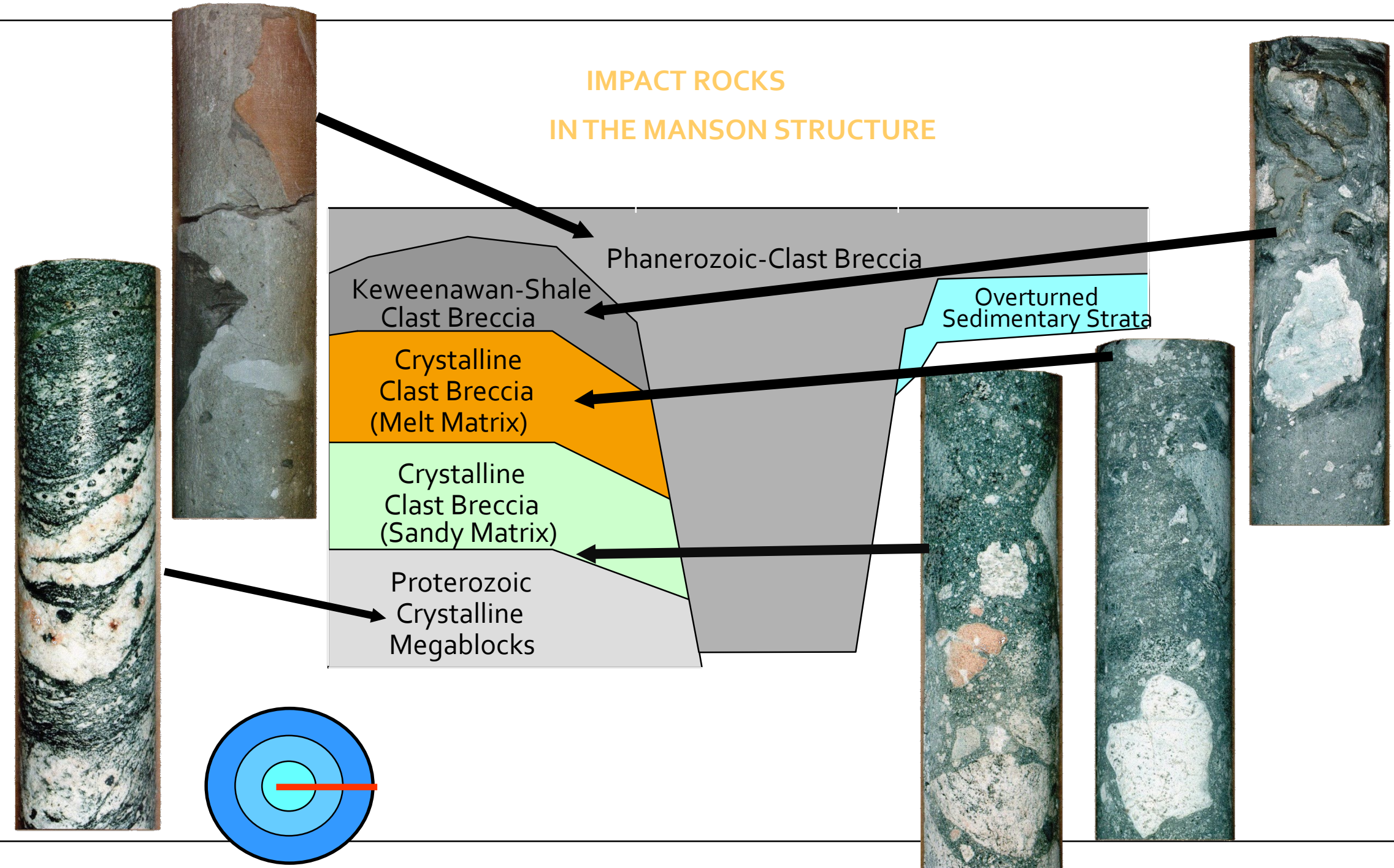
collected 3,257 ft core
98% recovery

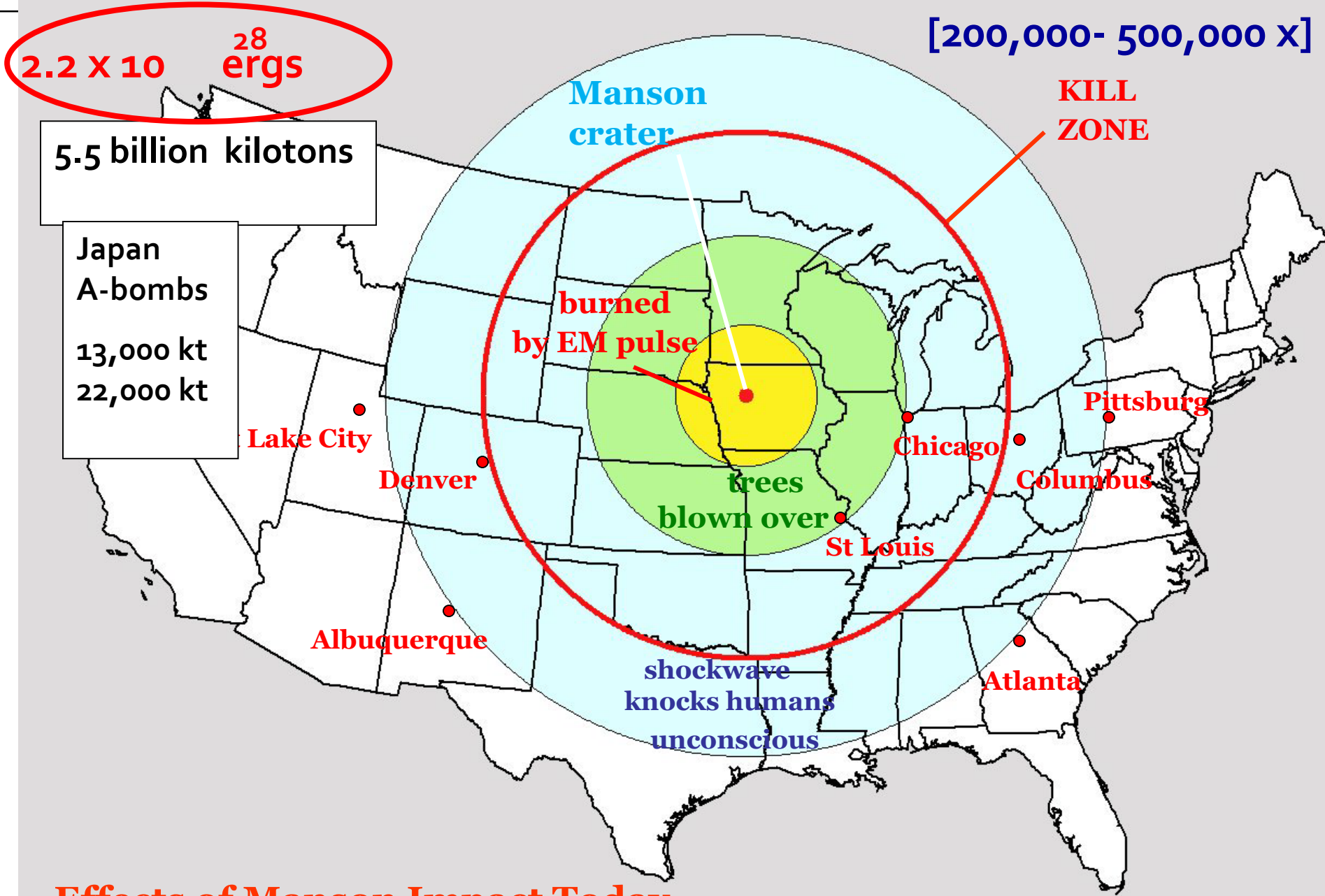


Drilling of the Manson M-3 Core near Clare



IMPACT ROCKS
IN THE MANSON STRUCTURE





Effects of Manson Impact Today

Time for a Glacial Ice story?

