

Devonian to Quaternary

Major Silurian-Devonian Outcomes

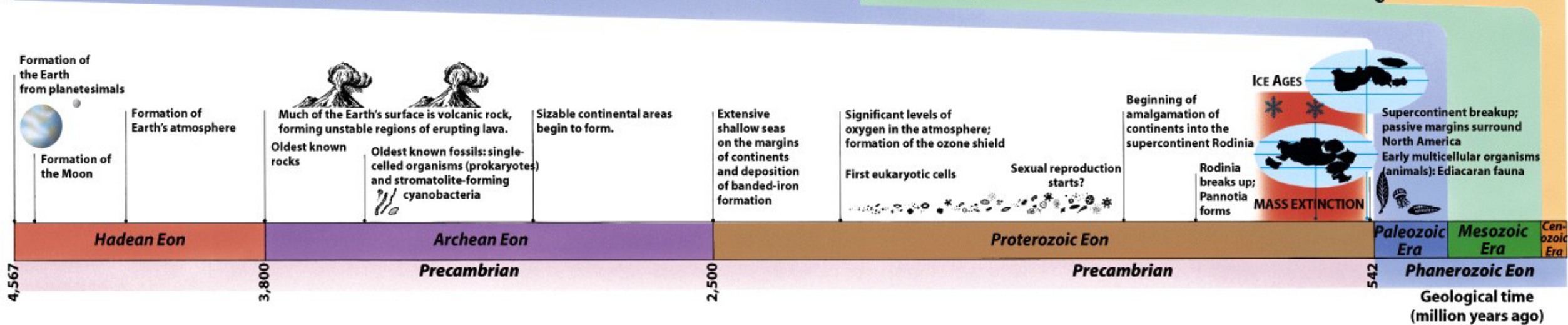
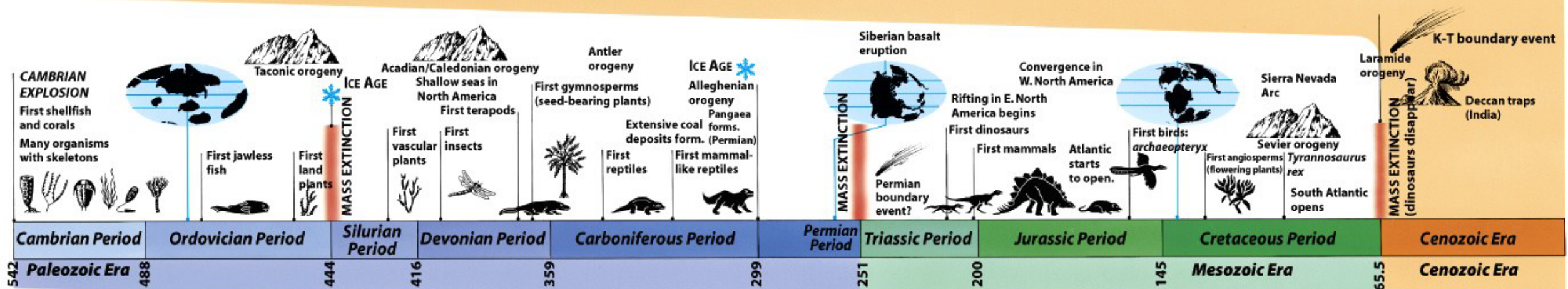
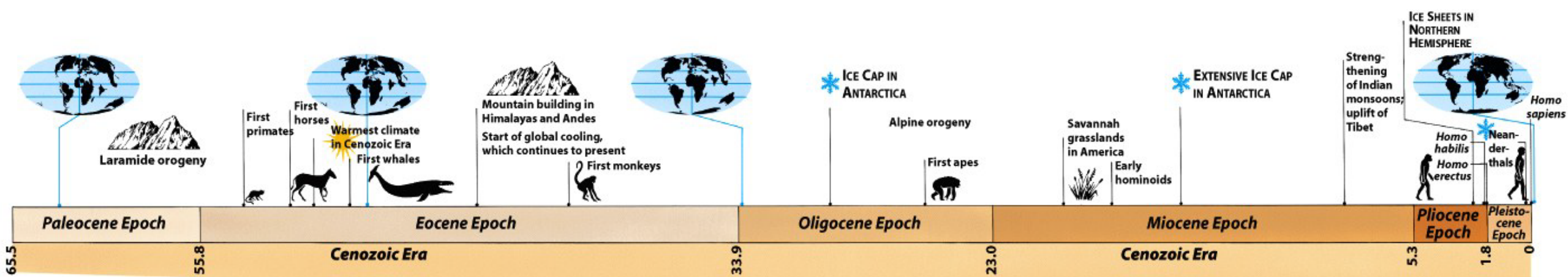
A carbonate
extravaganza

- Diversification of life following the Great Ordovician Biodiversity Extinction (GOBE)
- Jawed fish and mollusks expand into freshwater environments.
- First vascular plants on land (Silurian) along with amphibians and the first insects (Devonian).
- Coral reefs continue to thrive.
- Late Devonian Mass extinction removes much of marine life, nearly all coral-strome reef communities and placoderm fish.
 - Global cooling/glaciation likely triggered these extinctions.
- Acadian Orogeny occurred as Laurentia, Baltica and Avalonia collided creating the Appalachian Mountains of N. America.

Devonian - A Marine Extravaganza 😊

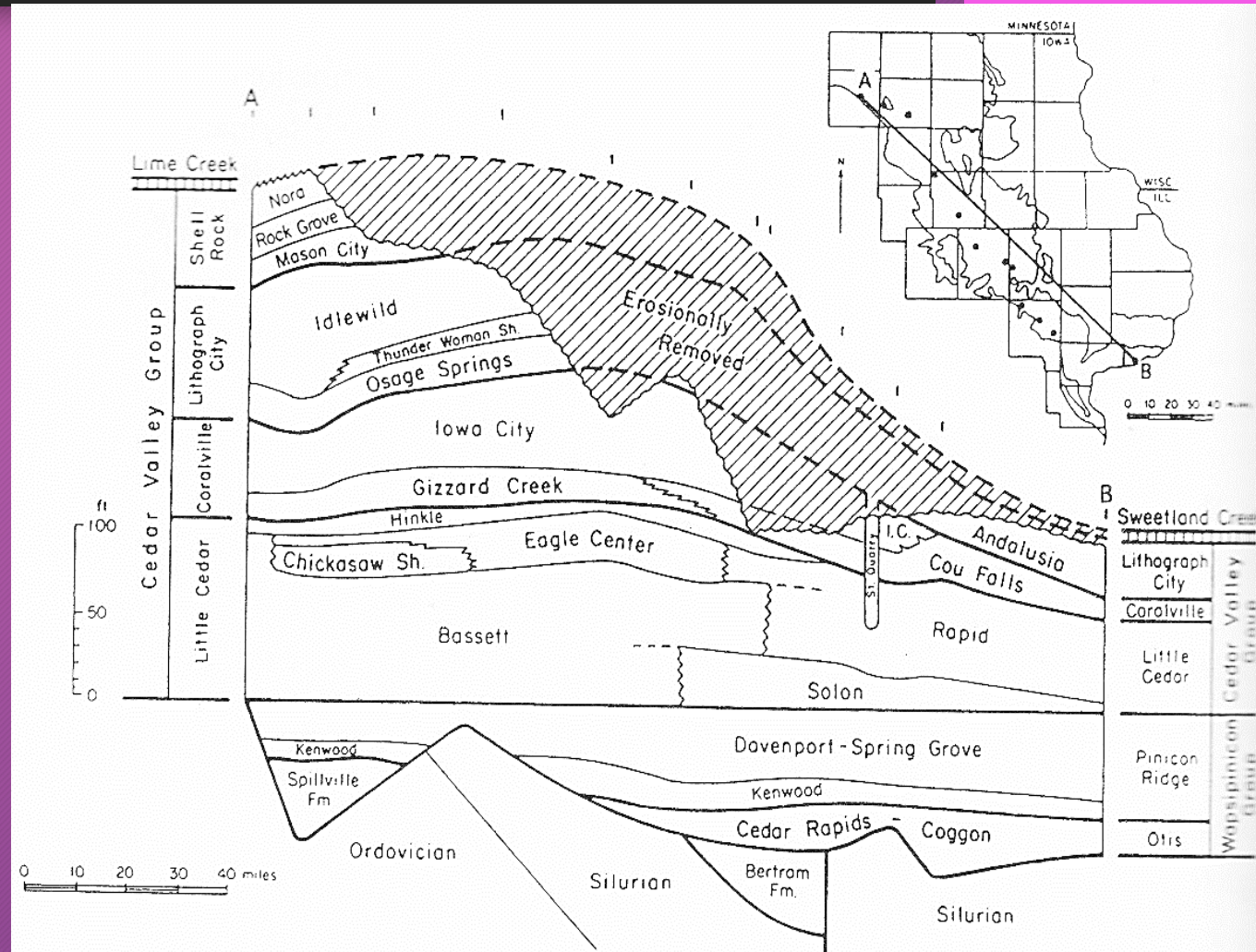
358 Ma
To
419 Ma

- The Devonian System contains 13 formations.
- Economically valuable resource for road and concrete aggregate in eastern Iowa and gypsum is mined southeastern and north-central Iowa for Portland Cement.
- The Devonian System also serves as an important aquifer/water source for eastern and north-central Iowa.
- These formations also contain significant and well-preserved fossils



Little Cedar Formation

- Basal Fm. of the Cedar Valley Group
- Solon Member is mostly limestone with abundant fossils
- Rapid Member fine-grained argillaceous limestone that is also fossil rich

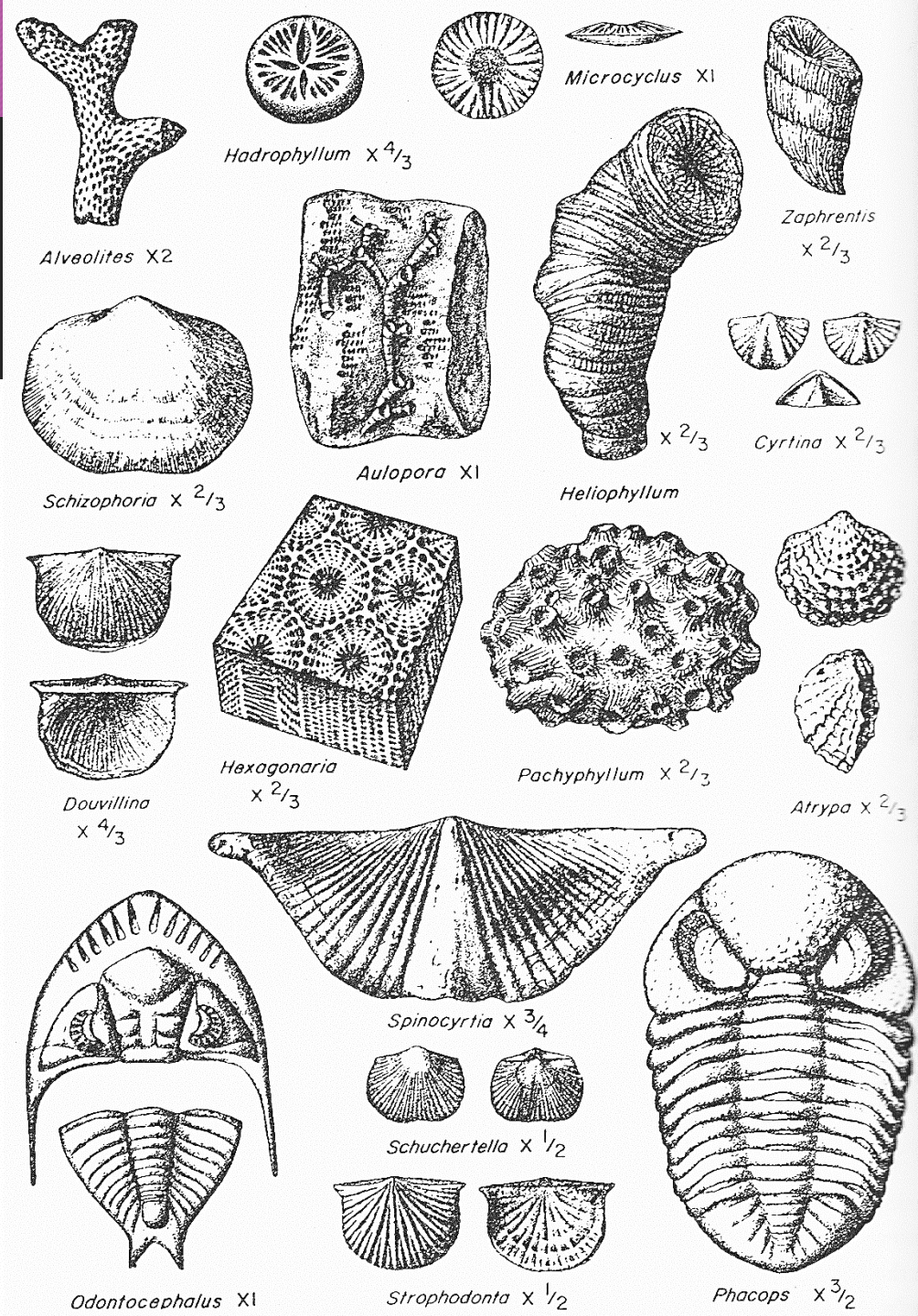
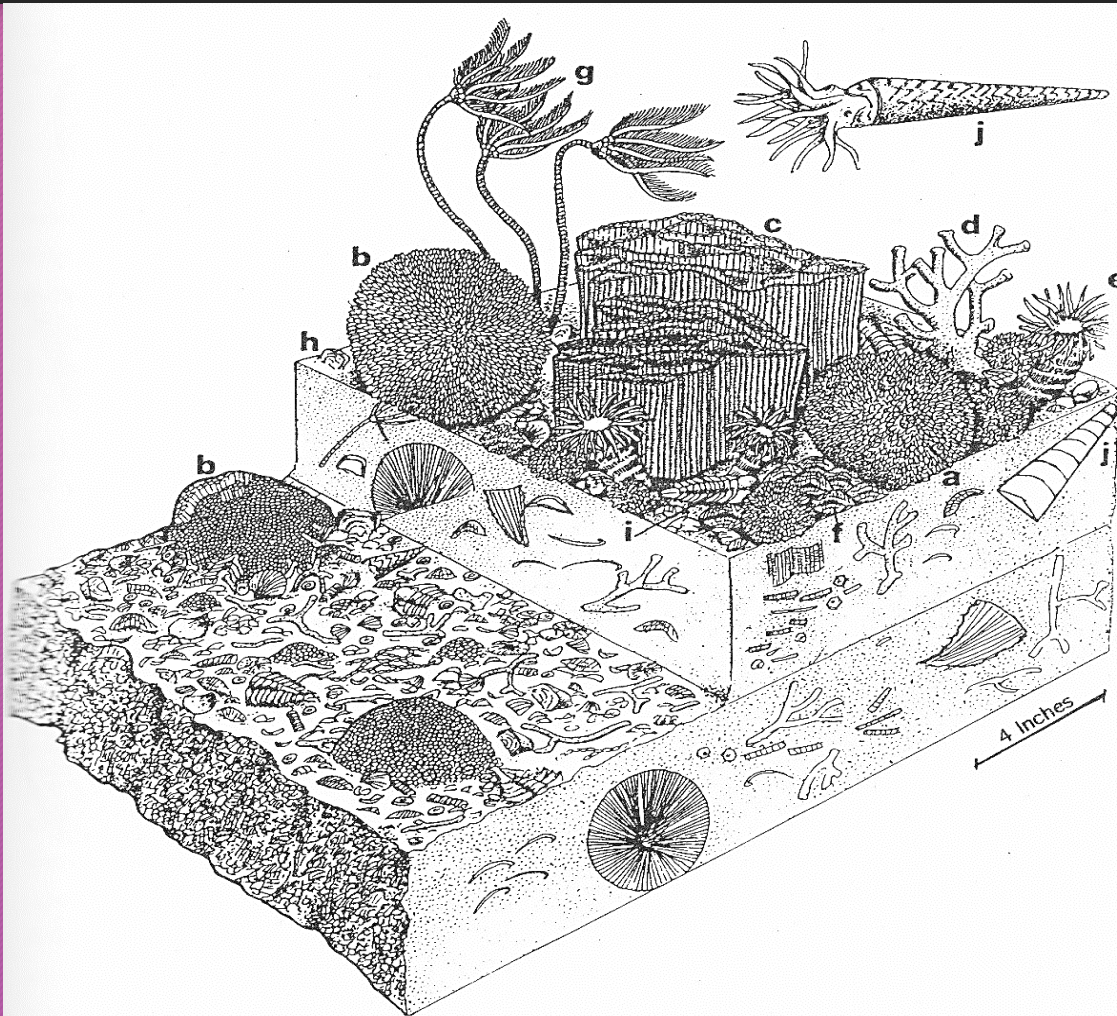


Lithograph City Formation

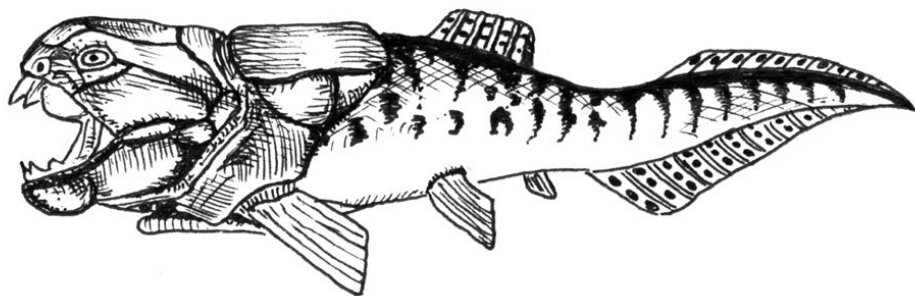
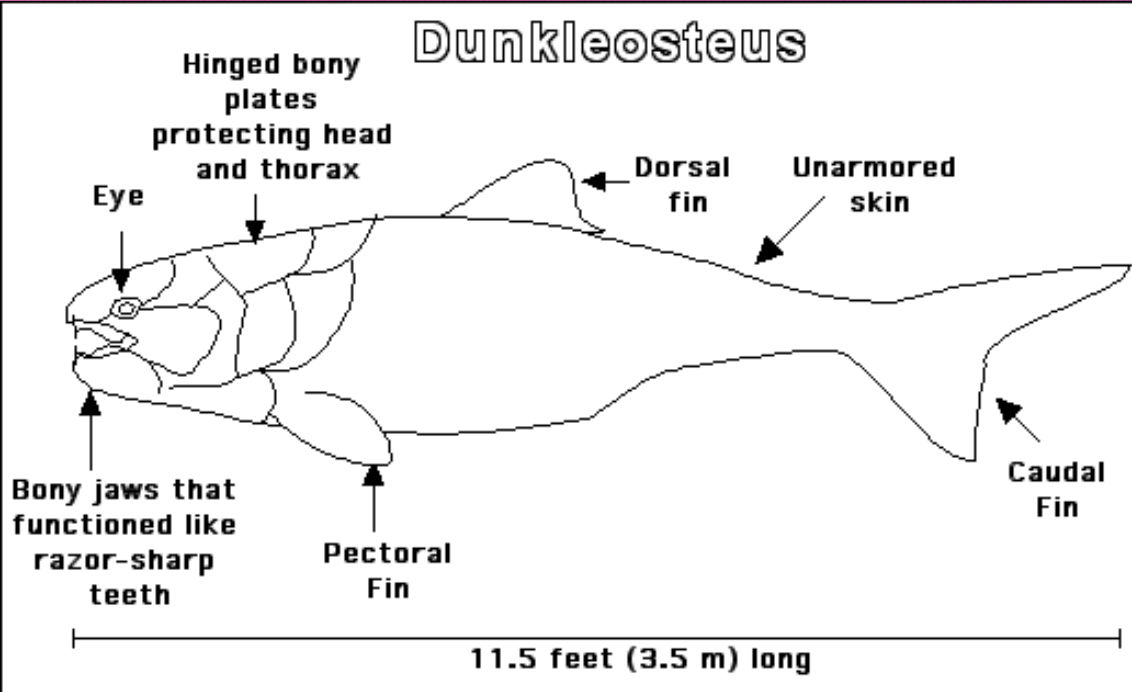
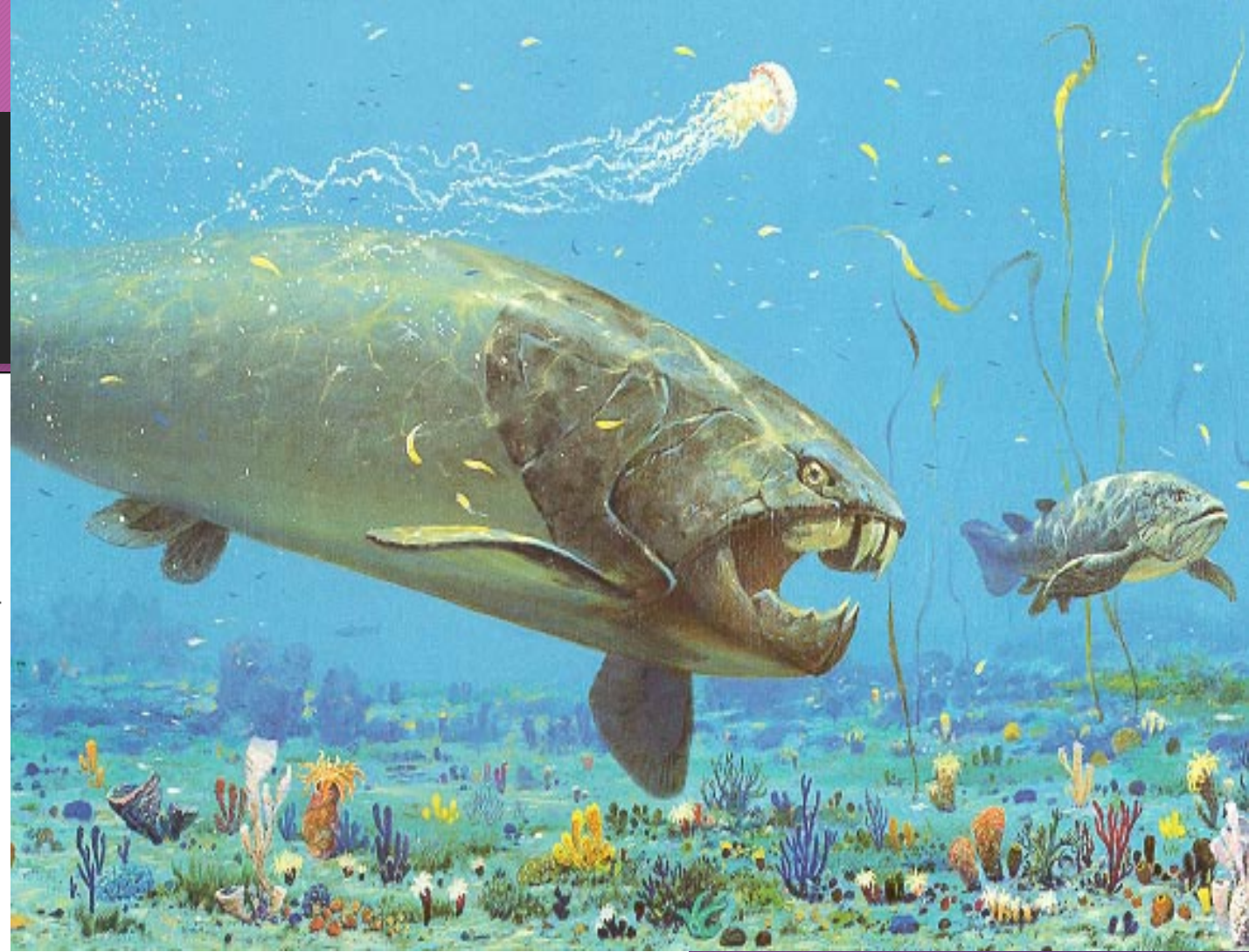
- An extremely fine grained / pure limestone
- Used for Lithography in the early 1900. Lithography City - Floyd-Mitchell county line
- Quarried extensively for road and concrete aggregate as well as Portland Cement



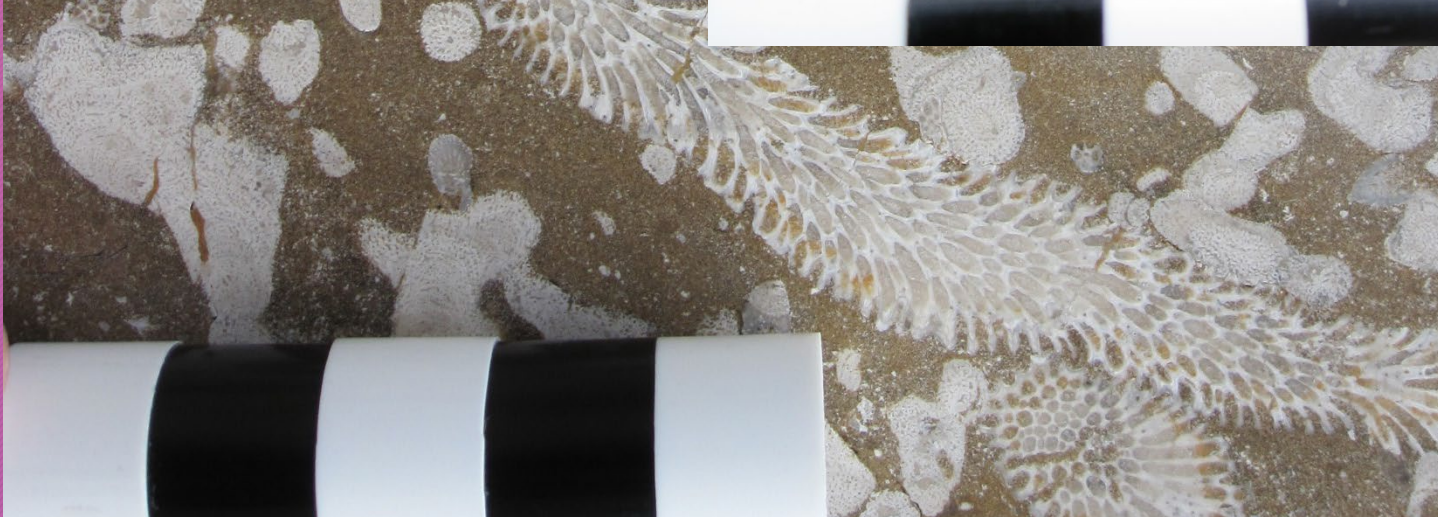
Devonian Life



Devonian Life

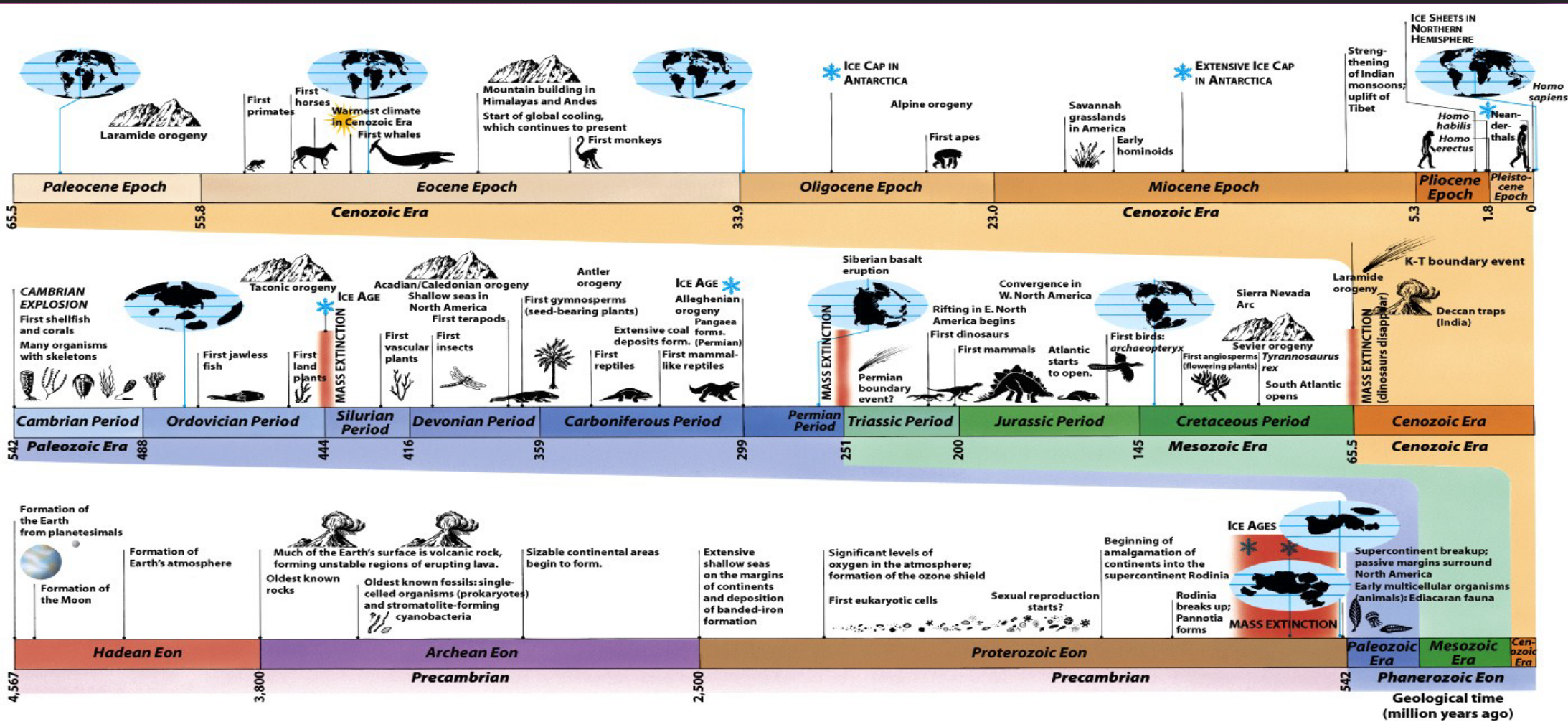


Devonian Life - Via the Devonian Fossil Gorge



Carboniferous - Mississippian - Last major sea

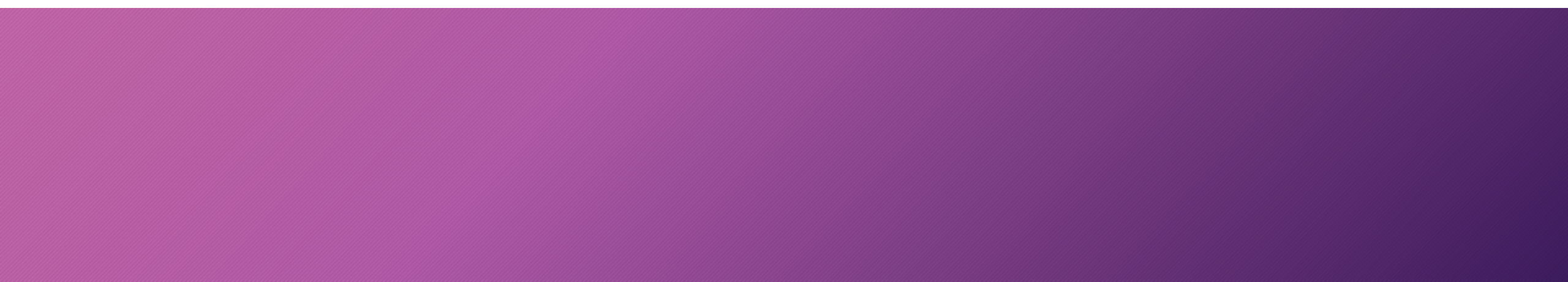
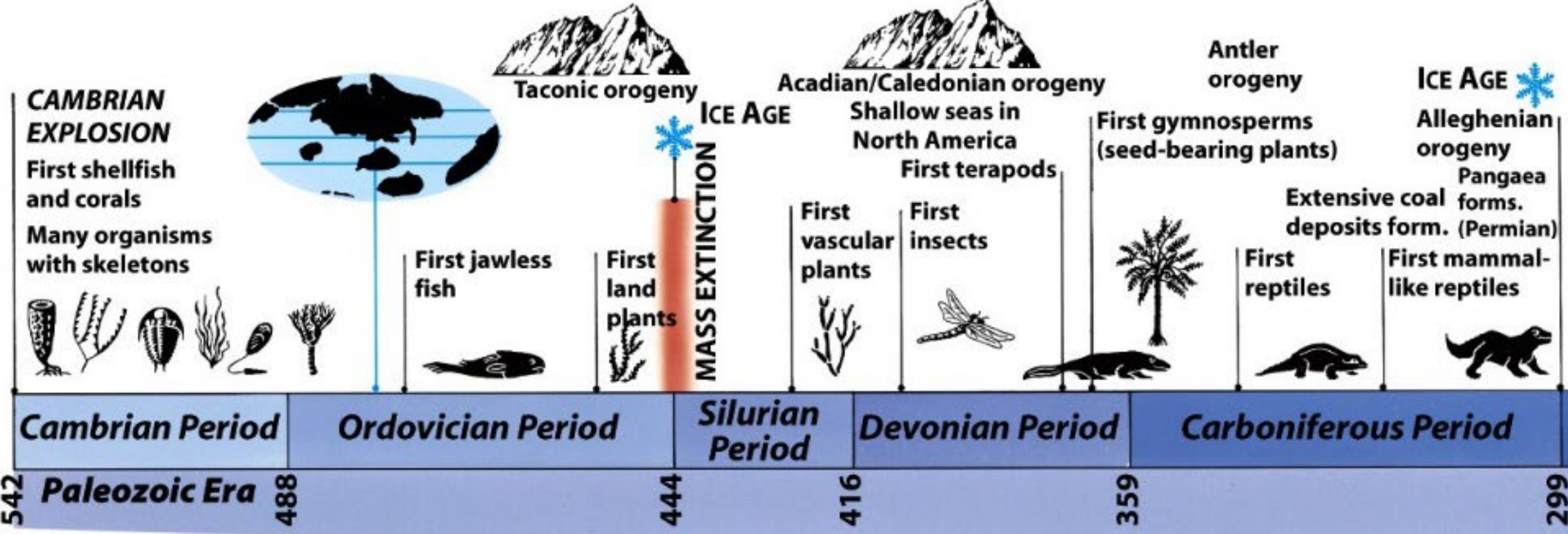
323 Ma
To
358 Ma



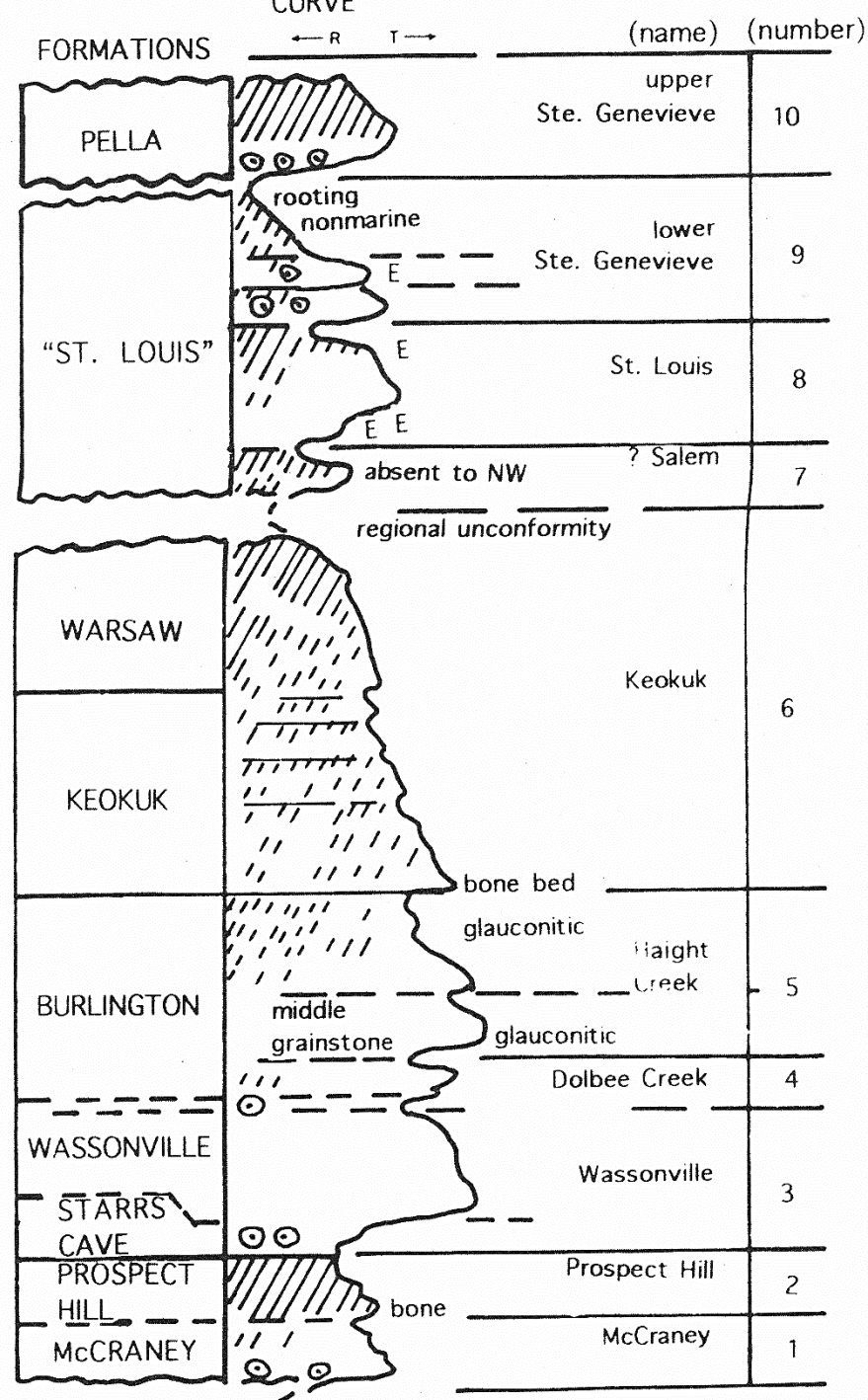
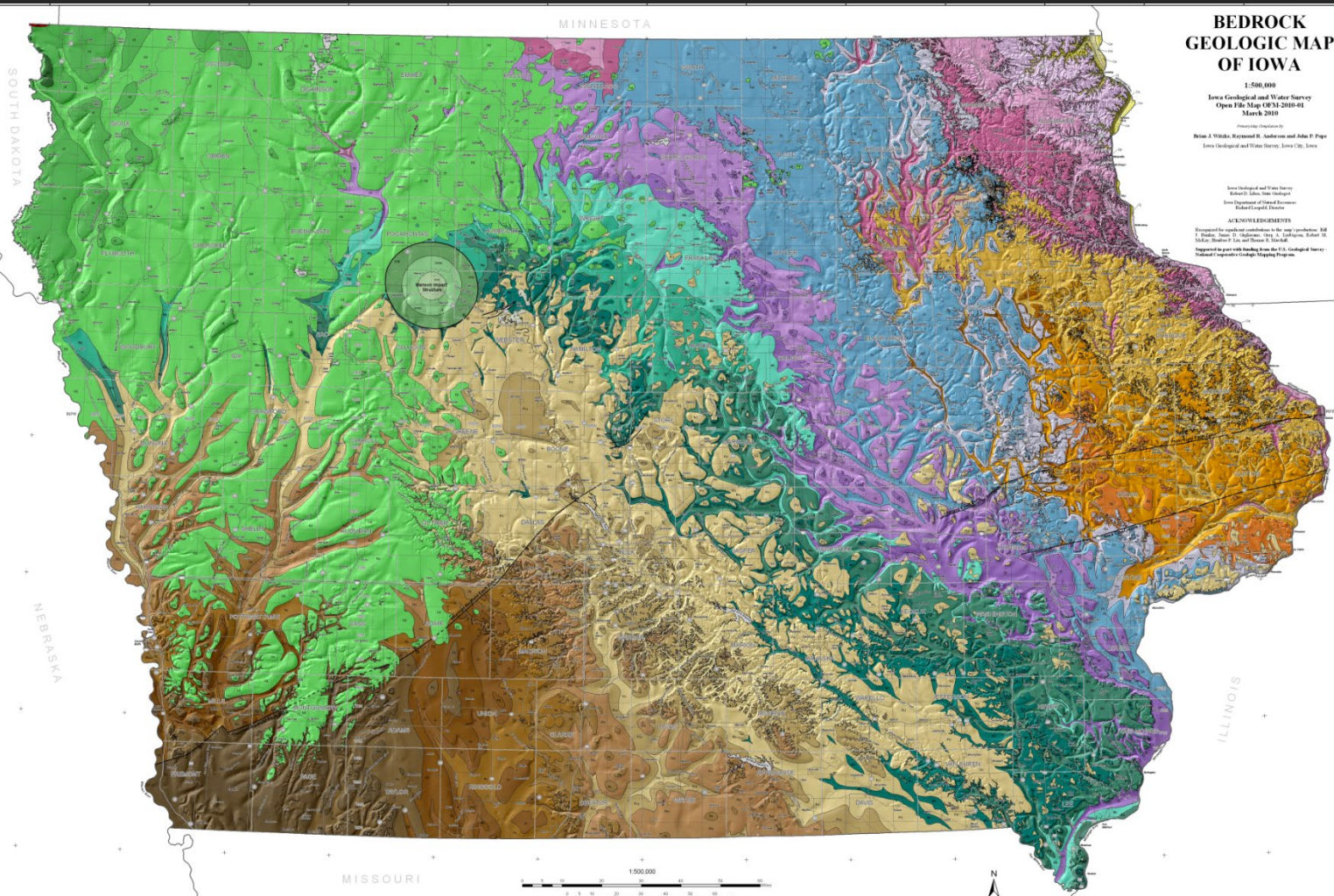
Carboniferous - Mississippian - Last major sea

323 Ma
To
358 Ma

- The stratigraphic record contains TEN Transgression-Regression (T-R) Cycles
- Oolites and sand-sized fossil fragments are abundant
 - Exceptionally preserved fossils!
- Likely similar to the Bahama Banks environment of deposition today
 - Uniformitarianism
- Is as an important groundwater reservoir for north central Iowa

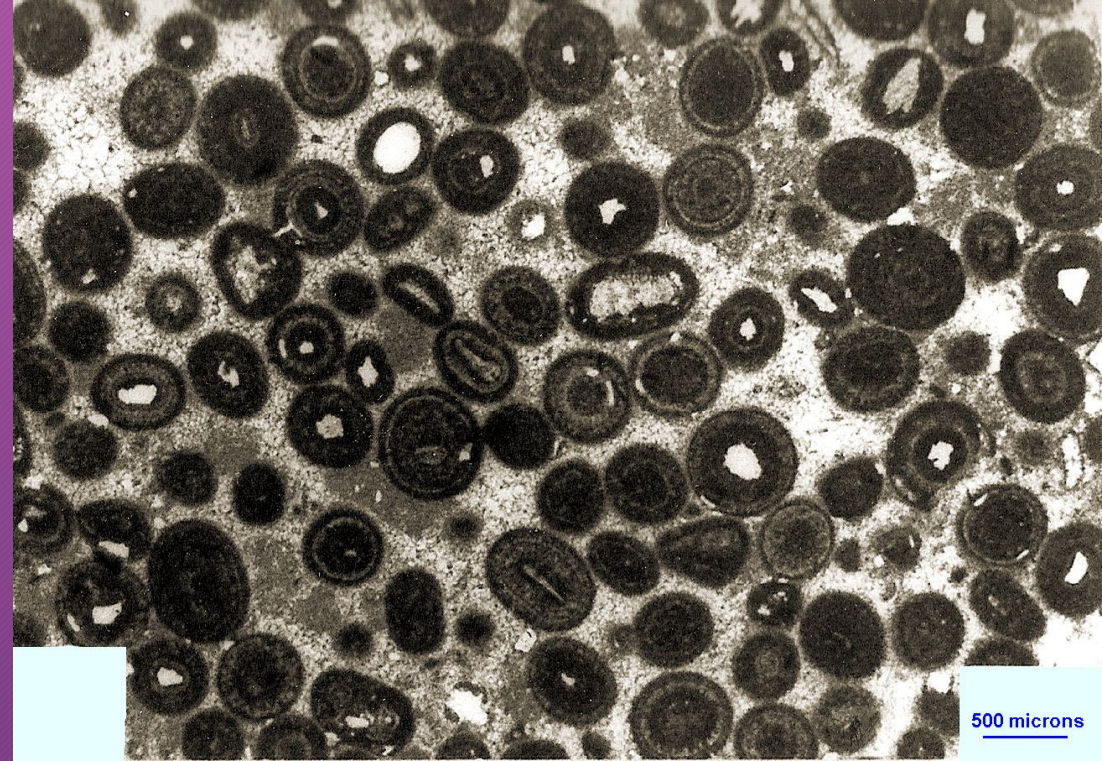


Mississippian



Starrs Cave Formation

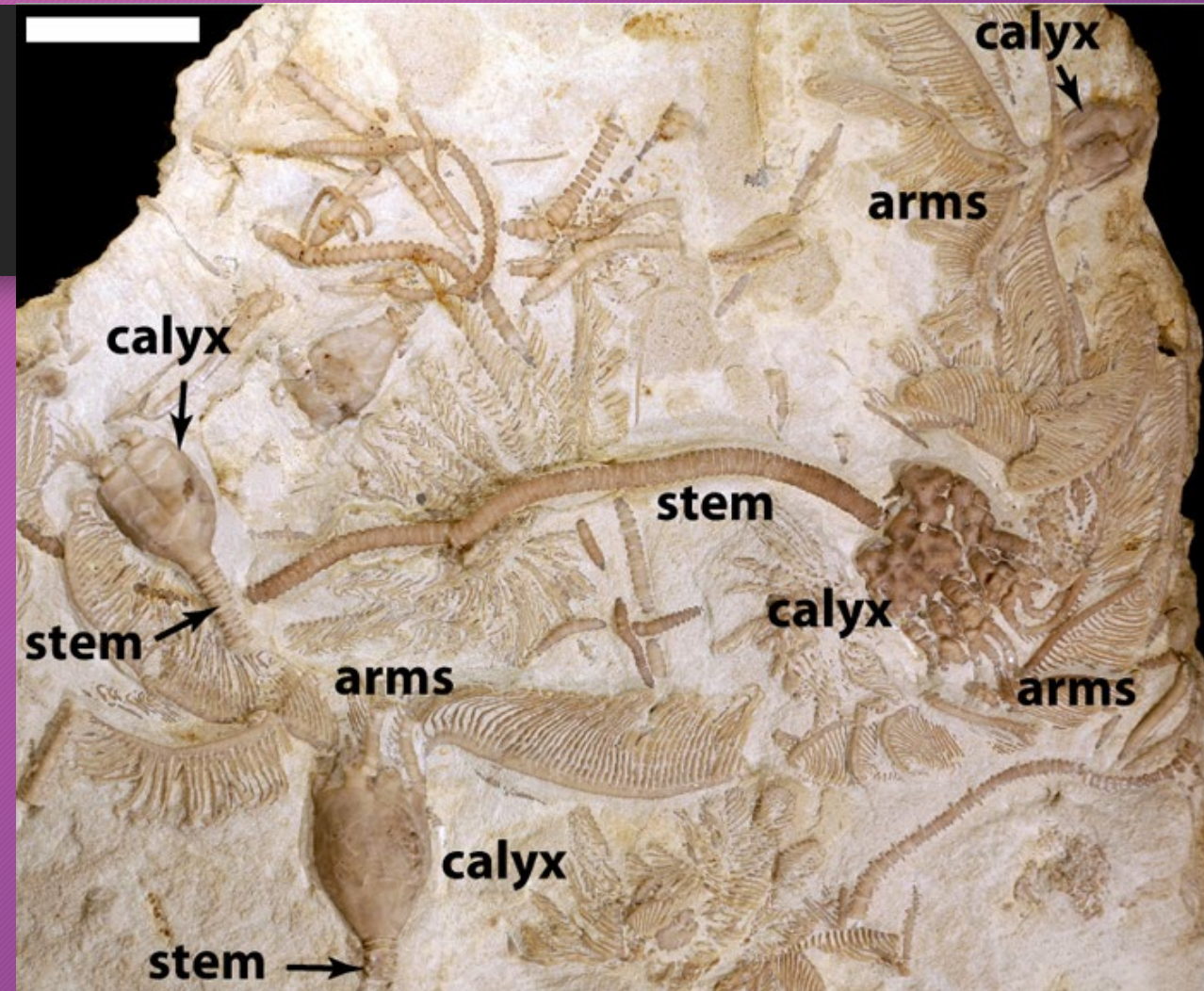
- Burlington, Iowa along Flint Creek
- Oolitic grainstone



500 microns

Burlington Formation

- One of Iowa's most well-known formations
- Excellent source for flint/chert used by native Americans
- Crinoidal limestone (packstone and grainstone)

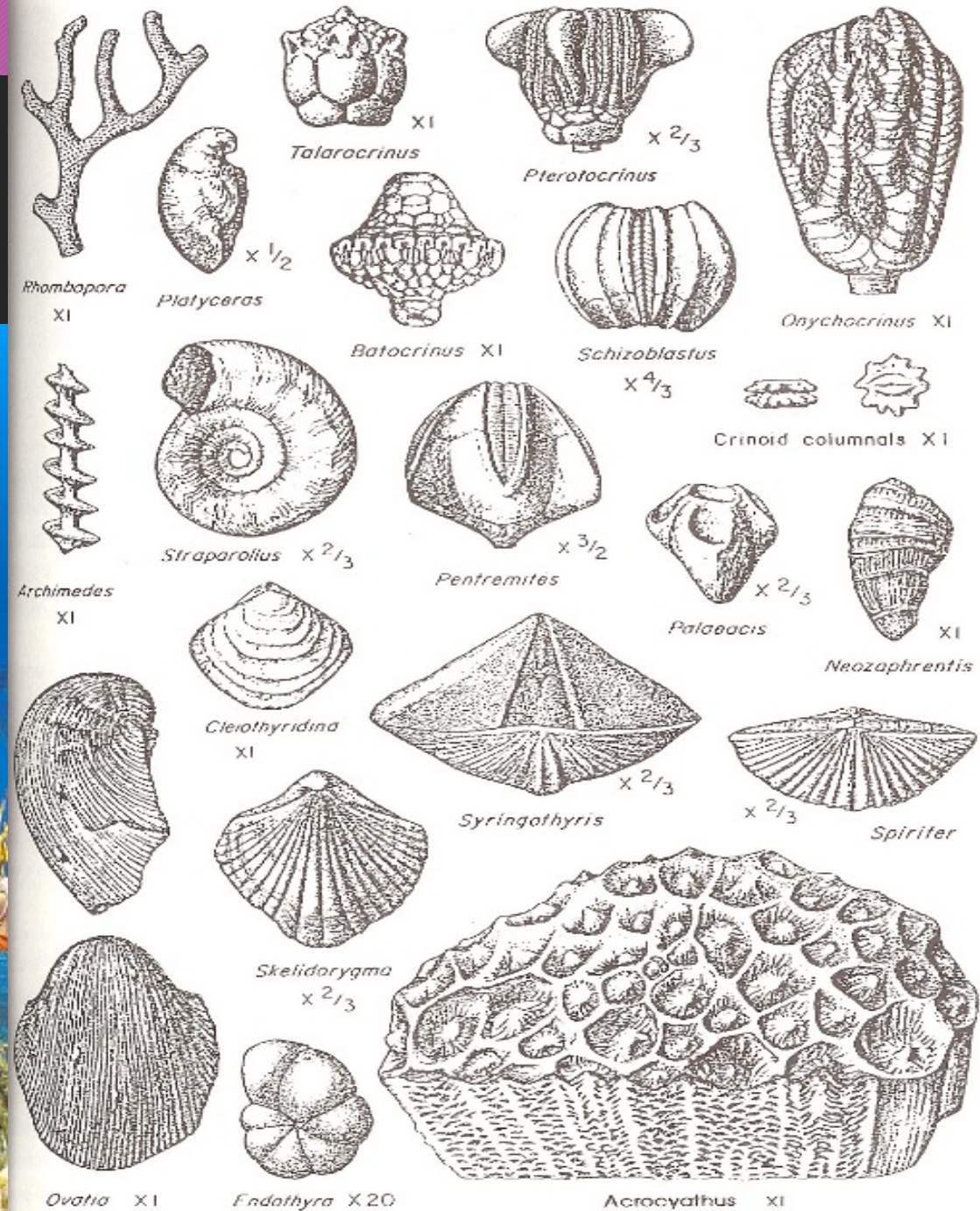


Warsaw Formation

- First described by James Hall near Warsaw, Illinois
- Southeastern Iowa
- Lower clay-rich dolostone unit yields abundant geodes



Mississippian Life





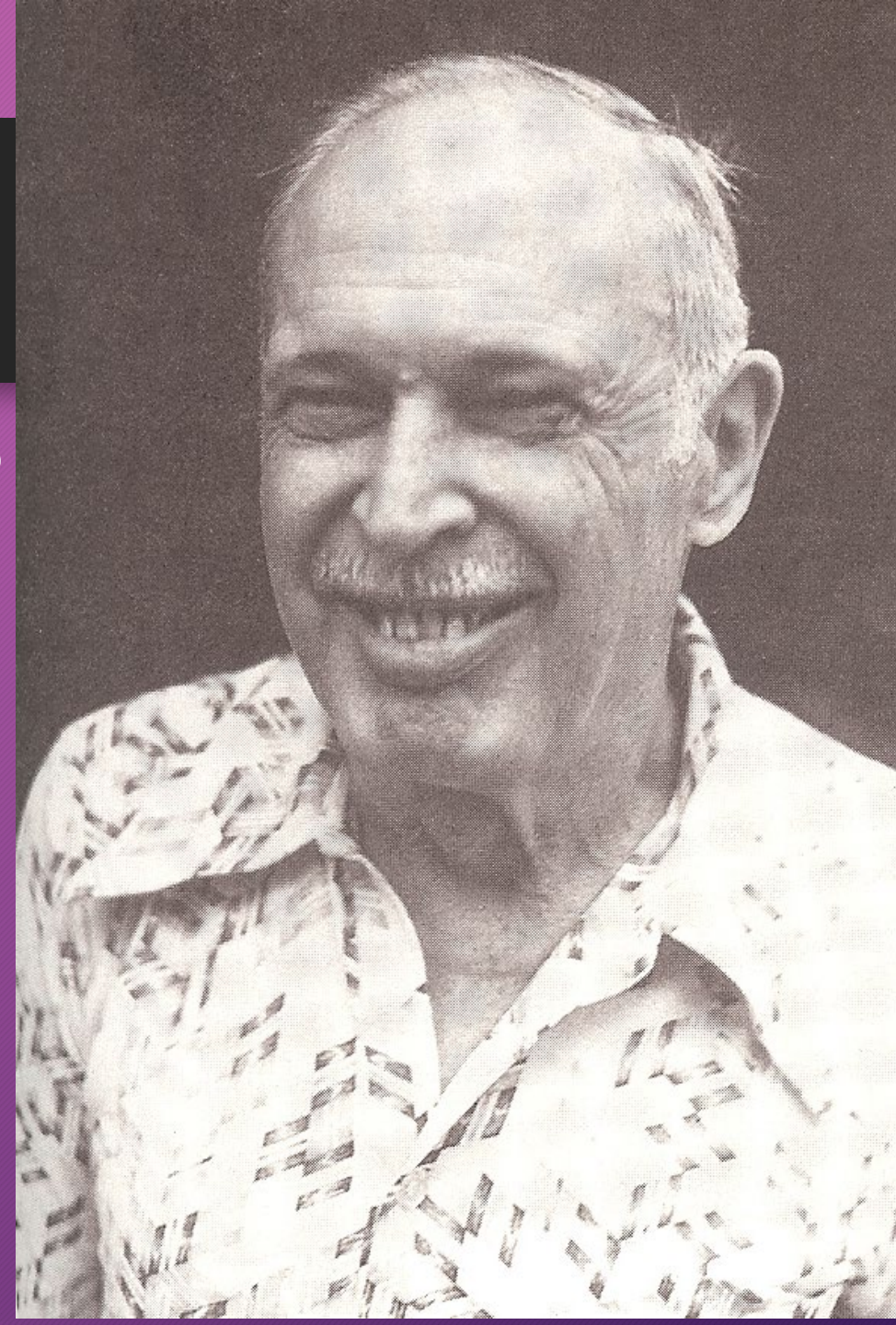
*Wachsmuth and Springer's
monograph on crinoids*

F. A. Bather

Charles Wachsmuth
1850s

Paleontologists
of all kinds!

Harrell Strimple
1970s



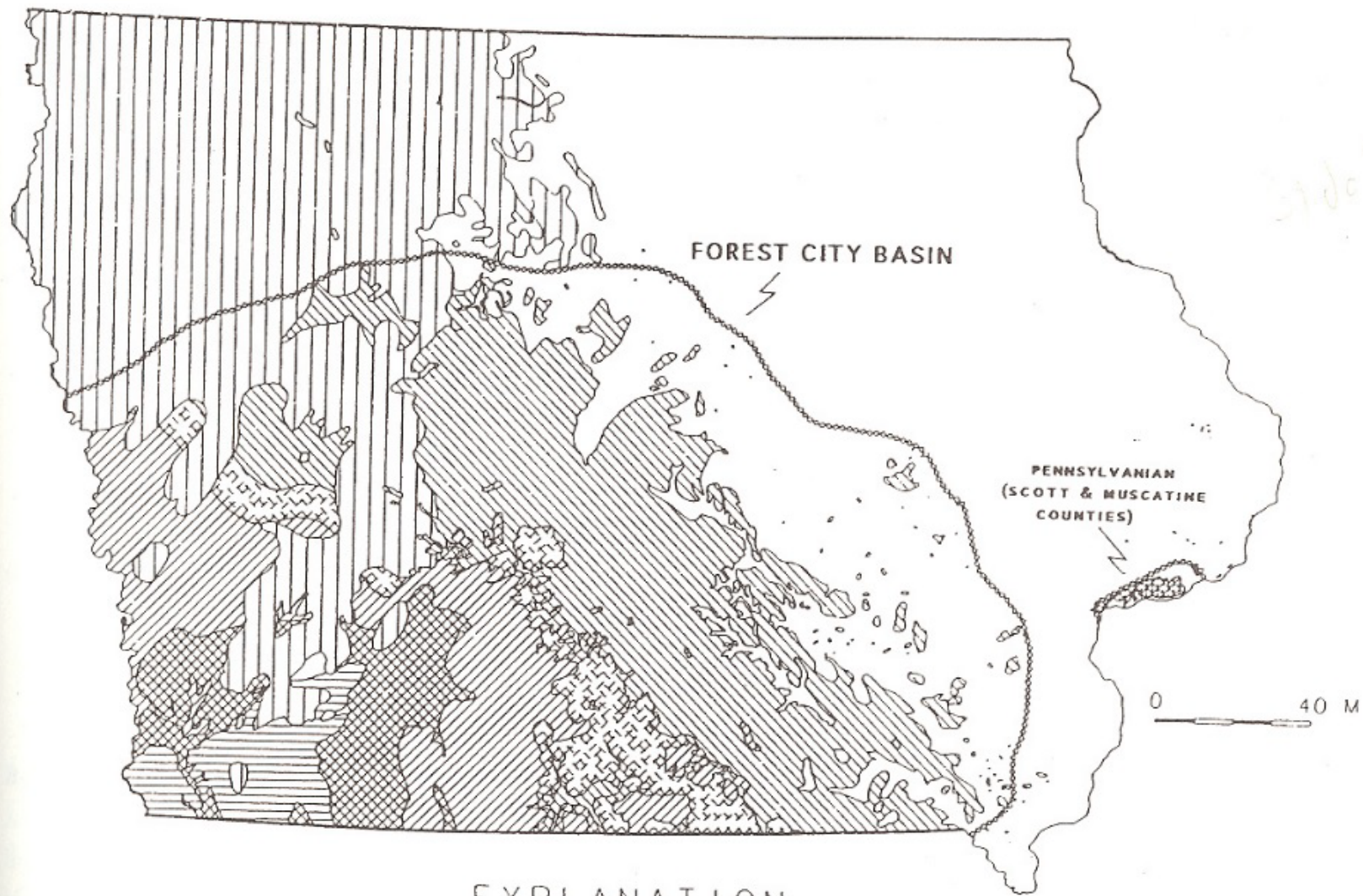
Carboniferous - Pennsylvanian - Coal swamps

232 Ma
to
298 Ma

- Coastal shorelines
 - Coal deposits
 - Cliff-forming Sandstone
 - Dolliver Memorial State Park
 - Ledges State Park
 - Wildcat Den State Park
 - Red Rock Reservoir
 - Pilot Knob County Park
- Deltas



Univ. of Michigan Exhibit Museum of Natural History Diorama



EXPLANATION

Cretaceous System

□ undifferentiated

Pennsylvanian System

Virgil Supergroup

▨ Wabaunsee Group

▩ all other units

Missouri Supergroup

▧ undifferentiated

Des Moines Supergroup

▨ Marmaton Group

▩ Cherokee Group

Morrow Supergroup

▩ Caseyville and Spoon Fms.

□ Older Paleozoics

BEDROCK GEOLOGIC MAP OF IOWA

1:500,000

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

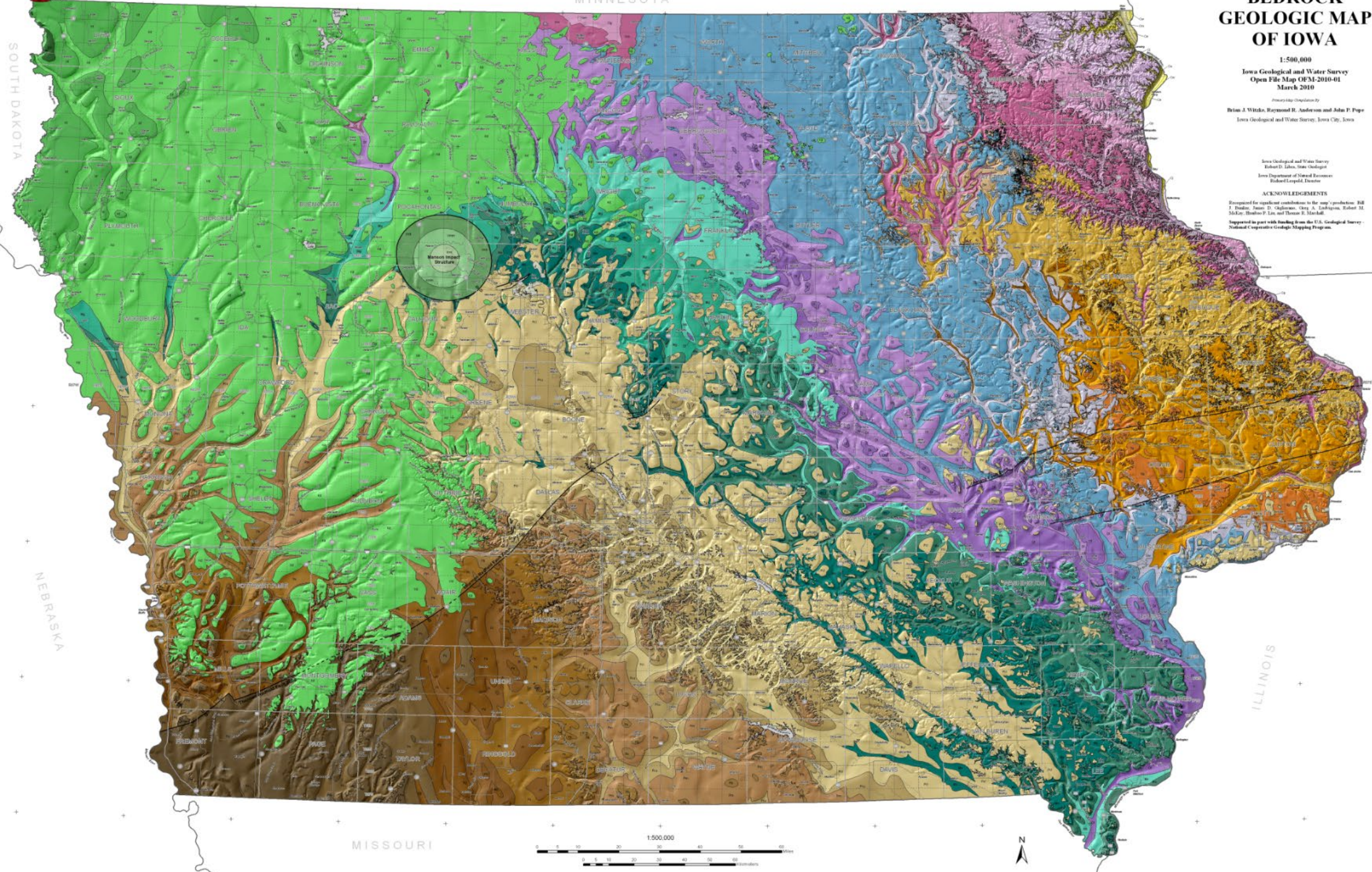
Primary Map Compilation by

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Iowa Department of Natural Resources
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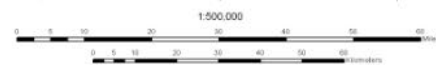


SOUTH DAKOTA

NEBRASKA

ILLINOIS

MISSOURI



Stratigraphy, petrology, and paleogeography
of the upper portion of the
Cherokee Group
(Middle Pennsylvanian),
eastern Kansas and northeastern Oklahoma

Robert L. Brenner

Geology Series 3 1989
Kansas Geological Survey



Cherokee Group

INTEGRATIVE STRATIGRAPHY Concepts and Applications

Robert L. Brenner
Department of Geology
University of Kansas
Lawrence, Kansas
Timothy R. McHugh
Kansas Geological Survey

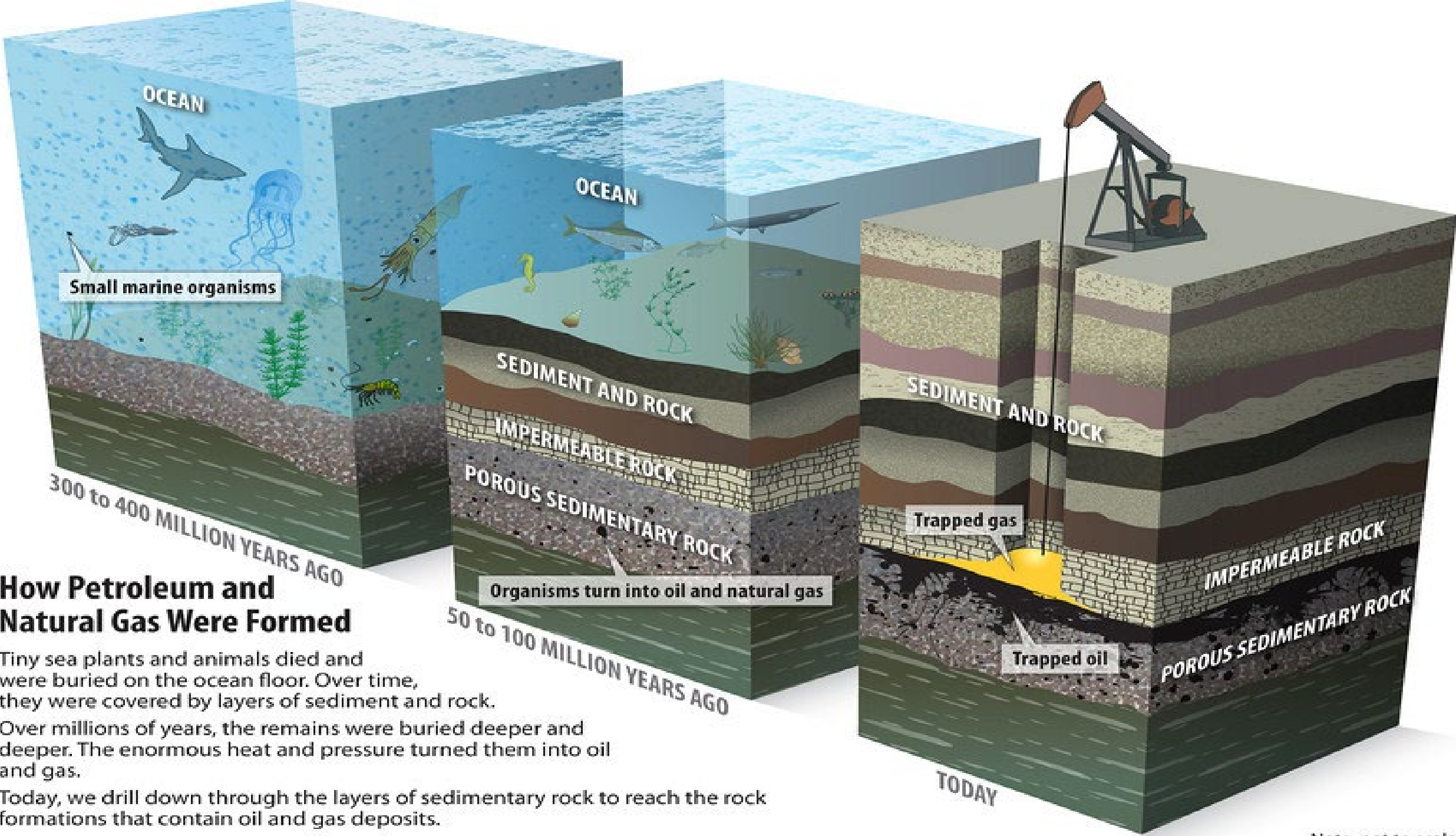


Published by the Kansas Geological Survey, Lawrence, Kansas

SUPERGROUP		GROUP	FORMATION	COALS	SERIES
VIRGIL	WABAUNSEE			Nyman Elmo Nodaway*	VIRGILIAN
	SHAWNEE				
	DOUGLAS			unnamed	
MISSOURI	LANSING				MISSOURIAN
	KANSAS CITY				
	BRONSON			Ovid	
DES MOINES	MARMATON	LOST BRANCH			DESMOINESIAN
		NOWATA			
		ALTAMONT			
		BANDERA		Lonsdale	
		PAWNEE			
		LABETTE		Mystic* Marshall/ Lower Mystic	
		STEPHENS FOREST			
		MORGAN SCHOOL		Summit	
		MOUSE CREEK			
		SWEDE HOLLOW		Mulky Bevier* Wheeler* Whitebreast* Carruthers*	
CHEROKEE	SPOON FM.	FLORIS		unnamed* Laddsdale*	?
		KALO		Cliffland*	
		KILBOURN		Blackoak*	
				unnamed*	
MORROW	CASEYVILLE			Wyoming Hill* unnamed Wildcat Den	MORROWAN

Lepidodendron





How Petroleum and Natural Gas Were Formed

Tiny sea plants and animals died and were buried on the ocean floor. Over time, they were covered by layers of sediment and rock.

Over millions of years, the remains were buried deeper and deeper. The enormous heat and pressure turned them into oil and gas.

Today, we drill down through the layers of sedimentary rock to reach the rock formations that contain oil and gas deposits.

Note: not to scale

Types of Coal

- Anthracite
- Bituminous
- Sub-Bituminous
- Lignite



Iowa Coal

- Sub-Bituminous to Bituminous
- High ash and sulfur content
 - Ash results from sediment (impurities) that were washed into the swamps
 - Sulfur occurs as pyrite (FeS_2)
- Iowa coal is not considered a natural resource because it is not economically feasible to extract.



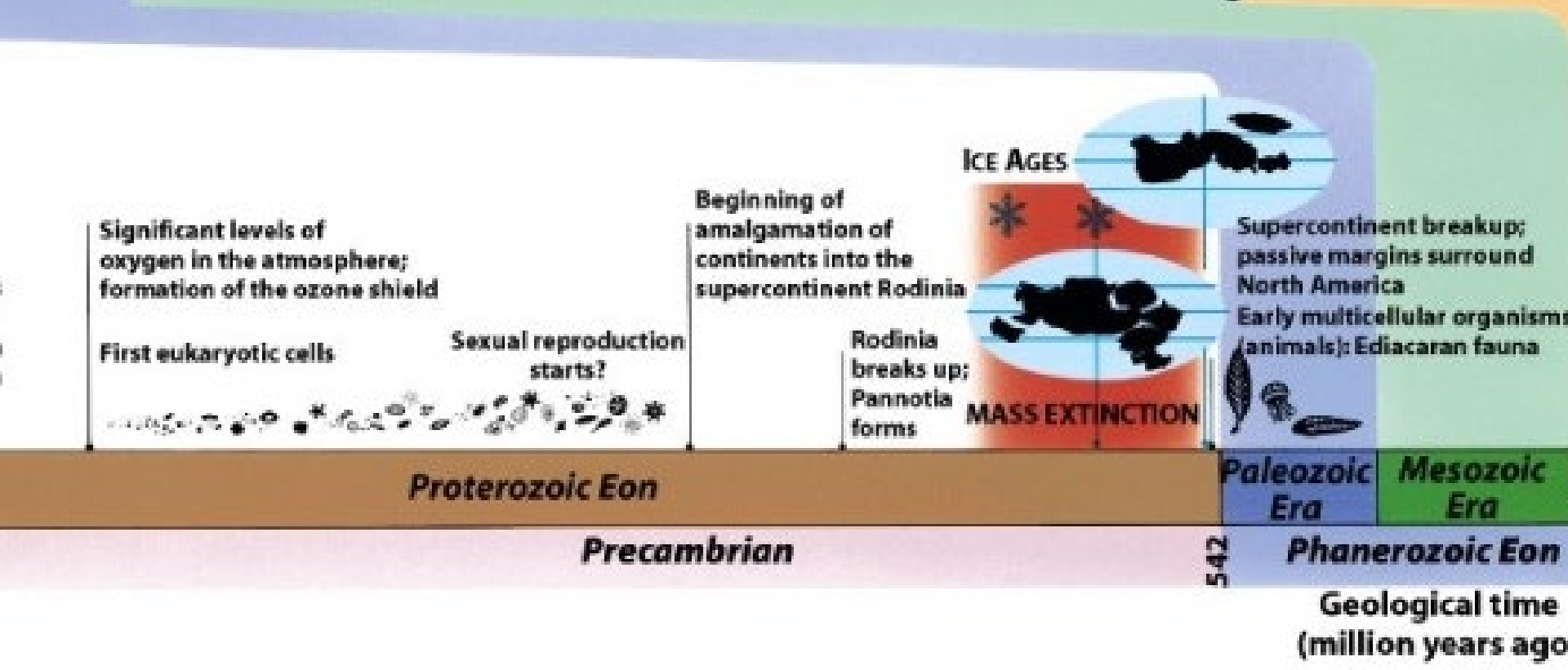
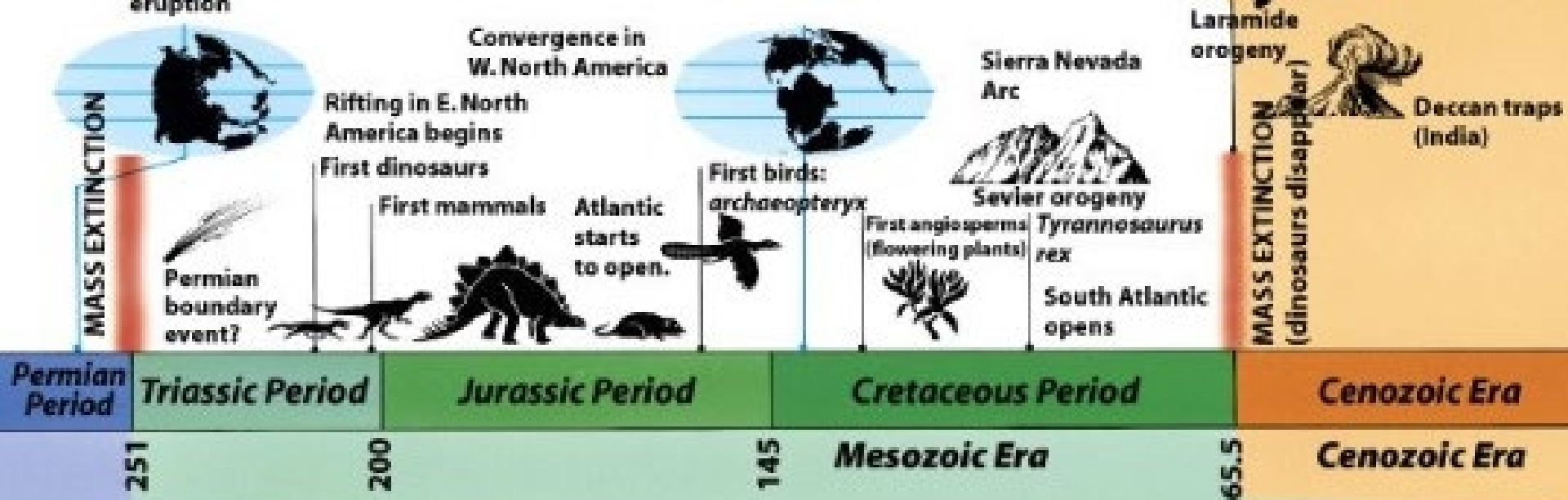
Mesozoic - Evaporite Deposits

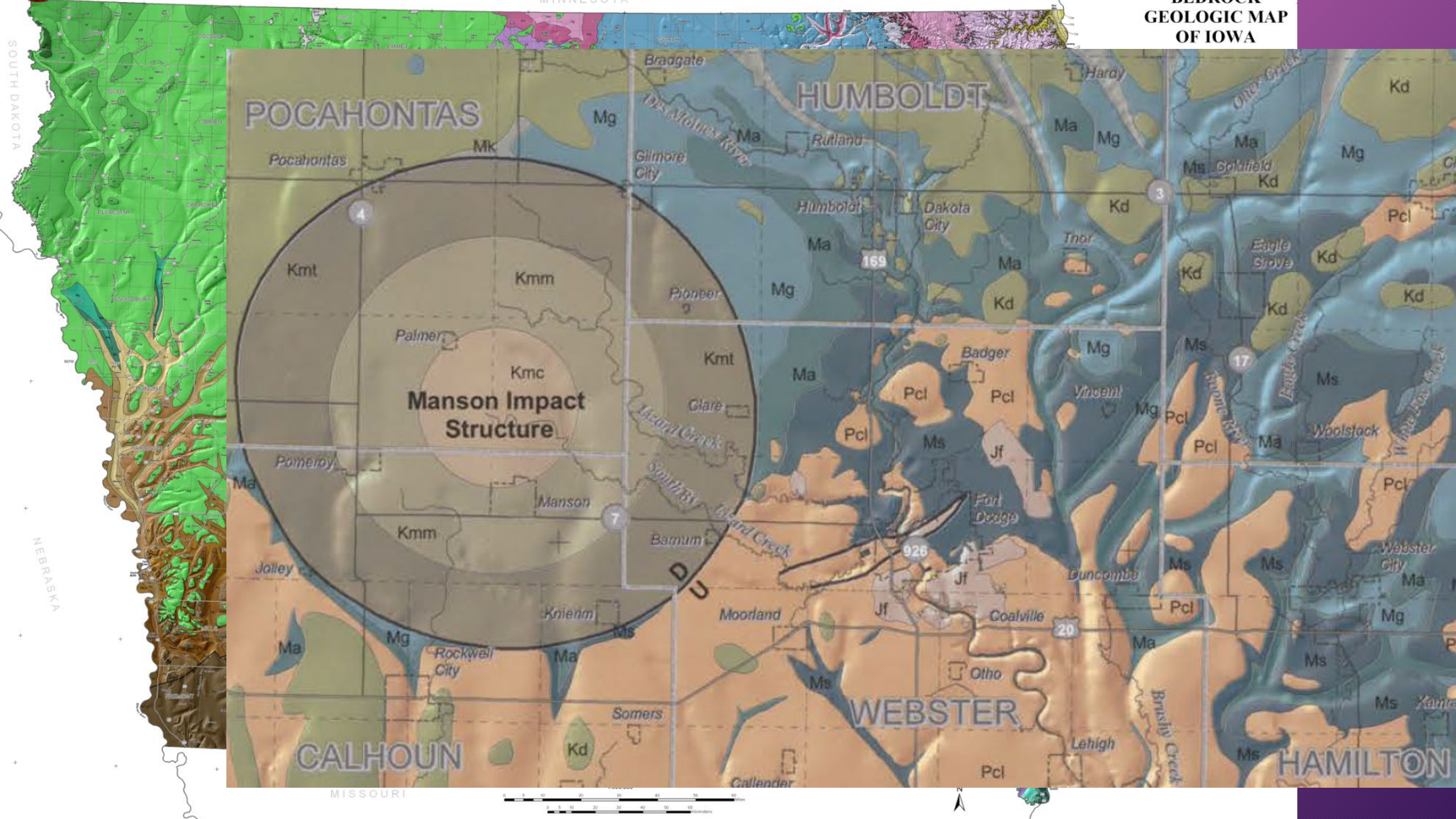
Last of the Shallow Inland Seas

66 Ma
to
232 Ma

66
to
252

- Massive weathering and erosion
 - Large unconformity between the Mesozoic and Cenozoic
 - Iowa has no Permian or Triassic rock record!
- Fort Dodge Formation contains thick evaporate deposits of rock gypsum with minor red, green, and gray clastic rocks.
- Manson Impact Structure at 73.8 Ma

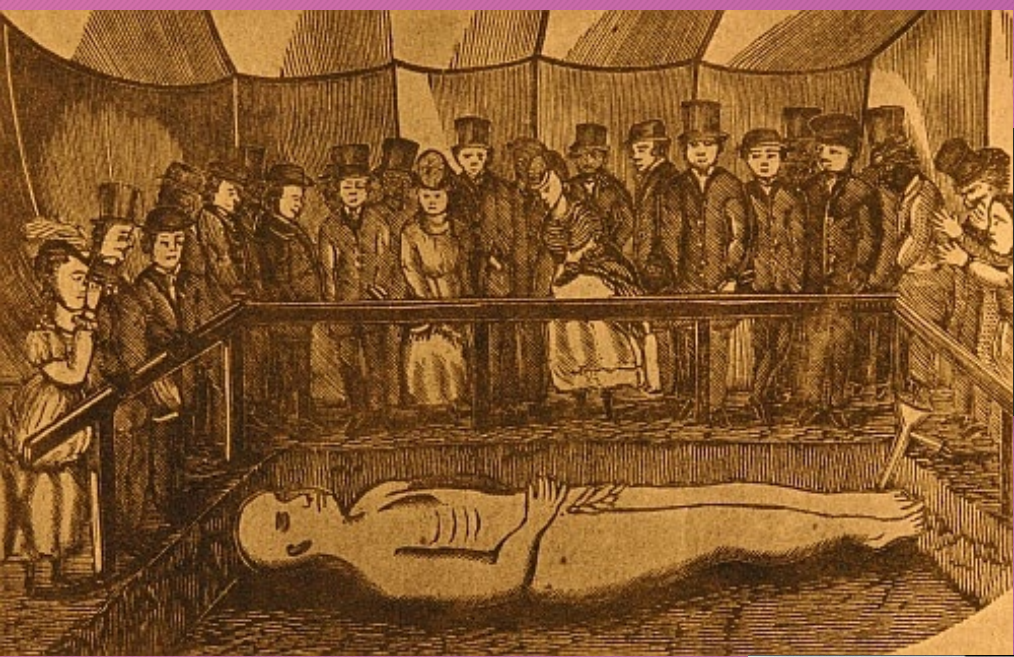




Fort Dodge Formation

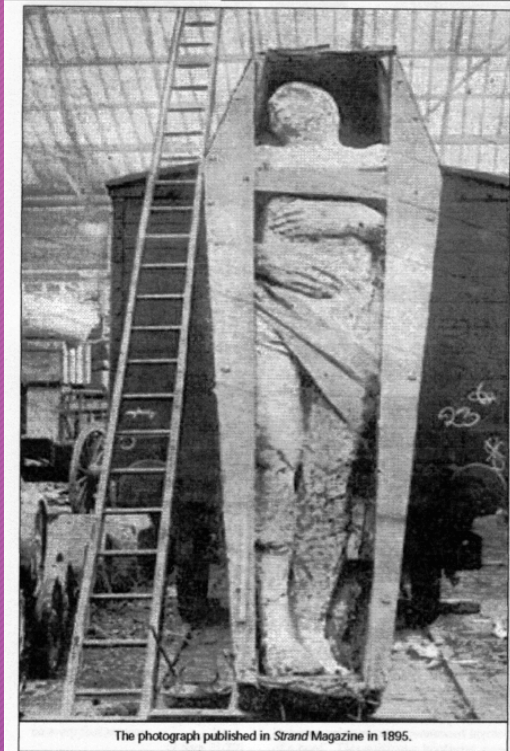
- First thought to be Permian, because of association with western USA gypsum and 'red-bed' deposits
- Jurassic - based on fossil plant remains
- Fort Dodge Gypsum
 - $\text{CaSO}_4 \cdot \text{H}_2\text{O}$





The Cardiff Giant

- 1866 - George Hull visits his sister in Ackley, Iowa and goes to church
- 1868 - One dark night the Gypsum Giant is buried on his Brother-in-laws farm near Cardiff, New York
- 1869 - The Giant was 'discovered', a tent was set up, droves of people came to see the giant @ 50 cents a person
- James Hall - The most remarkable object yet brought to light in this country'



The photograph published in Strand Magazine in 1895.

“People are gullible”
- George Hull





adunt. Nam cocodrillos tenos uo
tres feruans crustis secant & interi
mūt. Cocodrilli uo in aquis uidet
et insus. in tra uo acutillie uidet.



matu potat. In hoc bonu mudo
datur. qd heo bestia varissime i
ueniunt. Nullis mstruūtis cap
possi nisi tm veti ferreo ex cathe
nis qd apud dam ascenos in hoc
opus nura arte fabricatu est
Captum uo malleis tm ferreis
ocadit. Pellis eius un' cubiti
spissitudine hie dicitur tateq ee
duricie ut nullo iaculo uel ar
matura possit penetr. **De eos fluis**



Equus maris De equis maris
monstrum est magnum co
ac forte multu. Hoc monstru qd
omnia fere marina monst' forat
simu est. nihilq extra aqua pot
ut dicit aq. s statim ubi natura
cariit aquaz. carebit et uita. Pū
firma equi hie & hoc in syrois
Postior uo ps eius tinnat i pilis
uaturam. Vuuu carnis aliozum
piscium In pugna crudele est. s ho
mine timet et contra eum parti
ri bella formidat. **De equo mlo**
monstro mli fluminis



Quonitus ut dicit mschael
in flumine nli monstru est
ingens et ferocissimū in nulo flūie
bitans. Crura et pedes et unguēs
ut cocodrillus hie. s multo maioza
Humanaz mortuū cupidissimū
est. Nam cum naus illi i porta
occurrit unū pedē in tra figens.
Alio nauem in antiozi arripens
paciūne scindit ul aliqn iclina



Important fossil sites

1. Burgess Shale (Canada)

- Located in the Canadian Rockies
- Dates to about 508 million years ago (Cambrian period)
- Famous for preserving soft-bodied organisms, which are rarely fossilized
- Key to understanding the **Cambrian Explosion**, when complex life rapidly diversified

2. Solnhofen Limestone (Germany)

- Late Jurassic (~150 million years ago)
- Extremely fine-grained limestone preserved delicate fossils like feathers and wings
- Most famous for the discovery of **Archaeopteryx**, a transitional form between dinosaurs and birds

Jurassic Solnhofen



Fossil sites cont.

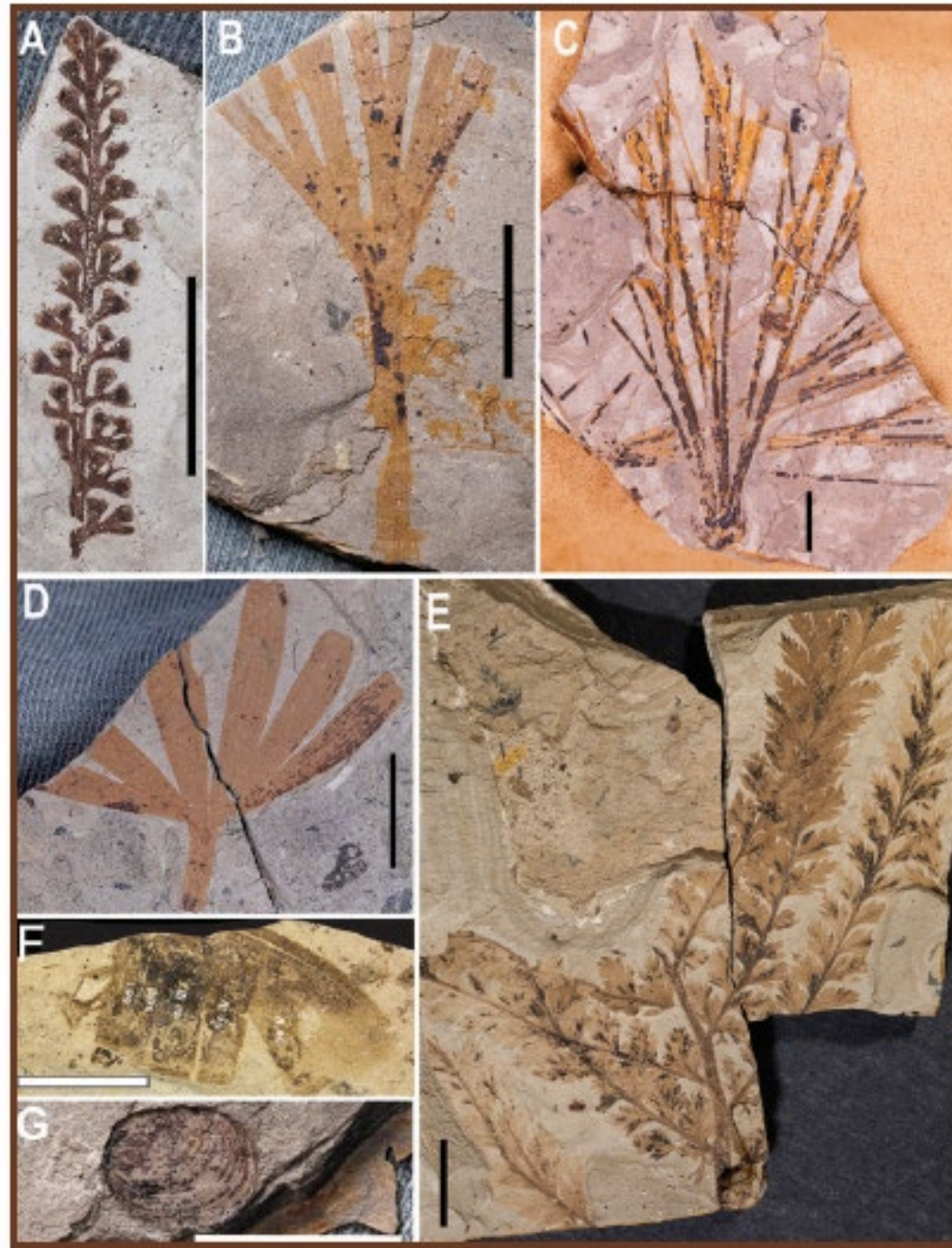
3. Morrison Formation (USA)

- Late Jurassic (~155-148 million years ago)
- One of the richest dinosaur fossil beds ever discovered
- Produced iconic dinosaurs like **Allosaurus**, **Stegosaurus**, and **Diplodocus**

4. La Brea Tar Pits (USA)

- Located in Los Angeles, California
- Dates mostly to the last Ice Age (~50,000-10,000 years ago)
- Natural asphalt trapped animals, preserving skeletons in remarkable detail
- Famous fossils include **Smilodon** and **Dire wolf**

Jurassic Morrison Fm.



La Brea Tar Pits



Dinosaurs: Land-based

- Saurischians (“lizard-hipped”) → includes meat-eaters like Velociraptor and long-necked giants
- Ornithischians (“bird-hipped”) → includes plant-eaters like Triceratops

Ironically, birds evolved from saurischians—not ornithischians.

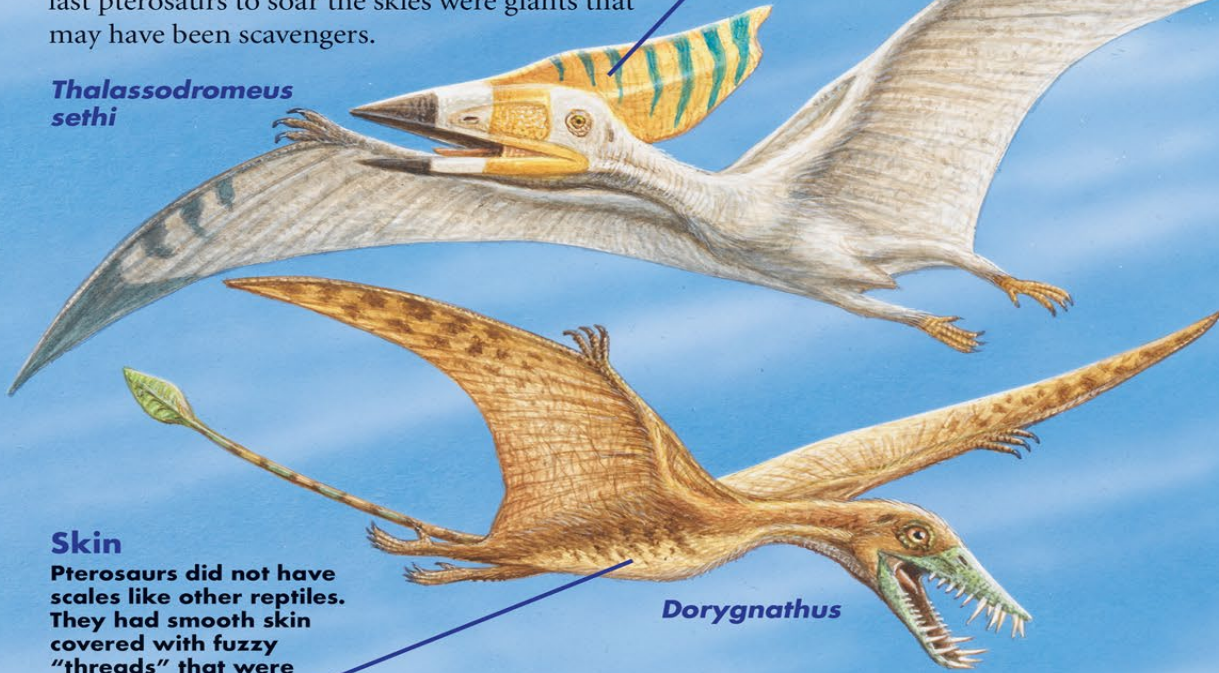


Pterosaur Traits

illustration by Phil Wilson

Pterosaurs lived across a span of more than 150 million years. Their bodies changed over the course of time. The smallest ones were the size of sparrows and caught flying insects. Larger pterosaurs caught fish and small animals. The last pterosaurs to soar the skies were giants that may have been scavengers.

Thalassodromeus sethi



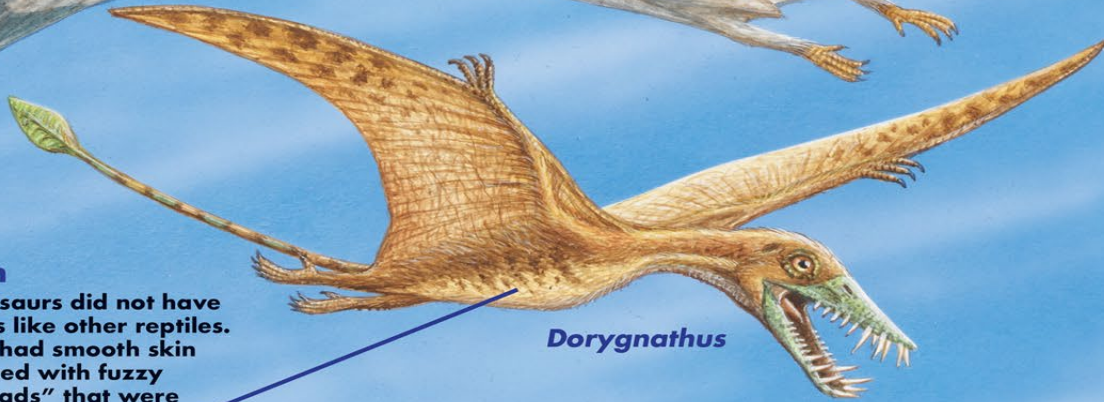
Head

Many pterosaurs impressed their mates with bony crests decorating their heads.

Skin

Pterosaurs did not have scales like other reptiles. They had smooth skin covered with fuzzy "threads" that were like early feathers.

Dorygnathus

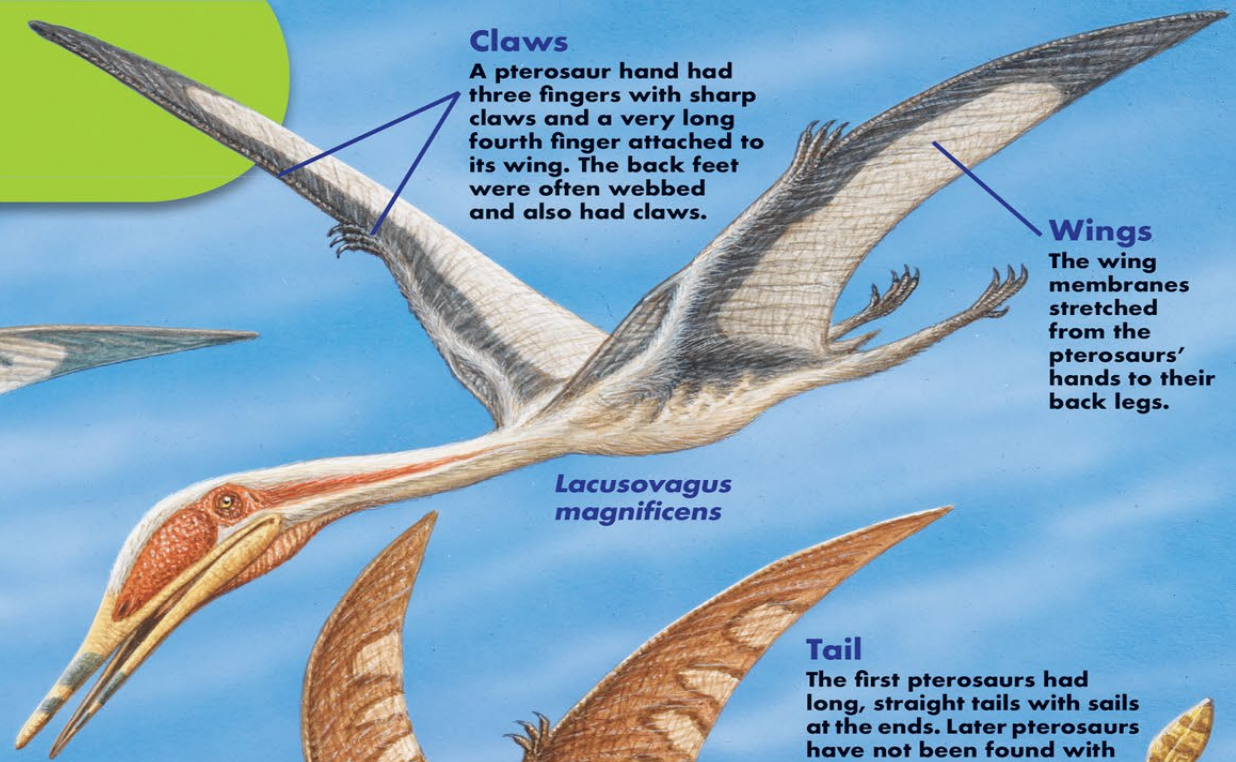


Claws

A pterosaur hand had three fingers with sharp claws and a very long fourth finger attached to its wing. The back feet were often webbed and also had claws.

Wings

The wing membranes stretched from the pterosaurs' hands to their back legs.



Lacusovagus magnificens

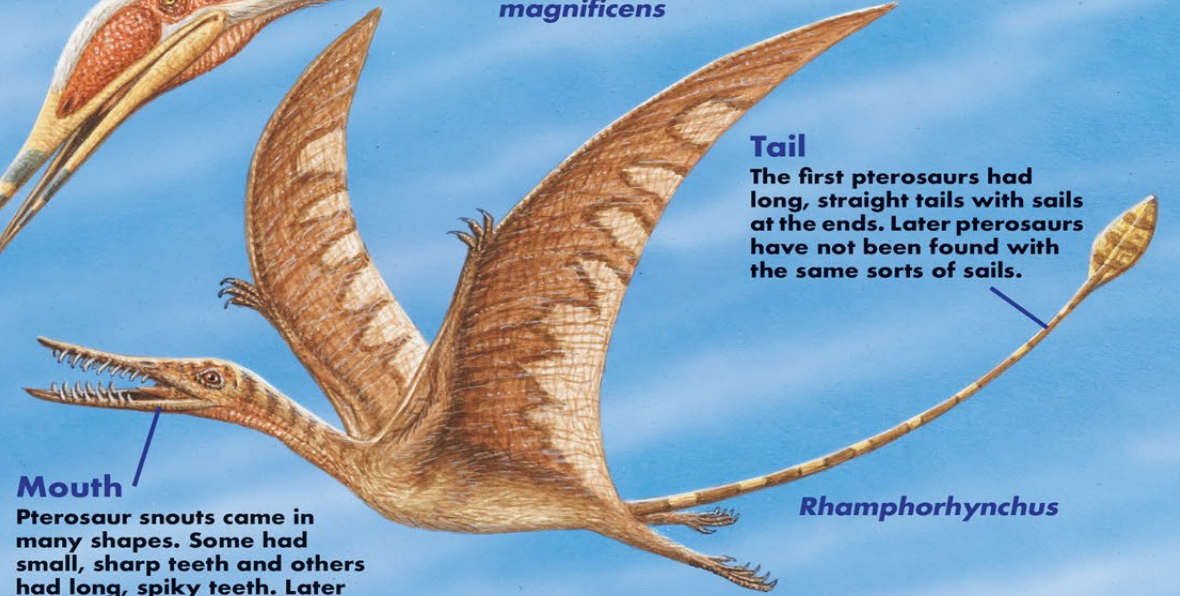
Tail

The first pterosaurs had long, straight tails with sails at the ends. Later pterosaurs have not been found with the same sorts of sails.

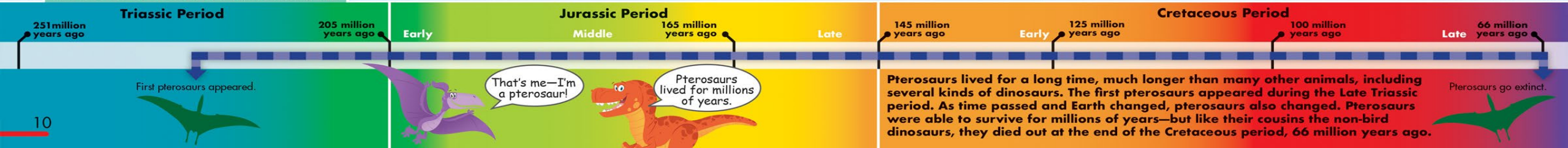
Mouth

Pterosaur snouts came in many shapes. Some had small, sharp teeth and others had long, spiky teeth. Later pterosaurs had big beaks with no teeth at all!

Rhamphorhynchus



MESOZOIC ERA 251–66 million years ago



MOSASAURUS FEATURES

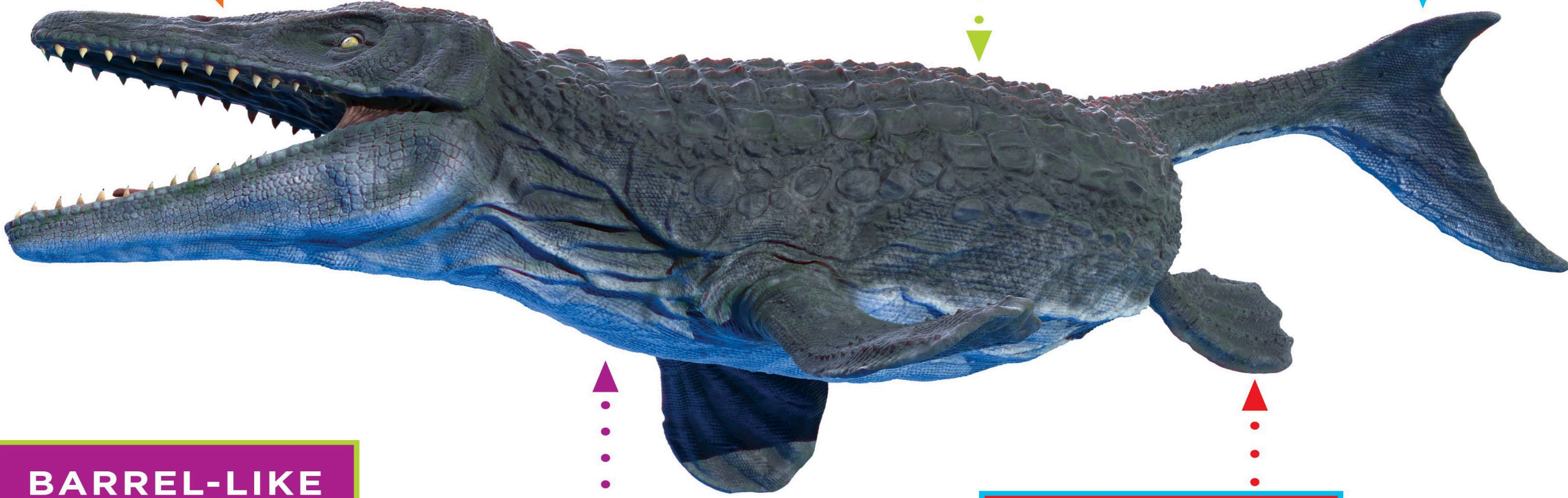
**DOUBLE-HINGED
JAW**



**DIAMOND
SHAPED
SCALES**



**SHARK-LIKE
TAIL**



**BARREL-LIKE
CHEST**



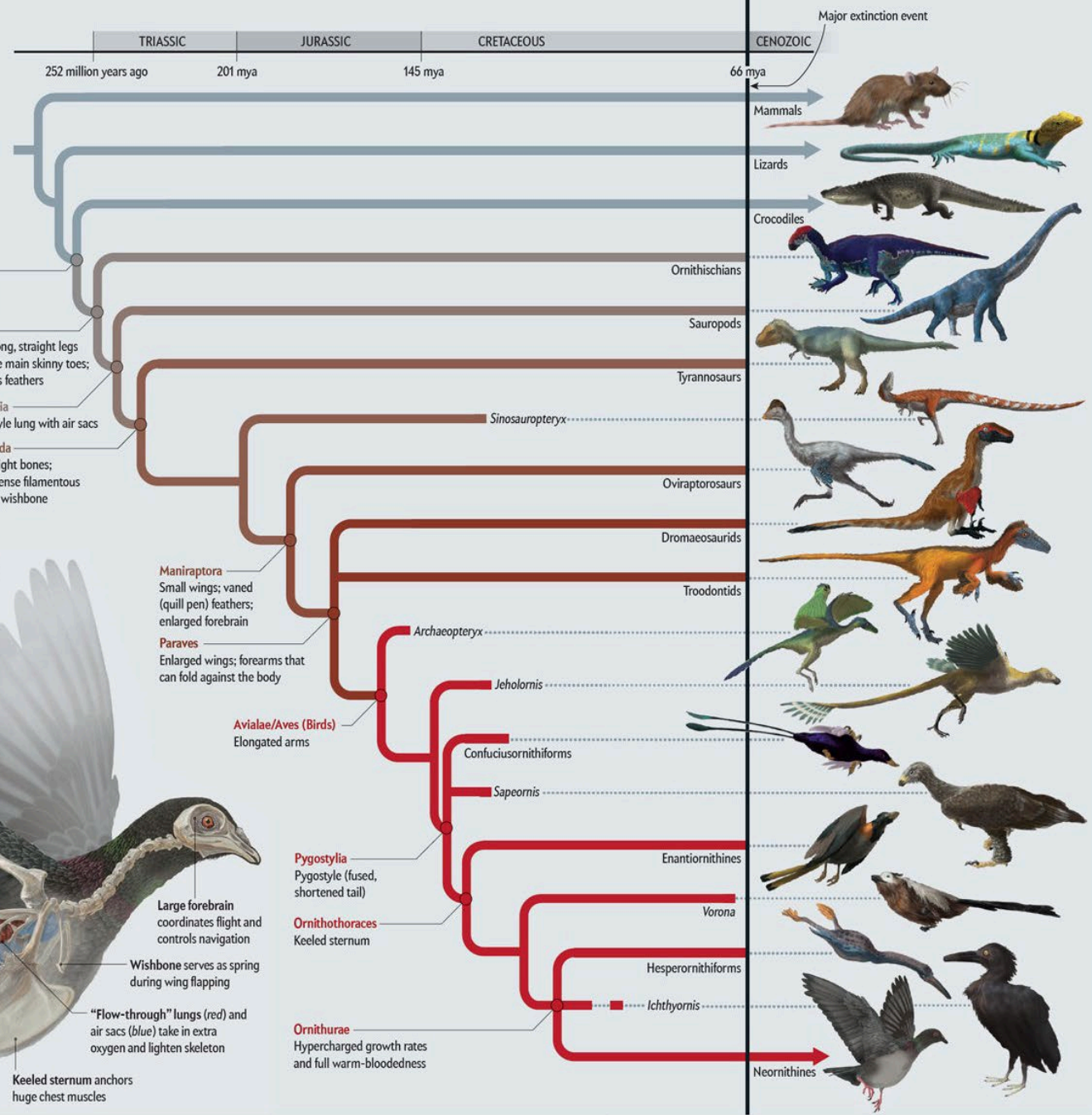
**STUMPY
PADDLE-LIKE
FLIPPERS**



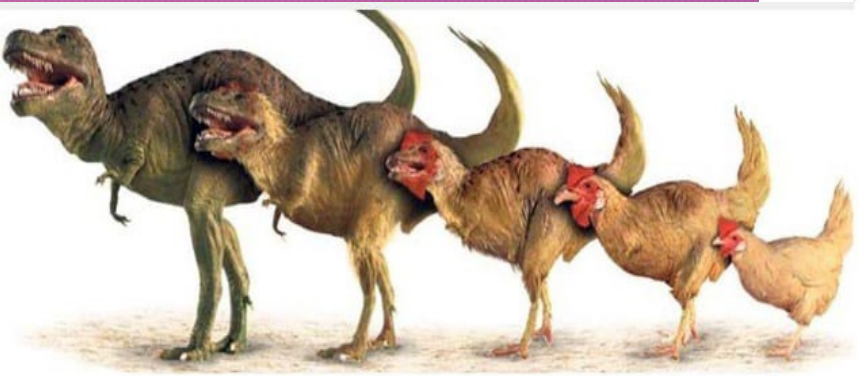
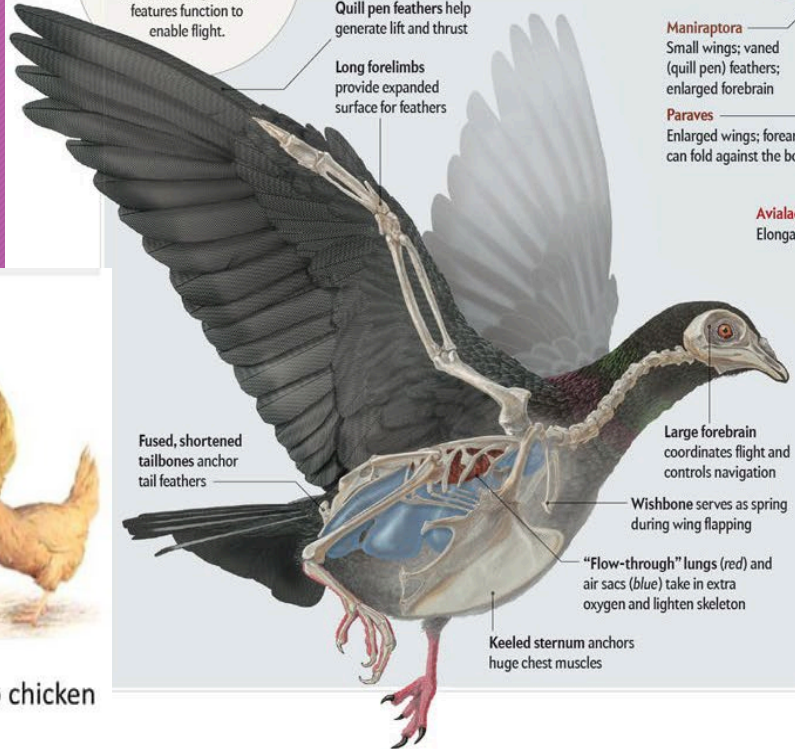
Therapods: Chickens to Eagles

A Gradual Transformation

Scientists have long wondered how evolution produces entirely new groups of organisms. The fossil record of birds and their dinosaur ancestors indicates that such transitions unfold very slowly. The hallmark traits of birds accumulated piecemeal over tens of millions of years and in many cases originated for reasons unrelated to the purposes they now serve.



Distinctive Anatomy
Birds have a multitude of characteristics that set them apart from other modern creatures. Many of these features function to enable flight.

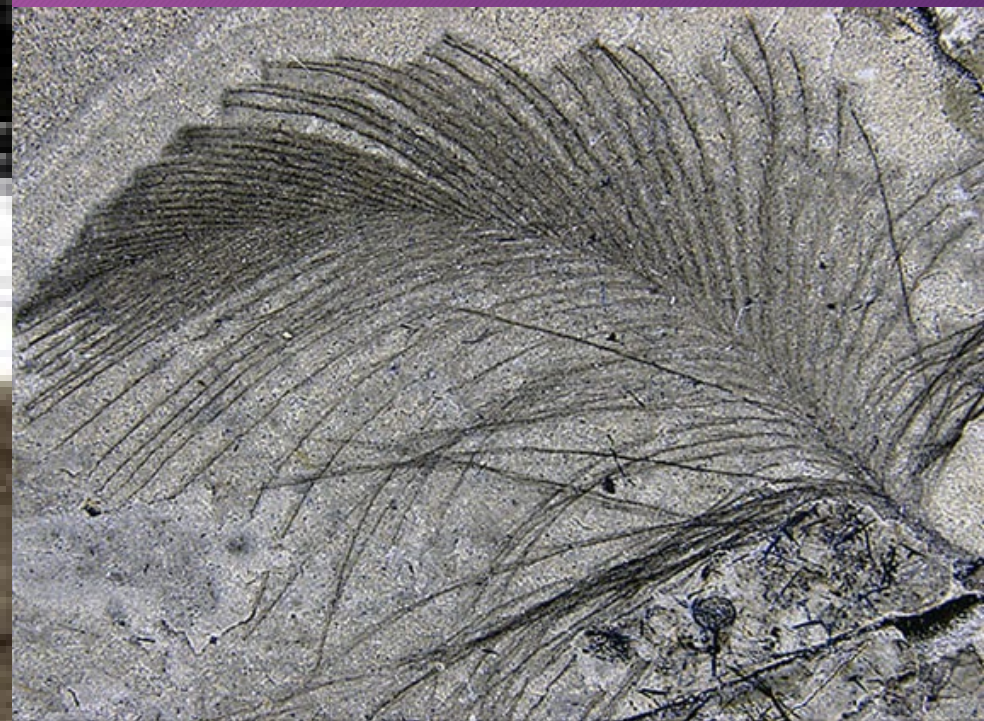


Simplistic view of evolution of the reptile line from dinosaur to chicken

Dinosaur: Scales/Fossils



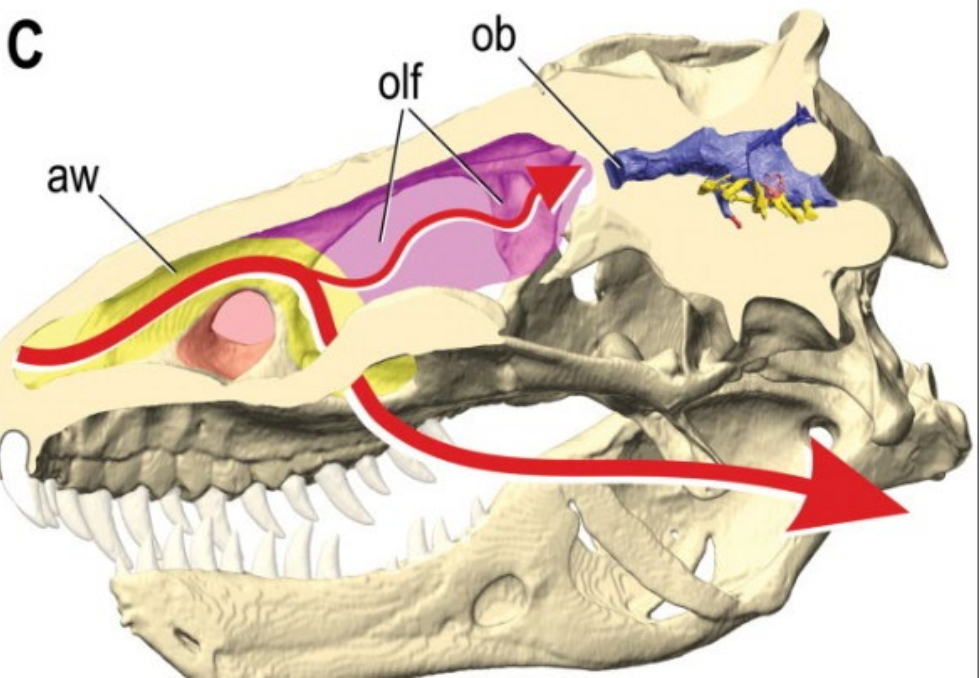
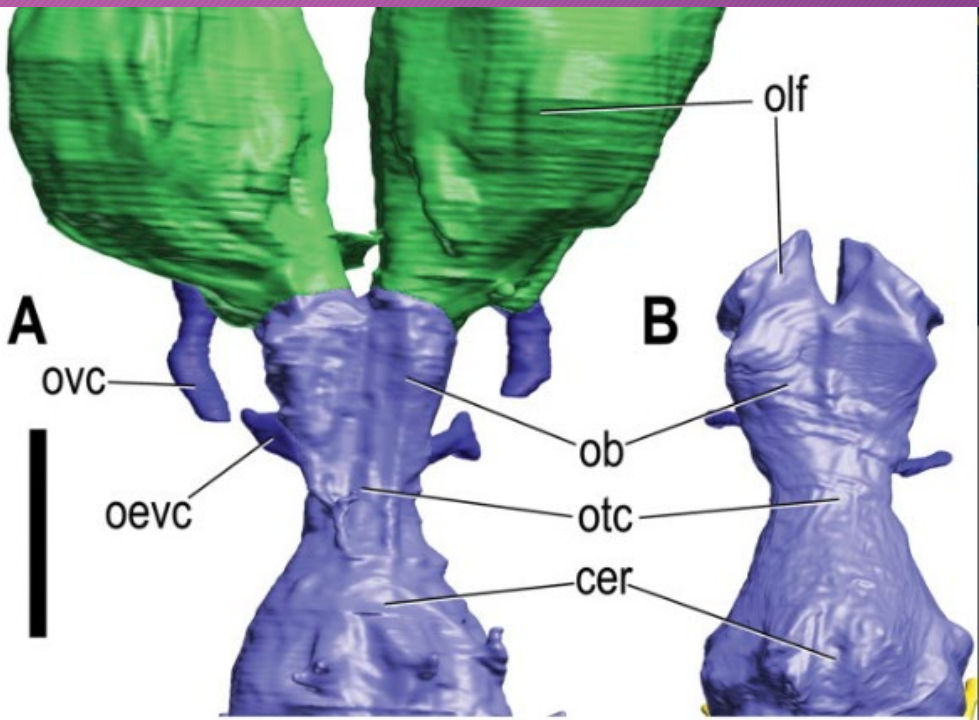
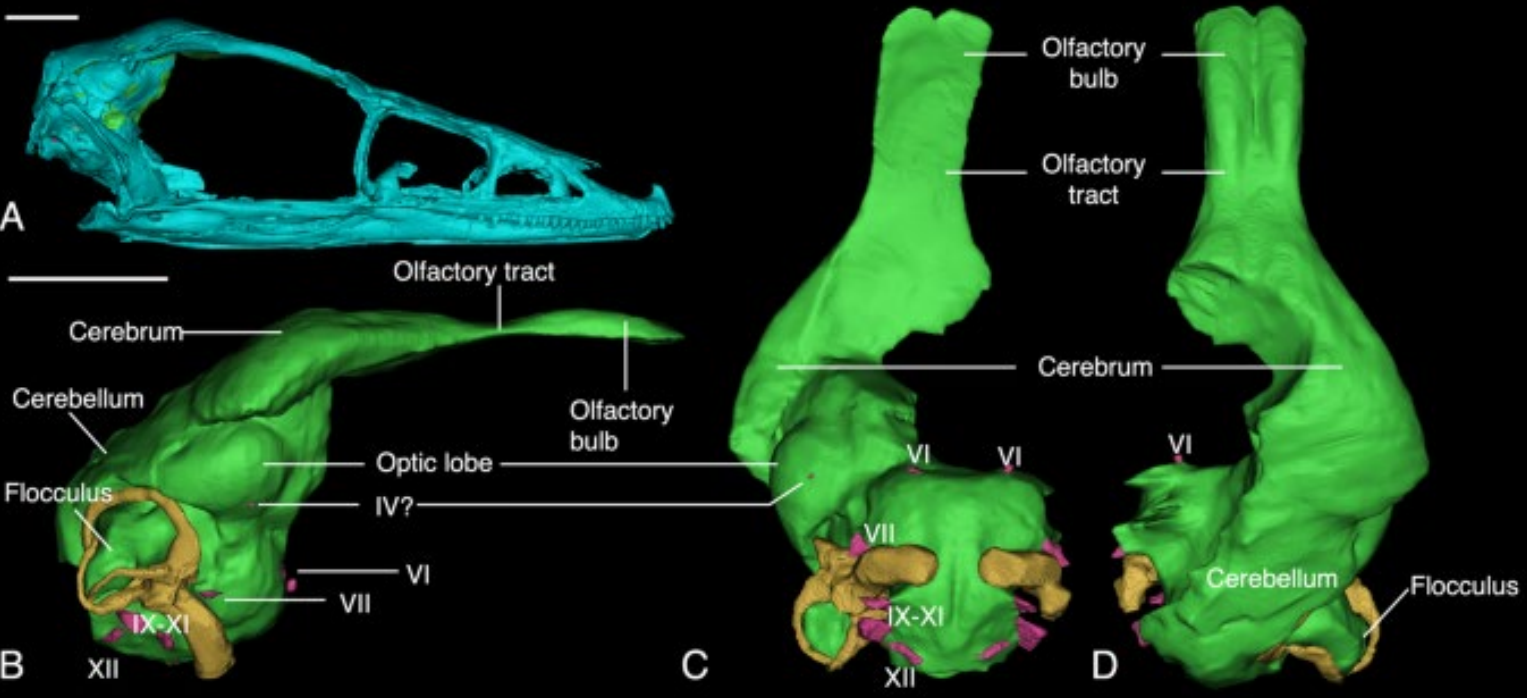
Dinosaur: Feather Fossils



Archaeopteryx

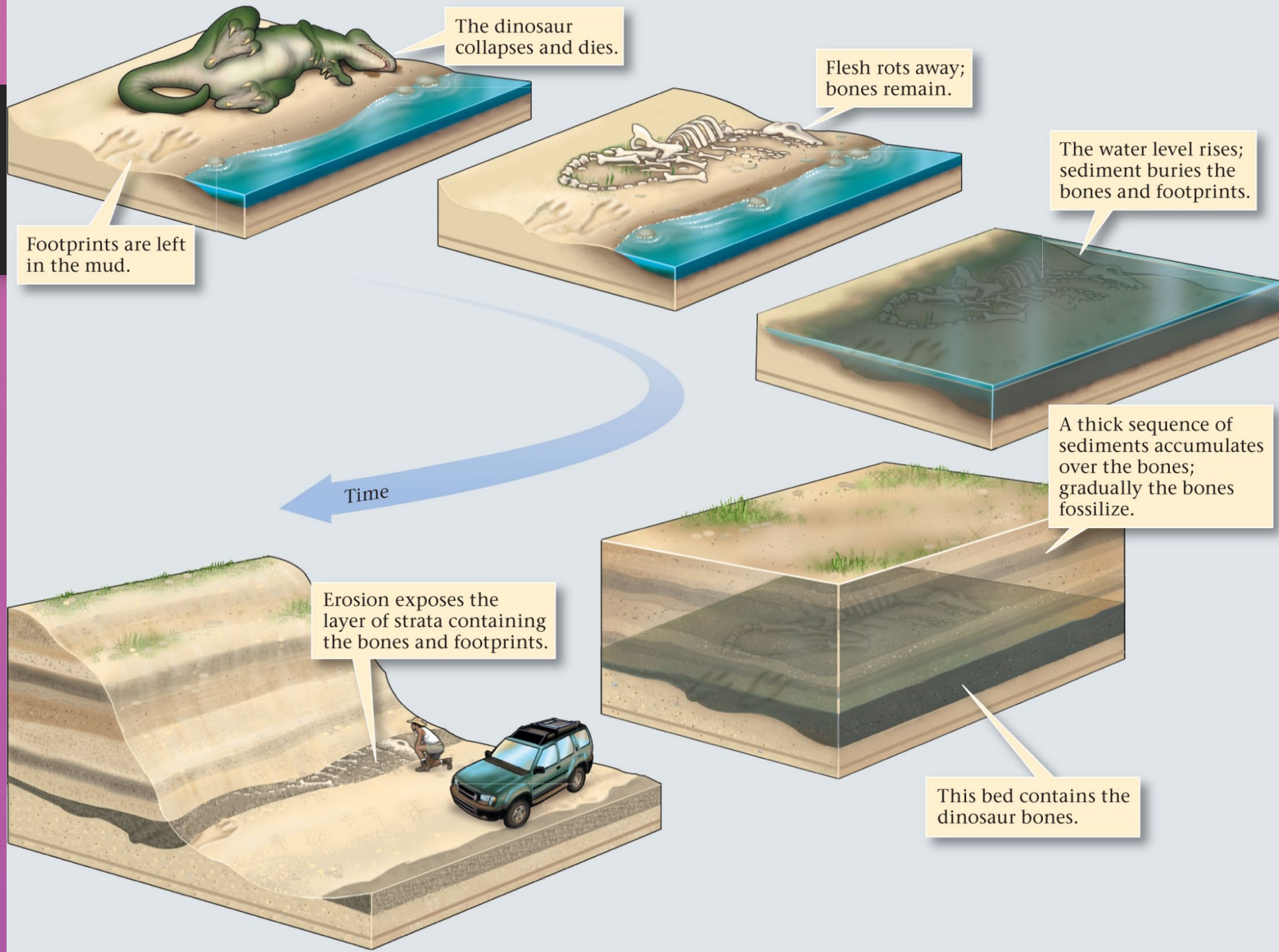


Dinosaur - Intelligence and senses



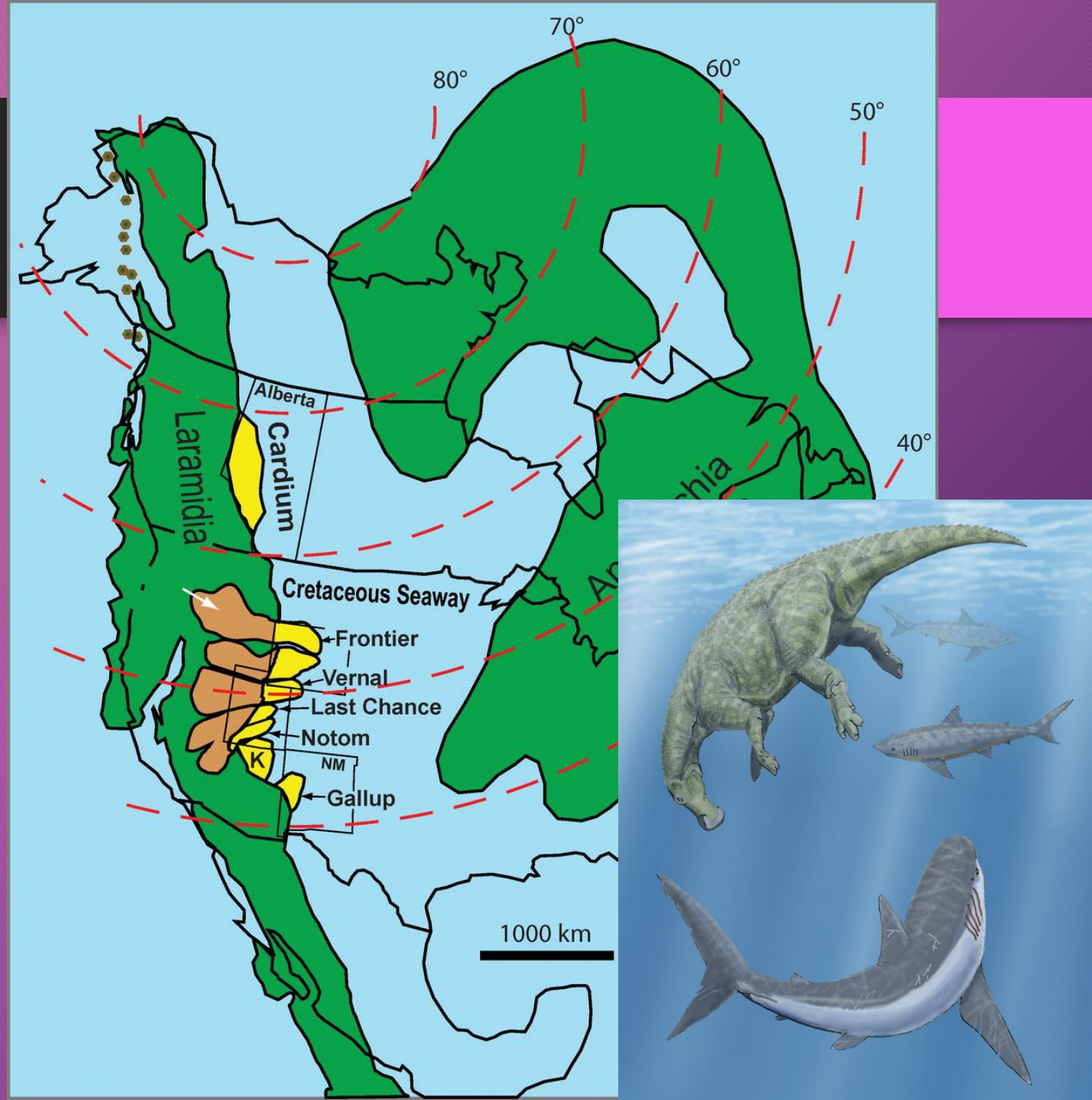
Preservation potential

- A. Anoxic conditions
- B. Rapid burial
- C. Presence of hard parts



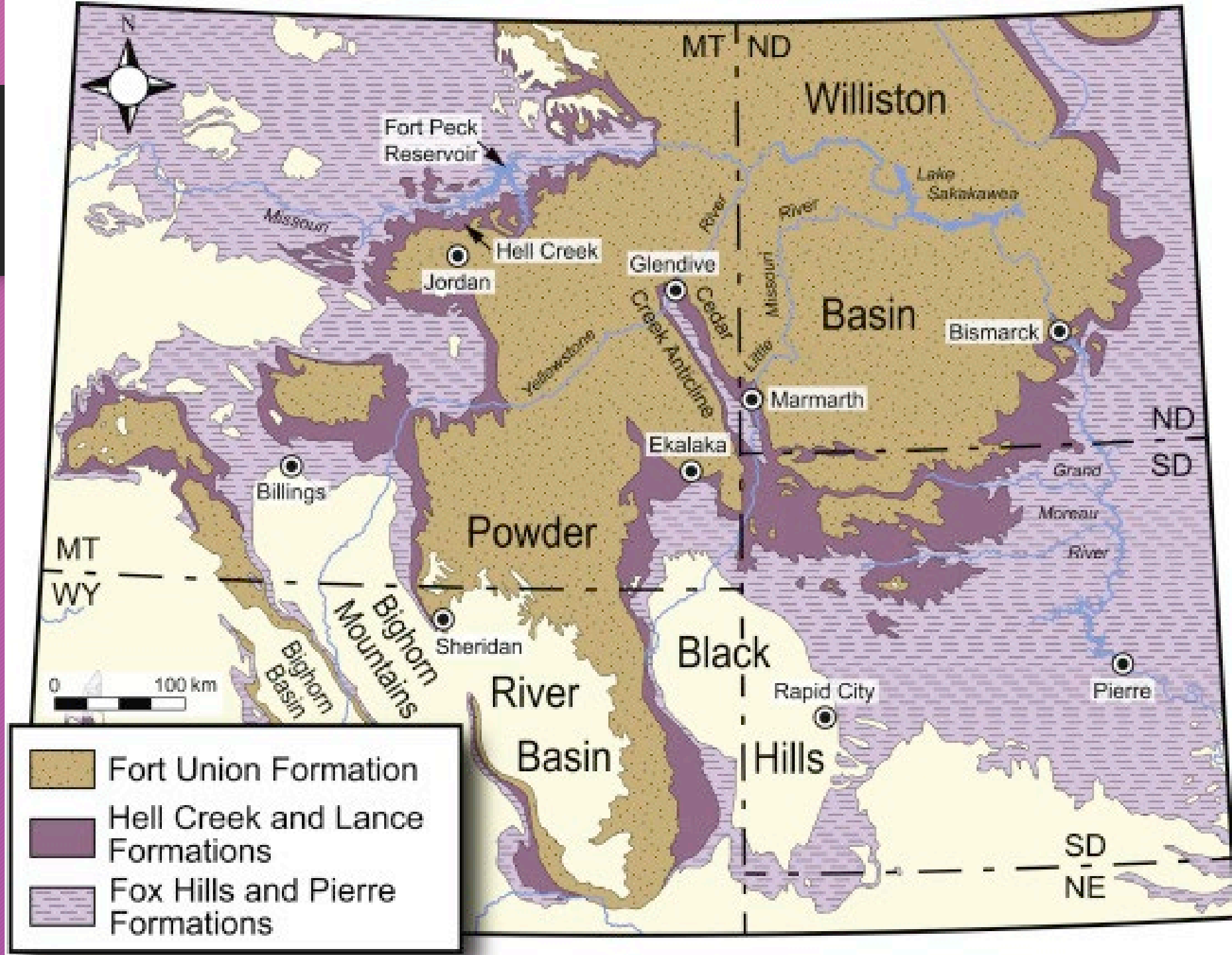
Cretaceous

- Dakota Formation
 - Western Iowa
 - Sandstone, mudstone, conglomerate
 - Fluvial environments



Late Cretaceous

- Hell Creek Formation



THE MANSON IMPACT STRUCTURE

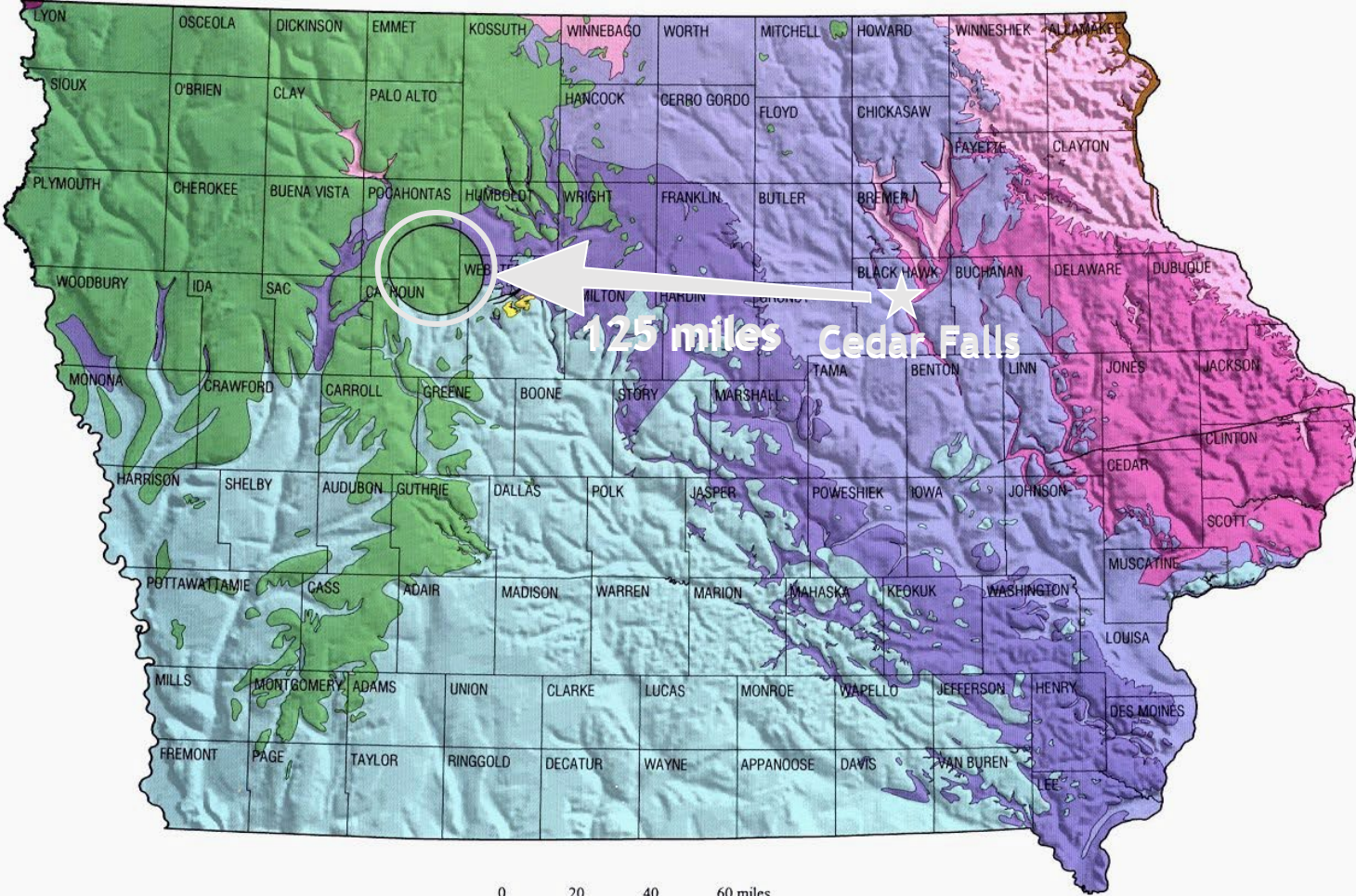
IOWA'S GREATEST CATASTROPHE

Viva Ray Anderson



BEDROCK GEOLOGIC MAP OF IOWA

1998



Geologic Systems

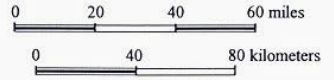
Age of rocks in Iowa
(million years before present)

- Cretaceous**
(74–102)
- Jurassic**
(160)
- Pennsylvanian**
(298–320)
- Mississippian**
(325–353)
- Devonian**
(355–385)
- Silurian**
(415–435)
- Ordovician**
(439–505)
- Cambrian**
(505–530)
- Precambrian**
(600?–2,910+)

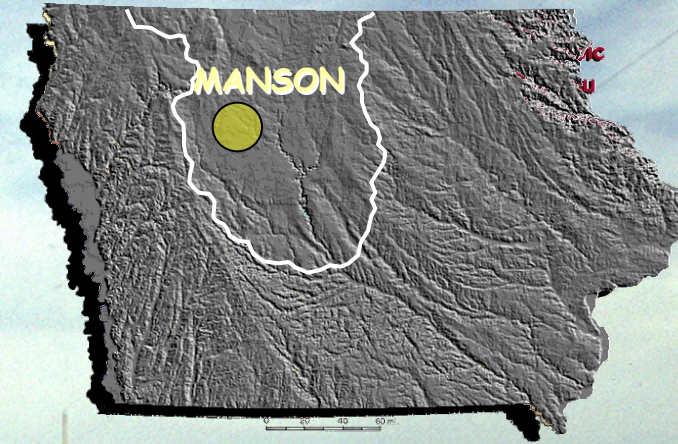
Fault trace

Manson Impact Structure

Shading highlights relief on the bedrock surface.



“Scenic Overview” of the Manson Impact Structure





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



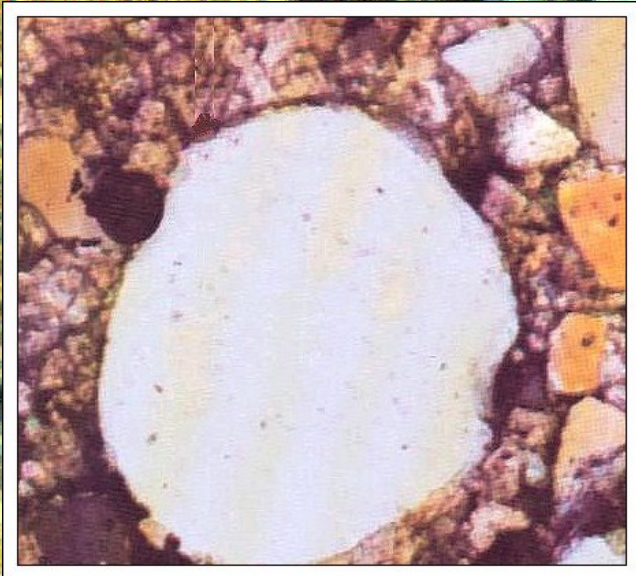
SKYLAB photograph of the Manson area

June 1978



(limits of the structure
shown by black line)





PDFs in
Quartz Grains

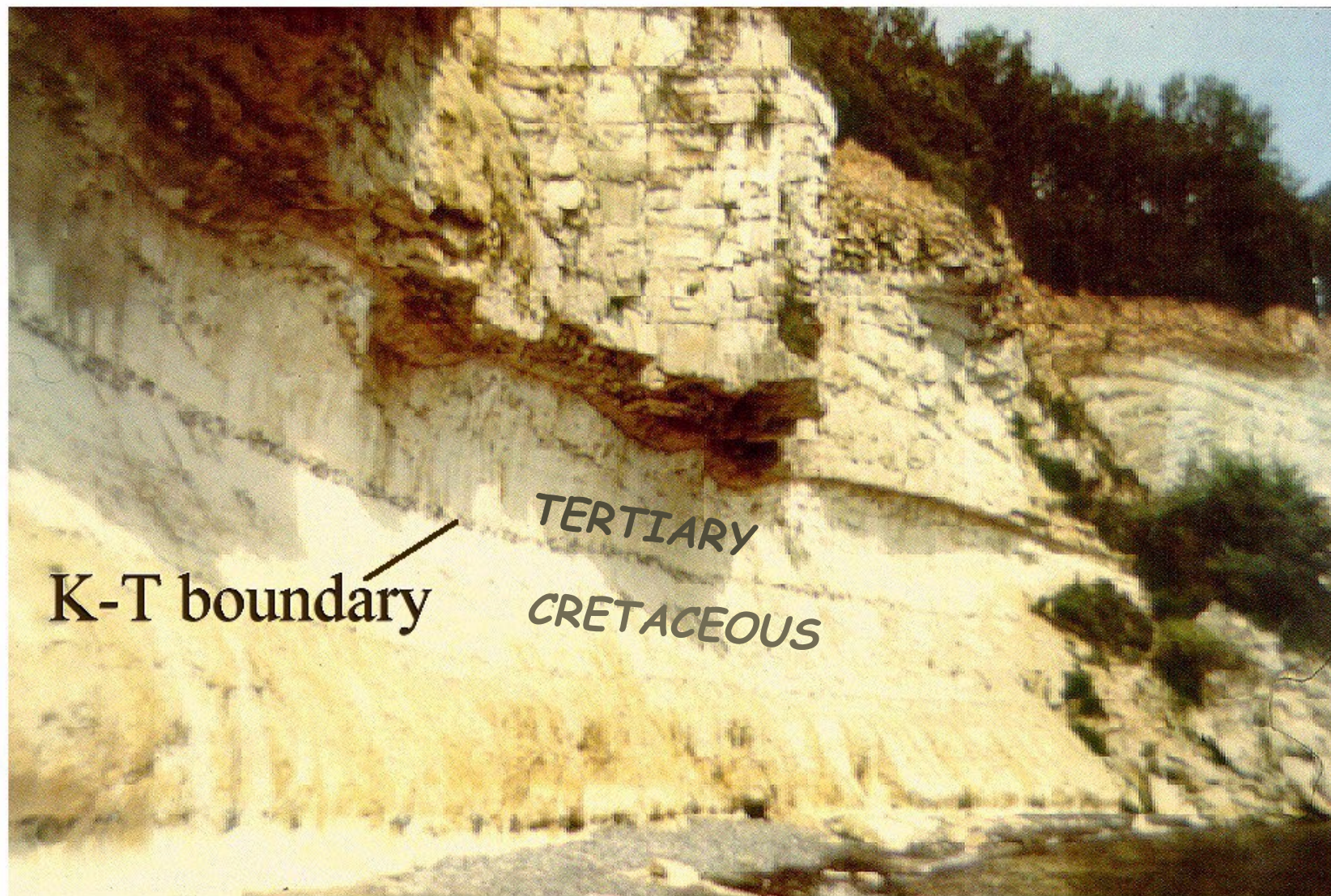
Manson 1-A core

1 mm

1980



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



K-T boundary

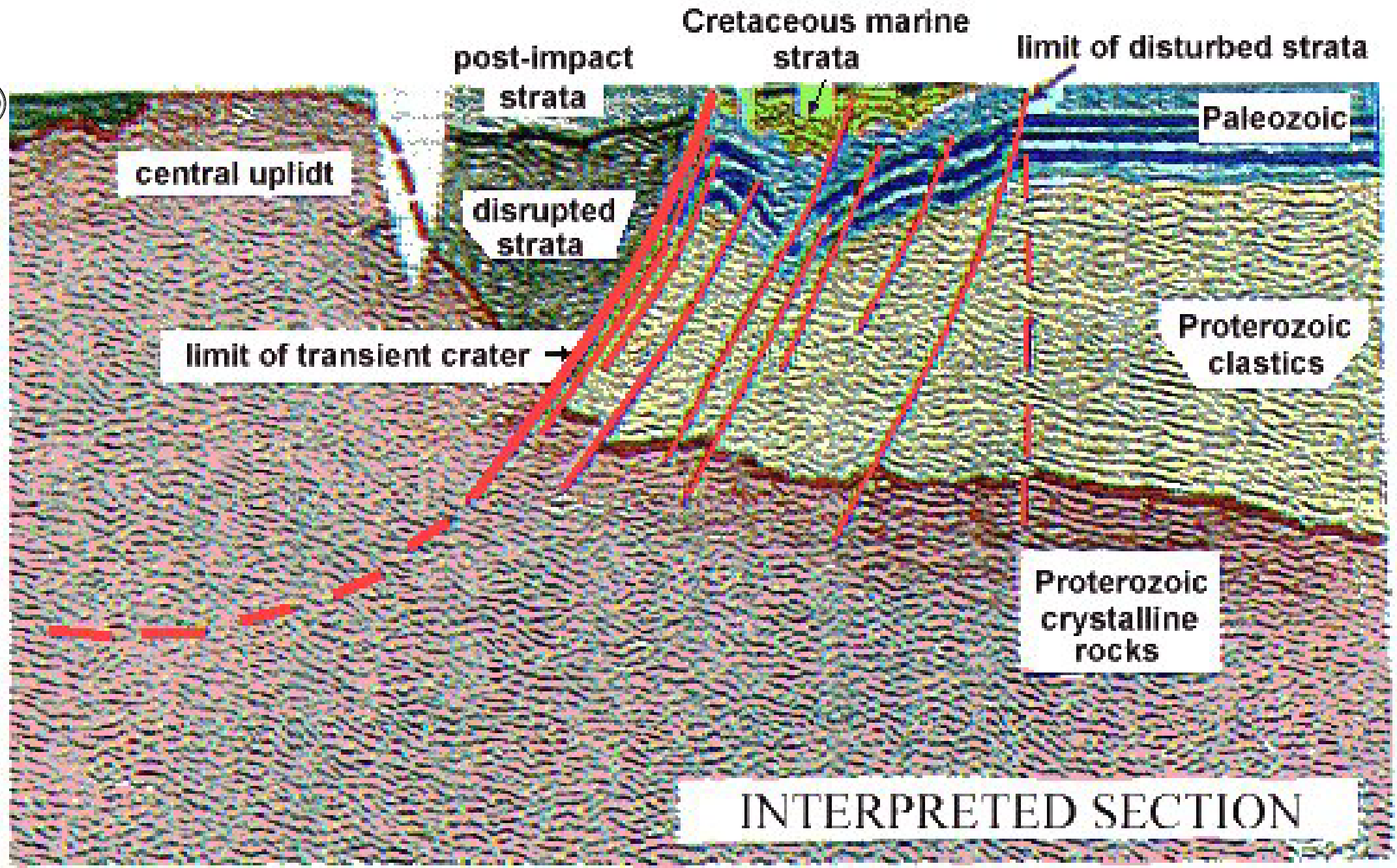
TERTIARY
CRETACEOUS

Stevens Klint, Denmark



TWO-WAY TRAVEL TIME(SEC)

0.5
1.0
1.5
2.0



Seismic data courtesy of Amoco Production Co.

Manson
100 Ma - 500,000

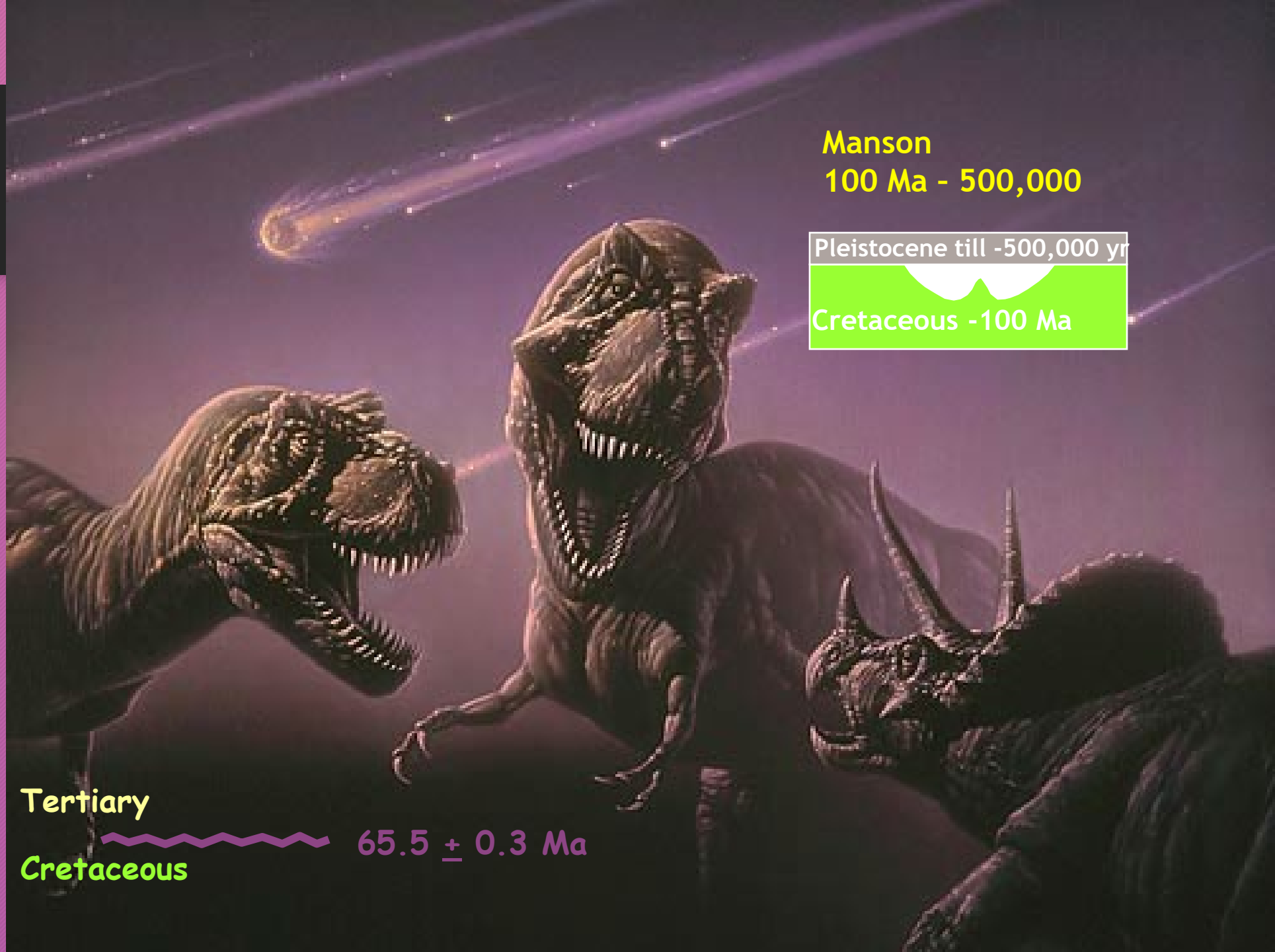
Pleistocene till -500,000 yr

Cretaceous -100 Ma

Tertiary

Cretaceous

65.5 ± 0.3 Ma



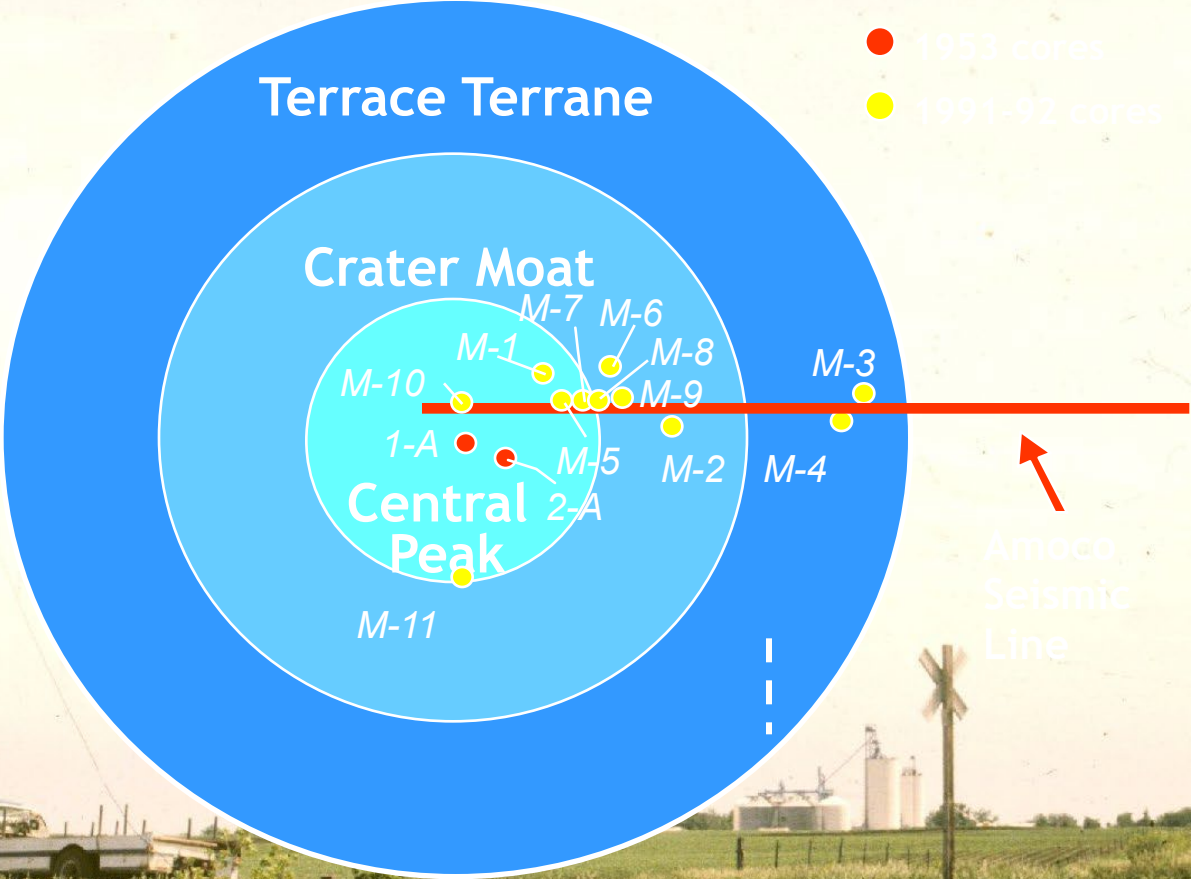
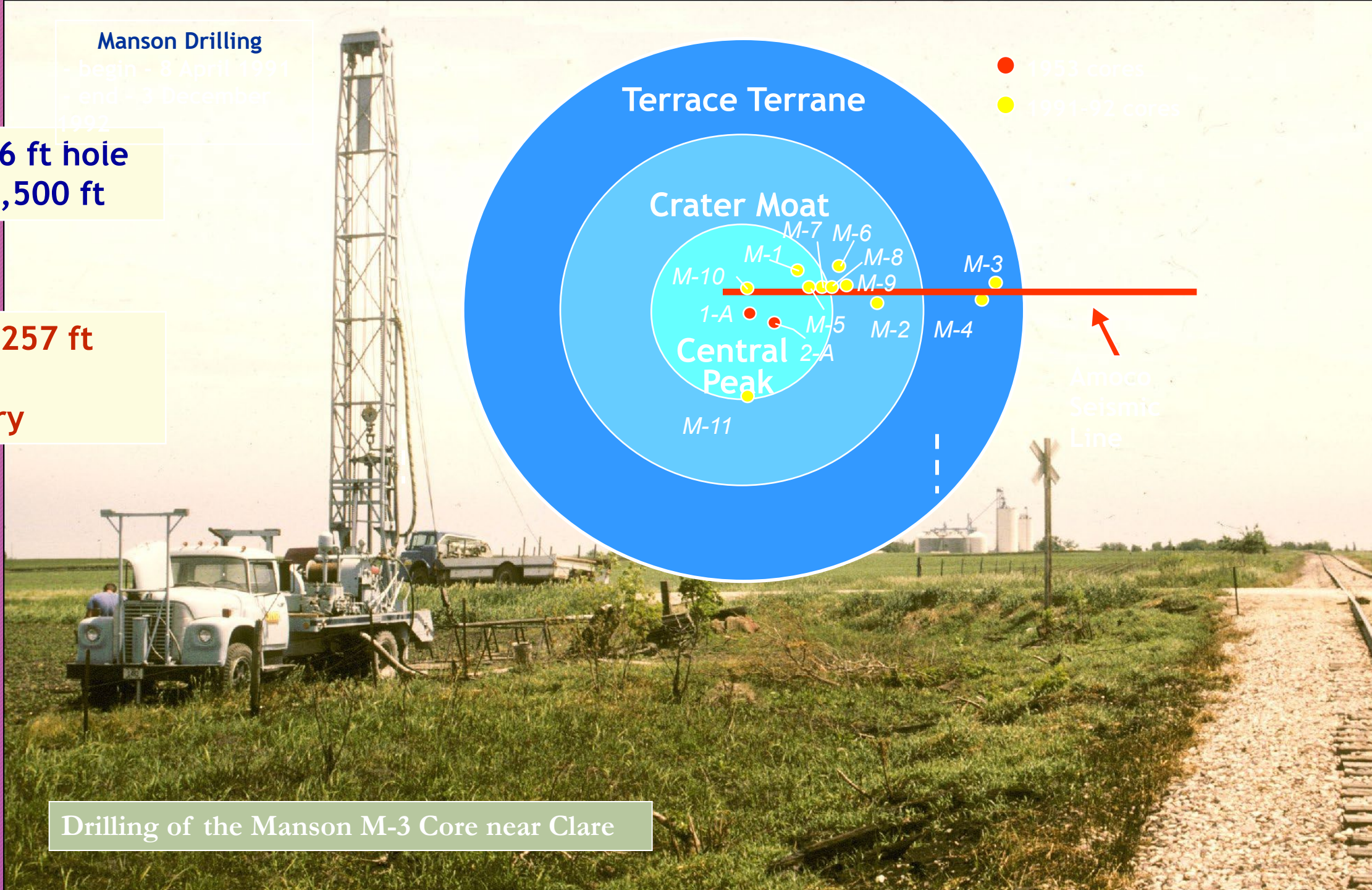
Manson Drilling

- 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



● 1953 cores
● 1991-92 cores

Amoco
Seismic
Line

IMPACT ROCKS IN THE MANSON STRUCTURE

Central Peak

Crater Moat

Ring Graben

Phanerozoic-Clast Breccia

Keweenaw-Shale
Clast Breccia

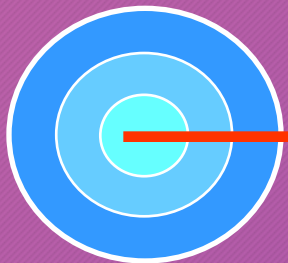
Crystalline
Clast Breccia
(Melt Matrix)

Crystalline
Clast Breccia
(Sandy Matrix)

Proterozoic
Crystalline
Megablocks

Overtuned
Sedimentary Strata

(cross section from crater center to eastern edge)

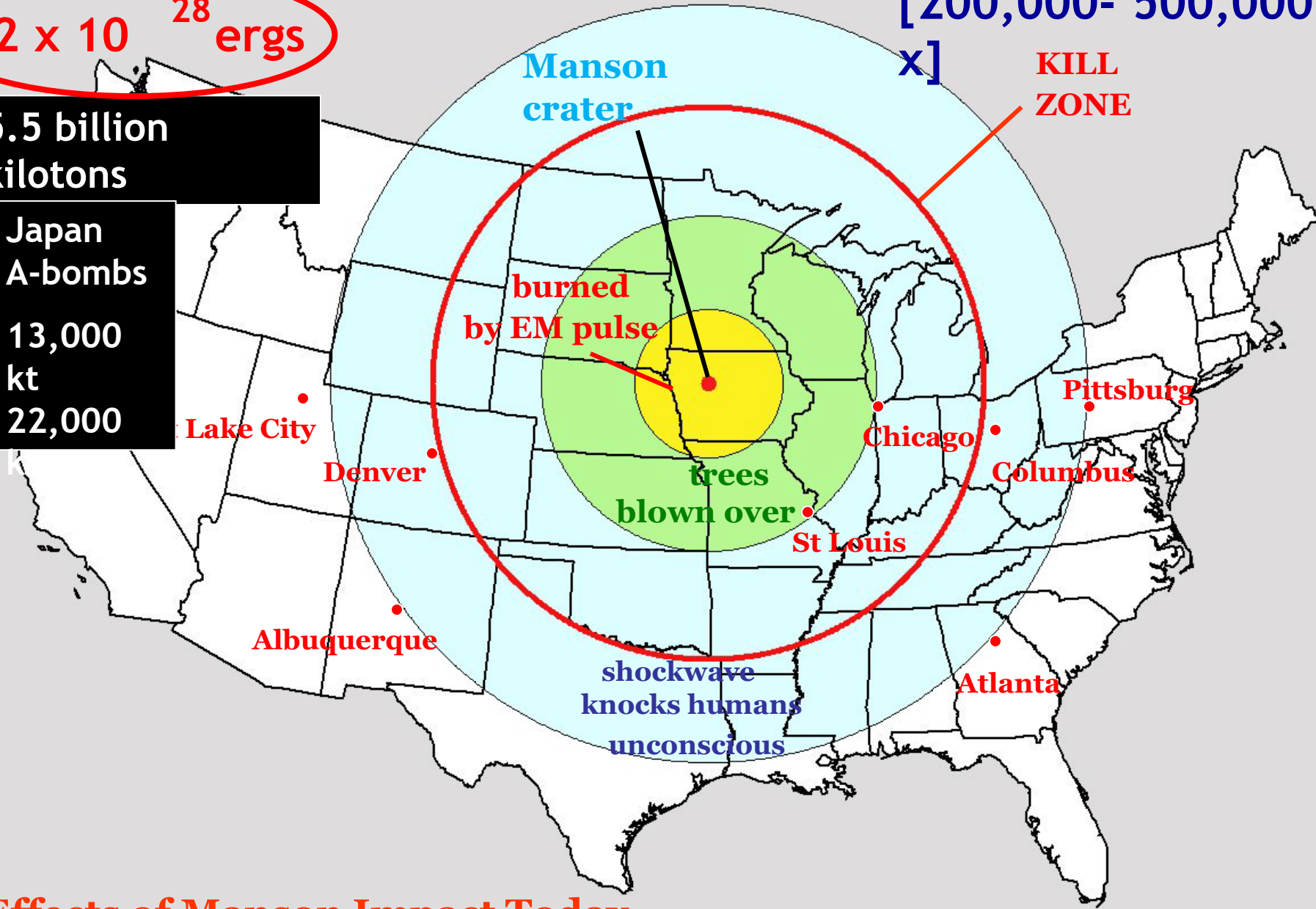


2.2×10^{28} ergs

5.5 billion kilotons

Japan A-bombs
13,000 kt
22,000

[200,000- 500,000 x]



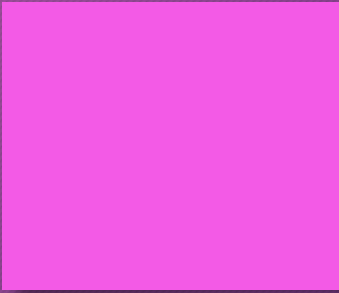
Effects of Manson Impact Today

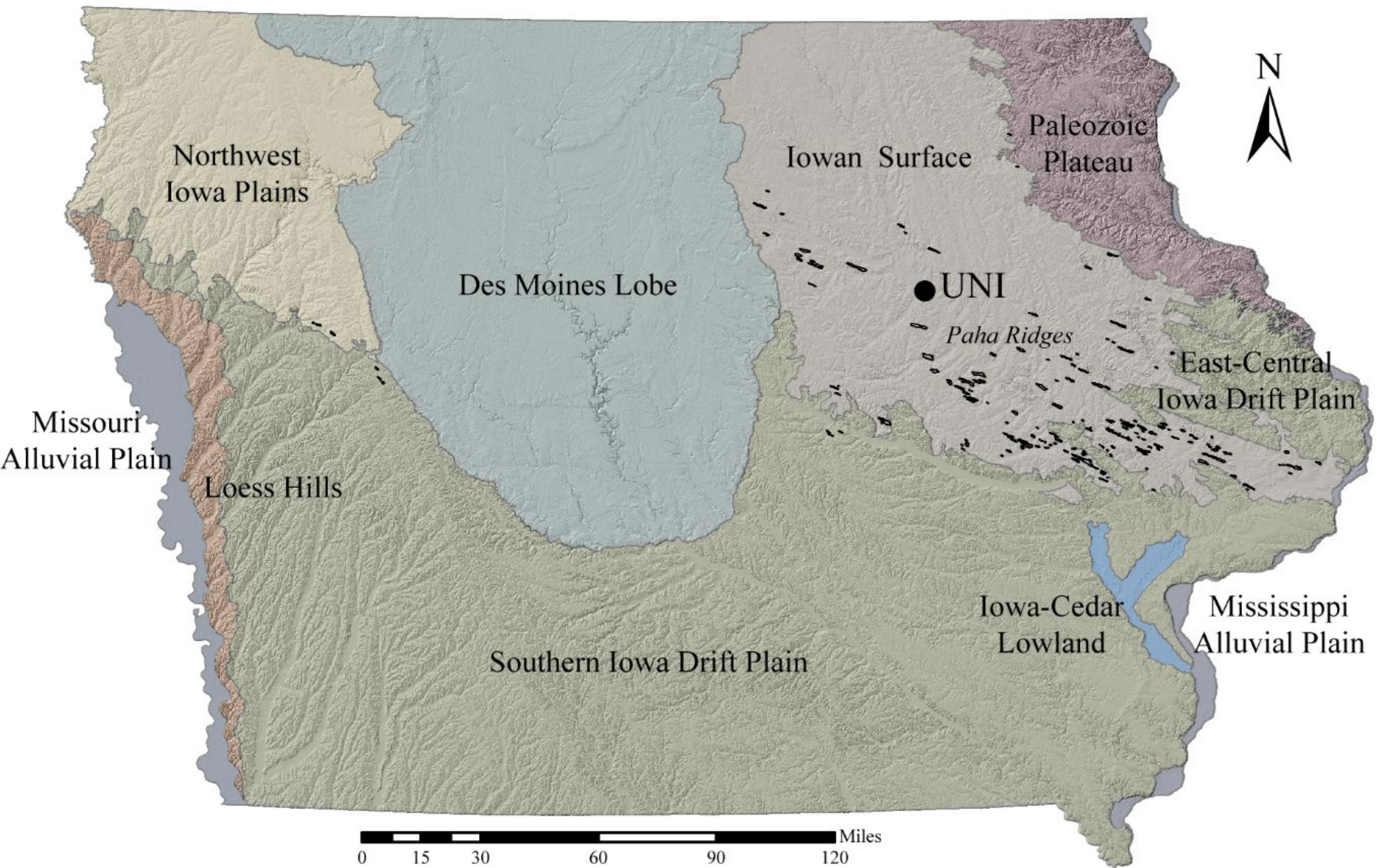


BILL BRYSON

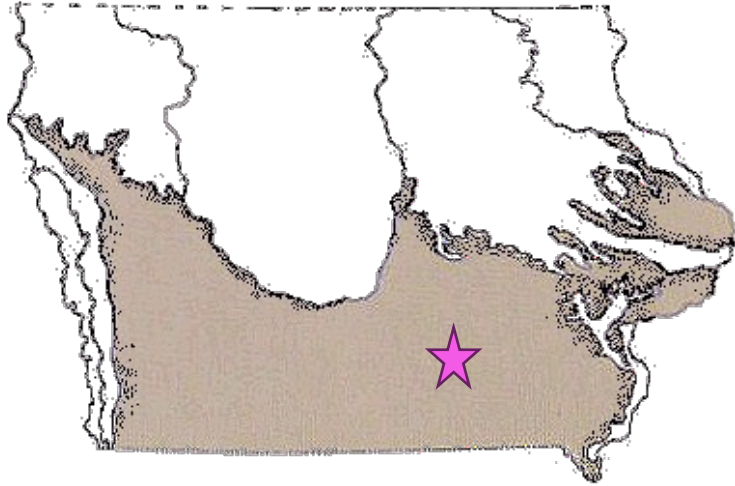
*A Short History of Nearly Everything

Author of A Walk in the Woods and In a Sunburned Country



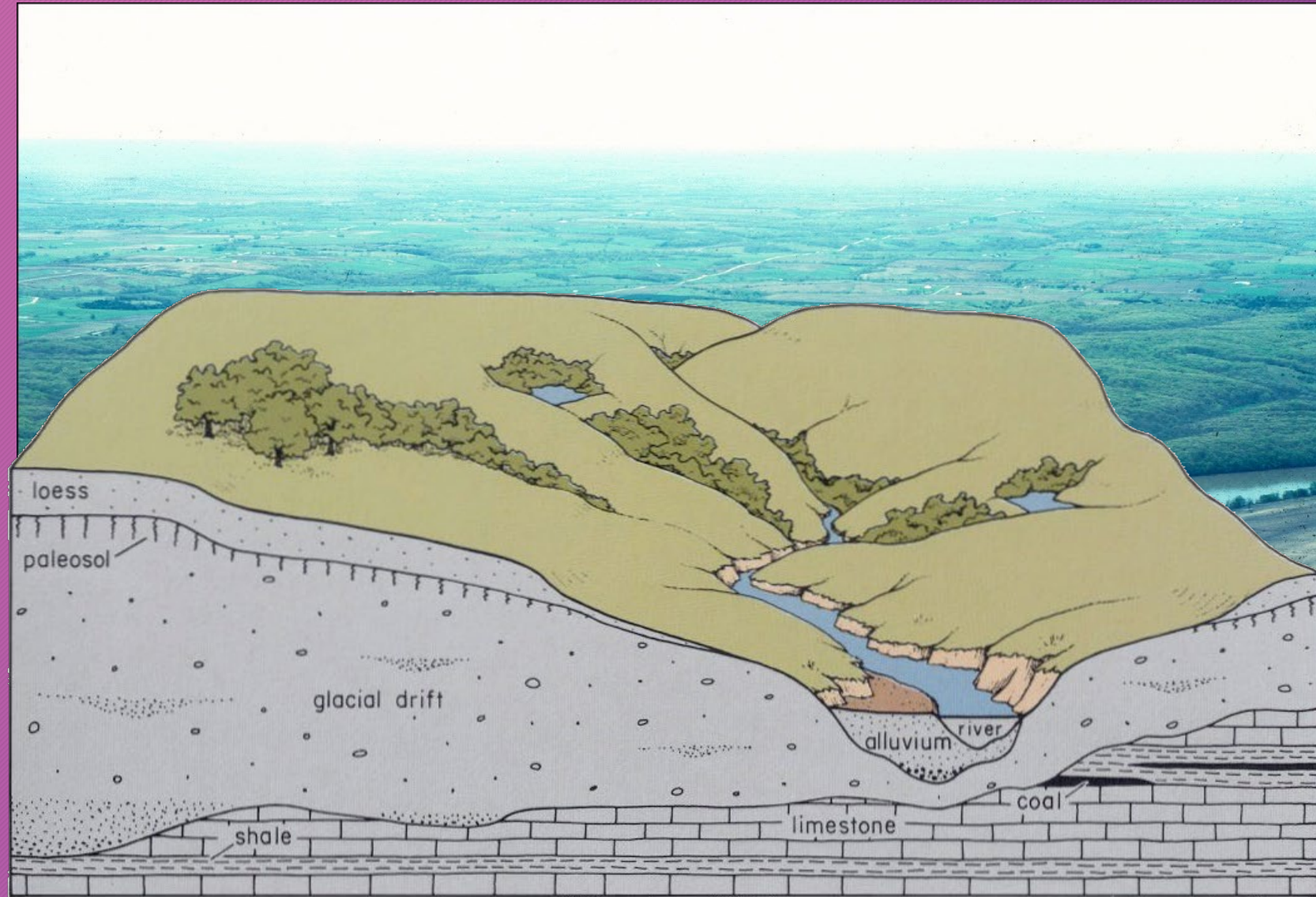


Southern Iowa Drift Plain

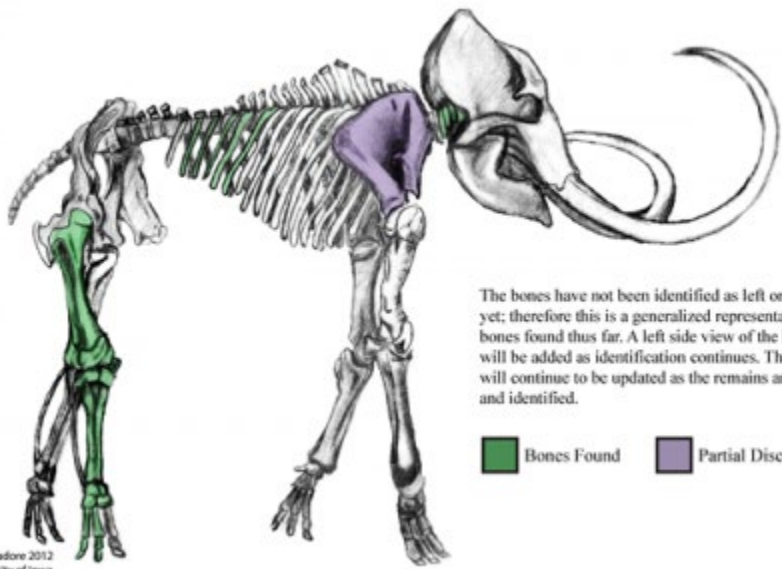


Terrain Characteristics

- * moderate loess cover
- * weathered glacial drifts with paleosols
- * integrated drainage network
- * bedrock exposed in deeper valleys



Mahaska County Mammoths



The bones have not been identified as left or right yet; therefore this is a generalized representation of bones found thus far. A left side view of the bones will be added as identification continues. This image will continue to be updated as the remains are found and identified.

■ Bones Found ■ Partial Discoveries

© Jessica hadore 2012
The University of Iowa



Hot Spring, SD - Mammoth Site

1. Largest concentration of mammoth fossils in the world 60+
2. Natural 'trap' setting
3. Exceptional preservation
4. Mostly young males
5. Active dig site



Ashfall Fossil Beds, Nebraska

- ‘Pompeii of the Plains’
- Ties into Yellowstone
- Slow motion ecological disaster

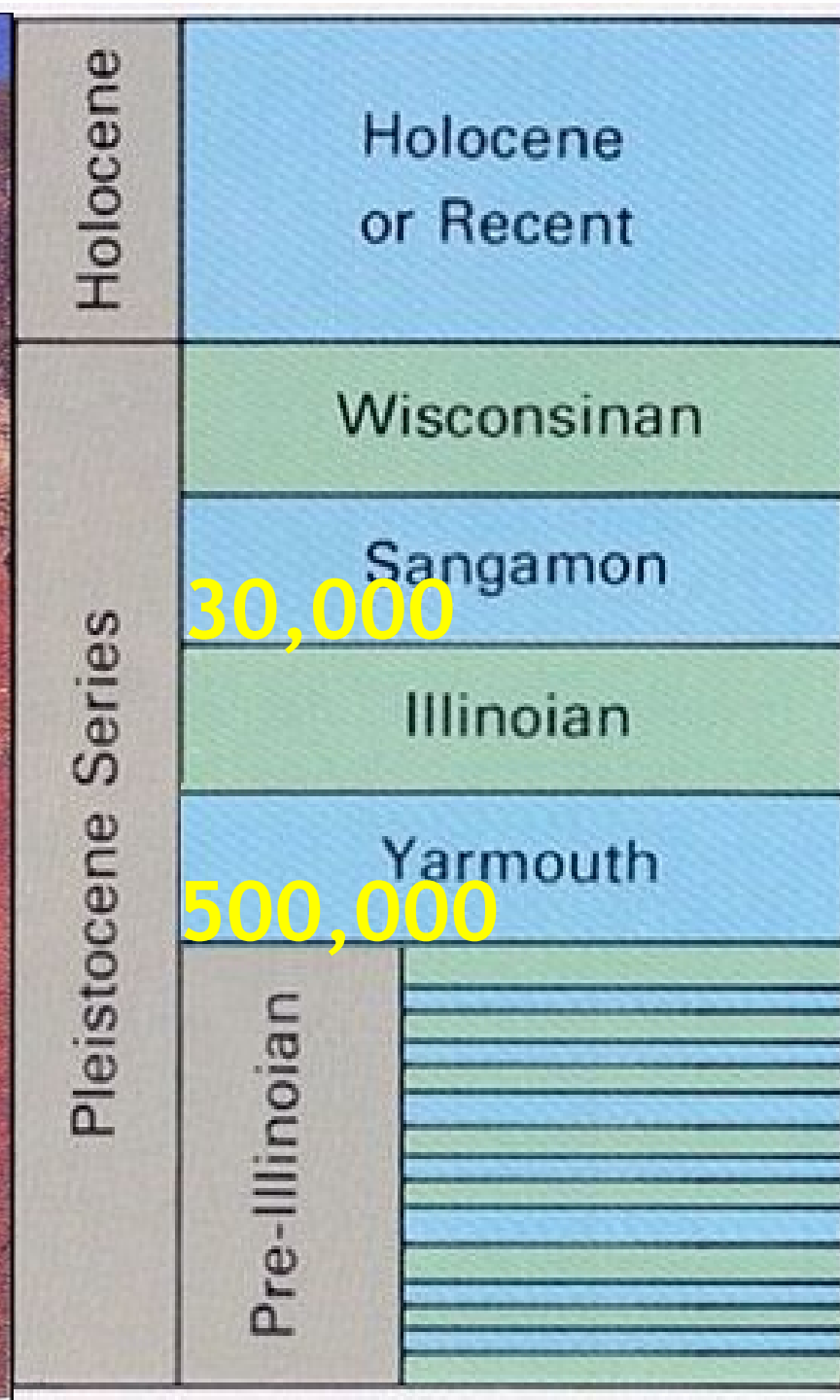
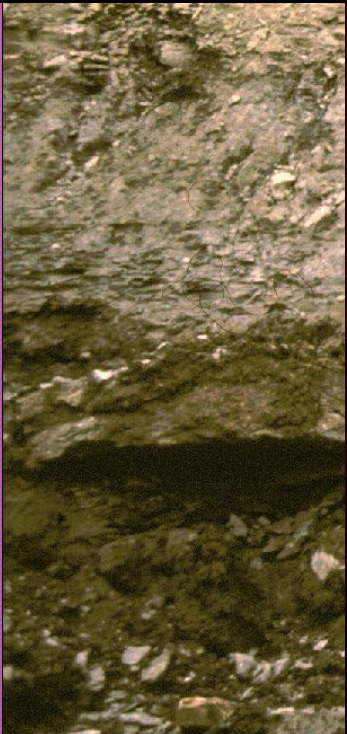


**moderate
loess cover**

*loess-capped hills, Iowa County photo by Gary
Hightshoe*



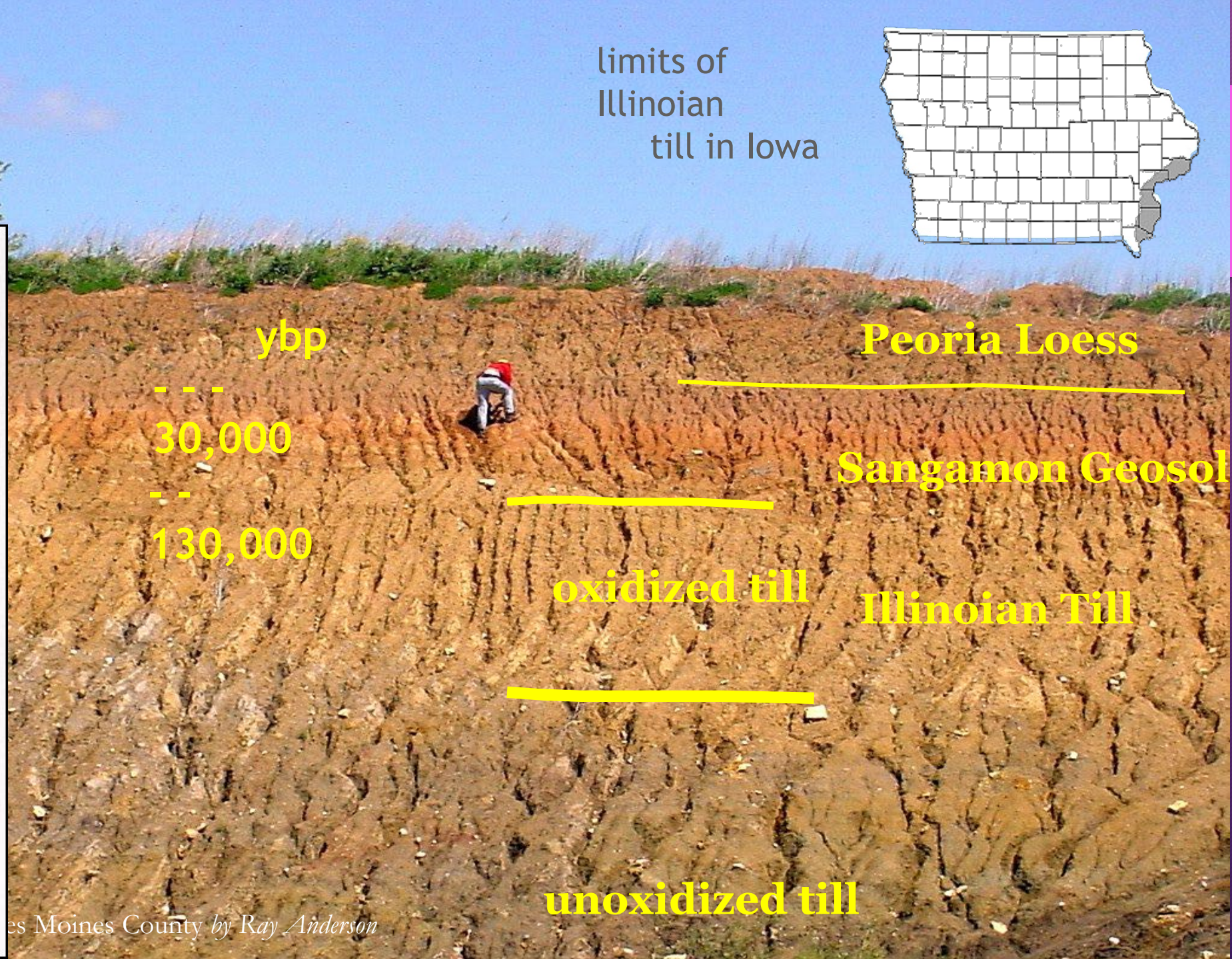
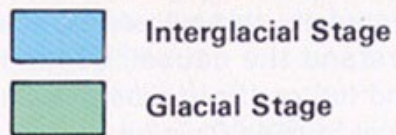
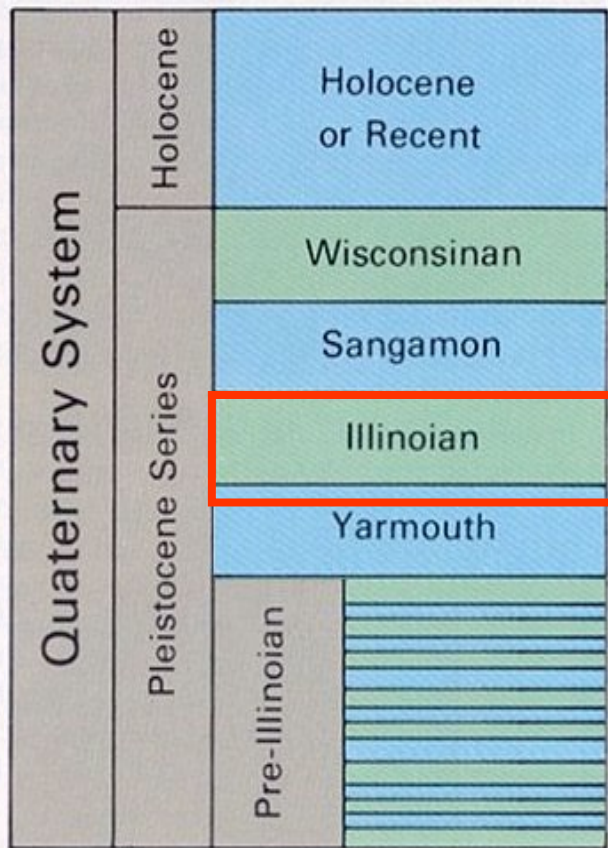
Weathered
drift with p



Two Pre-Illinoian tills at the Braddyville Quad
Yarmouth-Sangamon Paleosol "gumbo till",

weathered
glacial
drift &
paleosol

limits of
Illinoian
till in Iowa



ybp

30,000

130,000

Peoria Loess

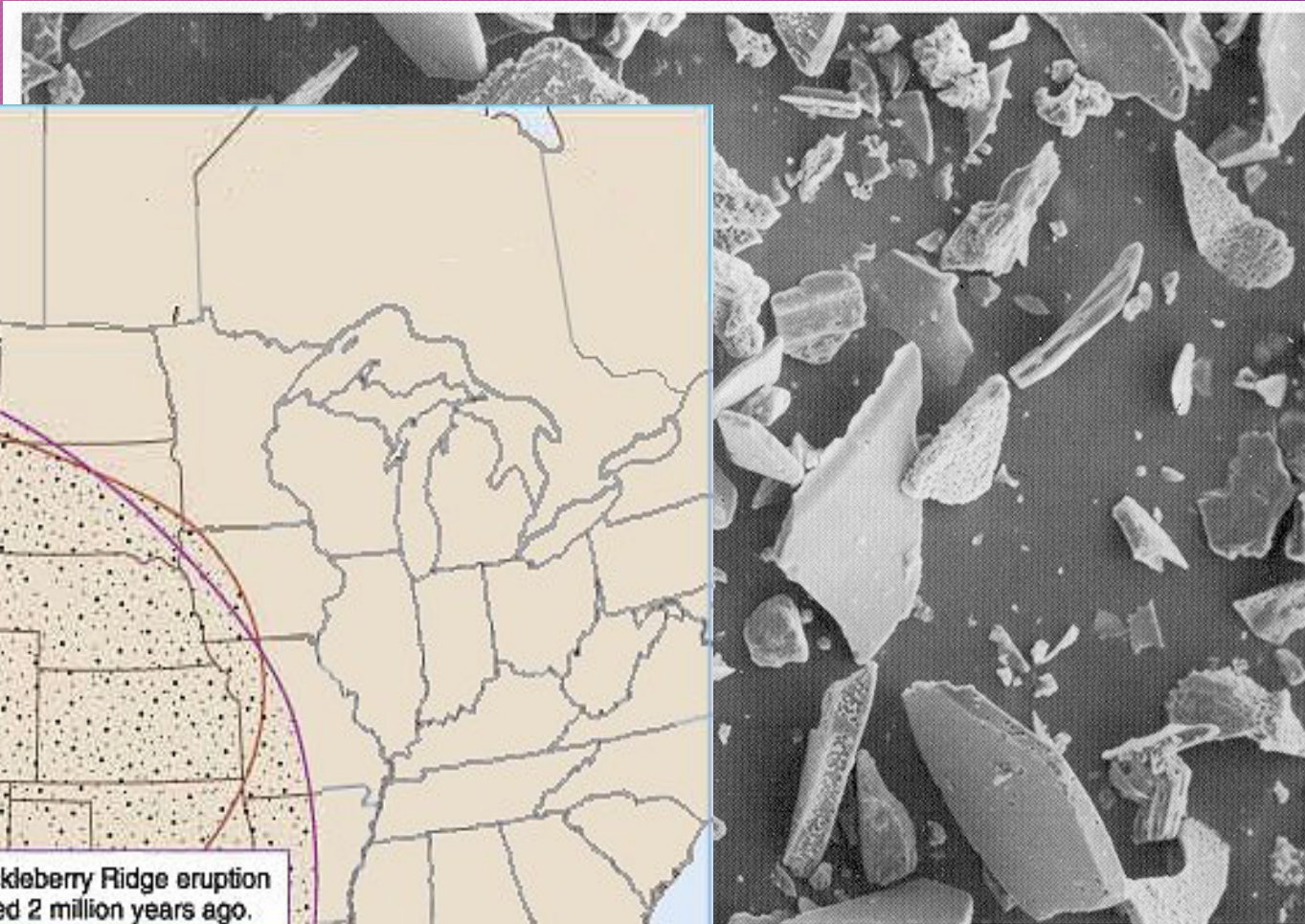
Sangamon Geosol

oxidized till

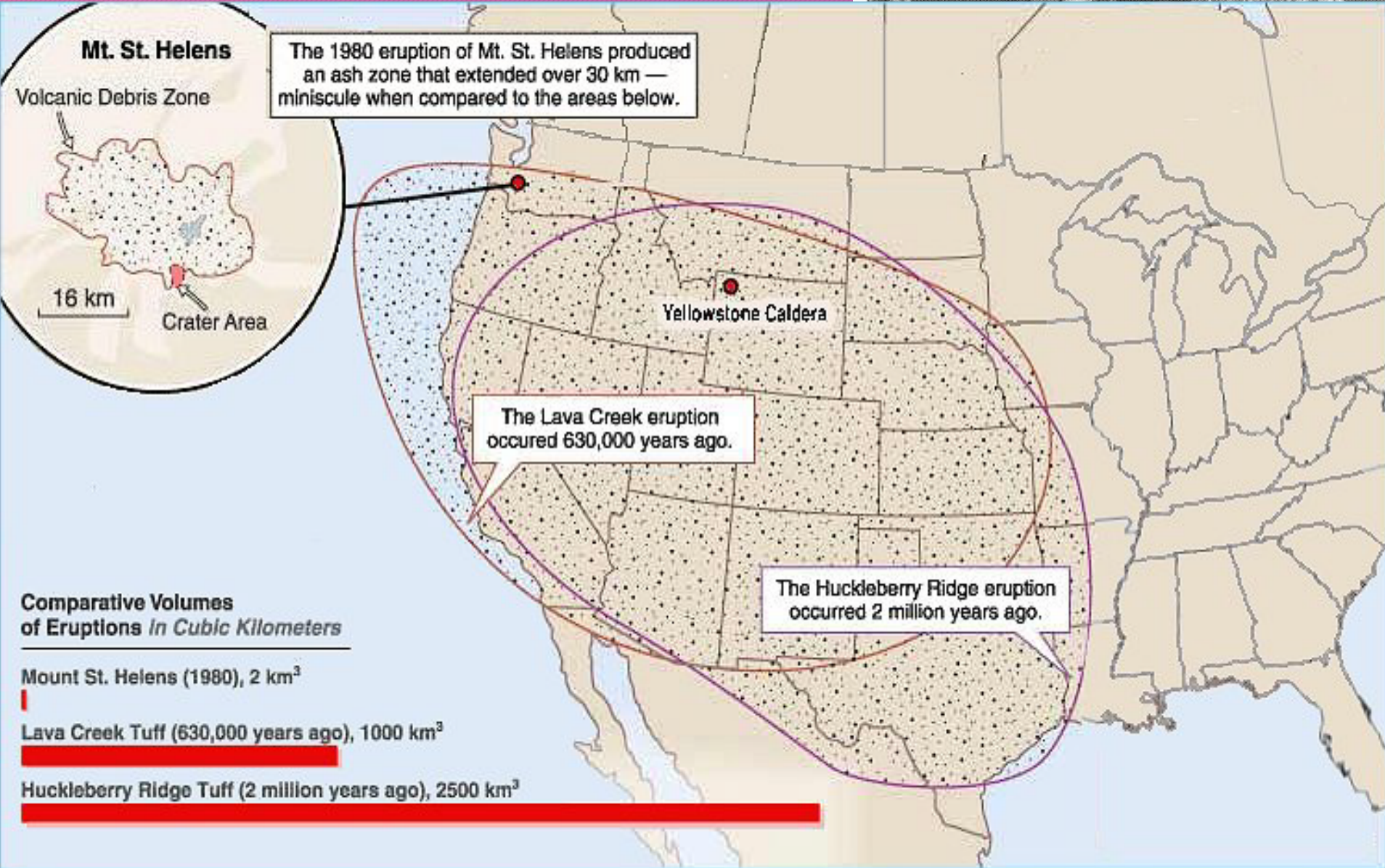
Illinoian Till

unoxidized till

* volcanic ash beds



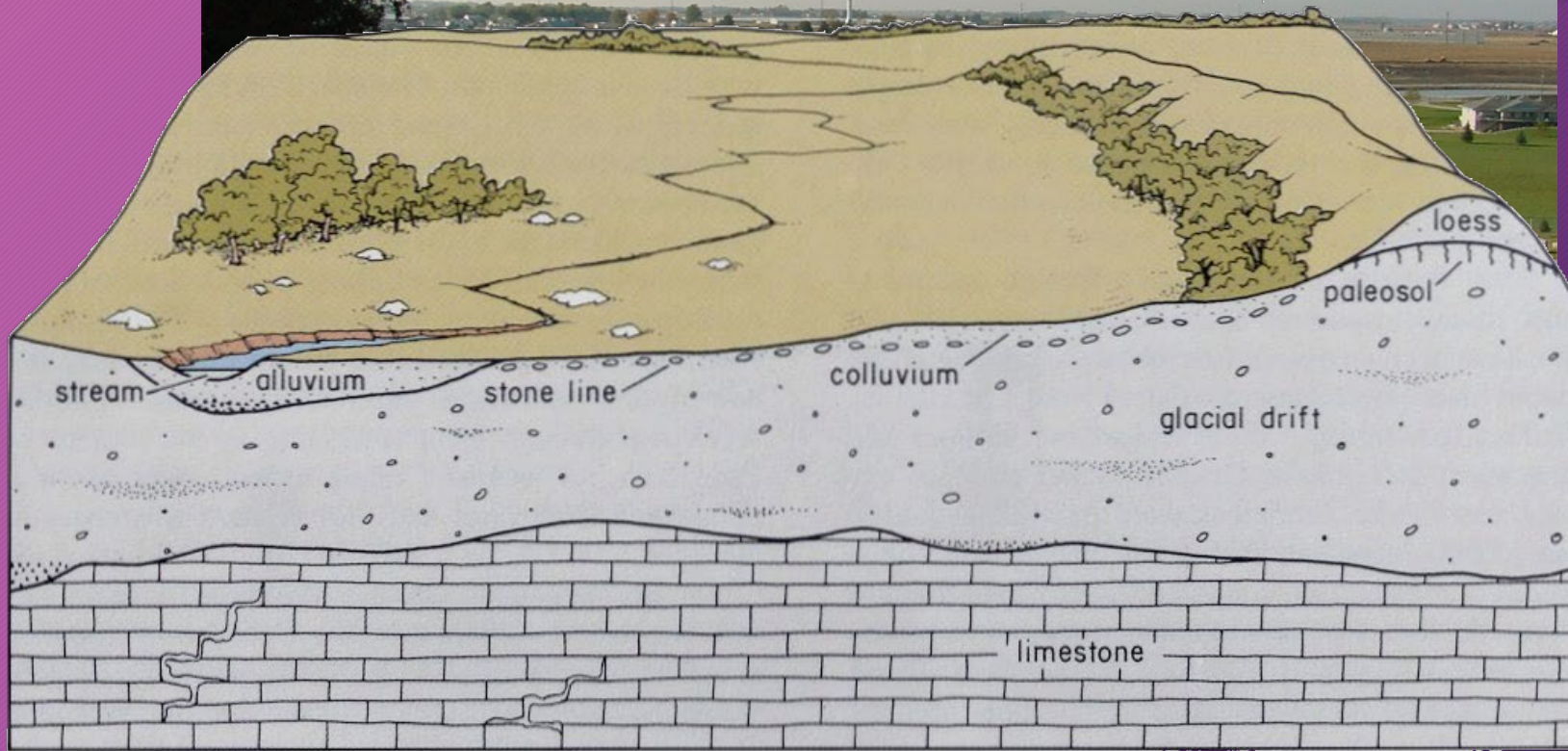
...showing very angular volcanic glass shard
...silted particles"). Photo by Robert McKa



lowan Surface

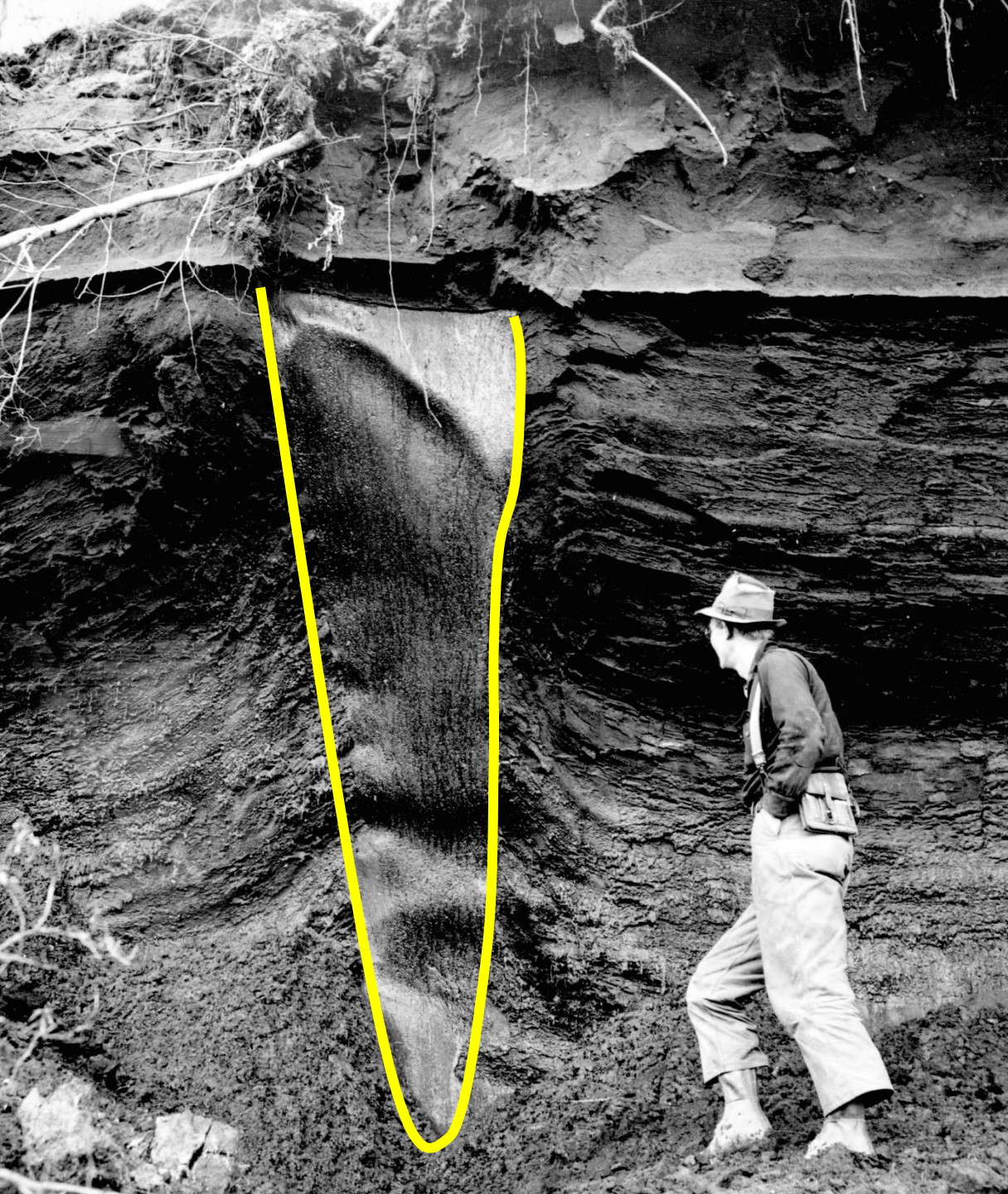


photo by Ray Anderson



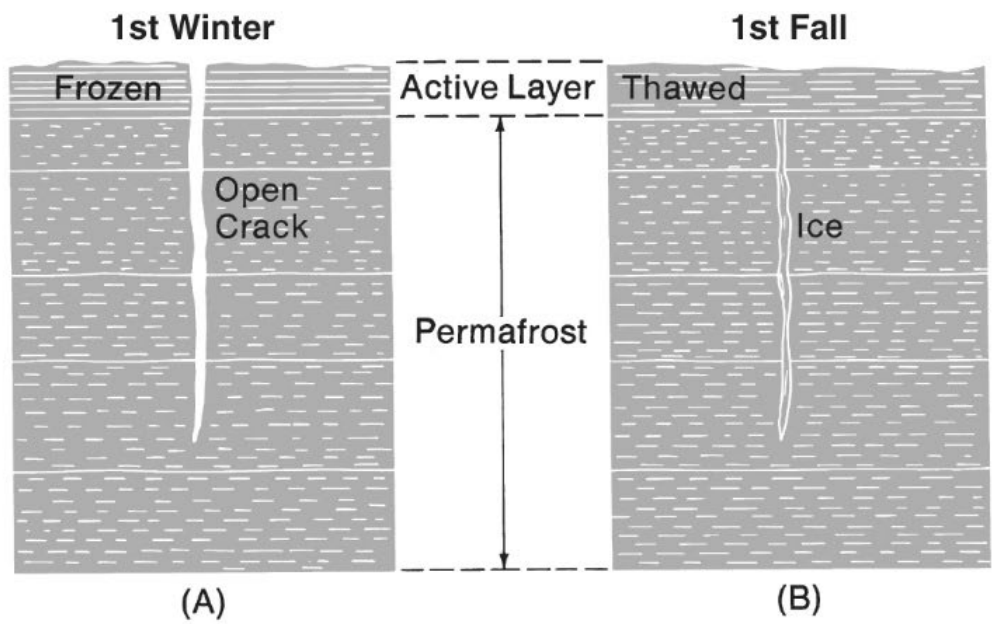
Terrain Characteristics

- * gently rolling terrain
- * thin, discontinuous loess or loam over glacial drift
- * bedrock near surface
- * local karst conditions
- * scattered glacial boulders
- * integrated drainage network
- * isolated elongate hills (paha)

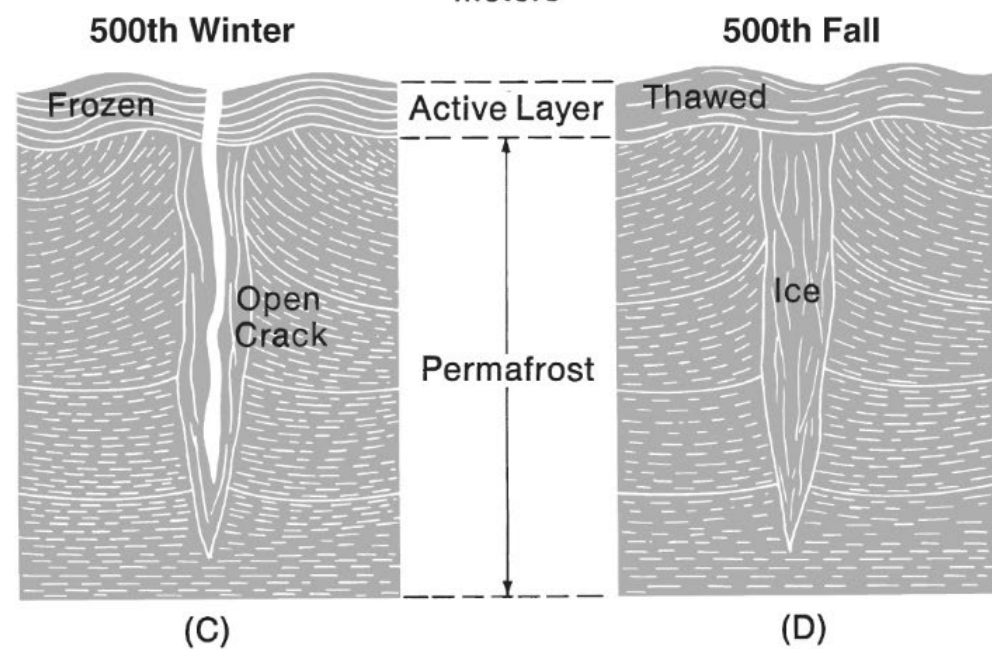


Permafrost

Or cryotic soil is at or below the freezing point of water $0\text{ }^{\circ}\text{C}$ ($32\text{ }^{\circ}\text{F}$) for two or more years. Most permafrost is located in high latitudes (i.e. land close to the North and South poles), but alpine permafrost may exist at high altitudes in much lower latitudes

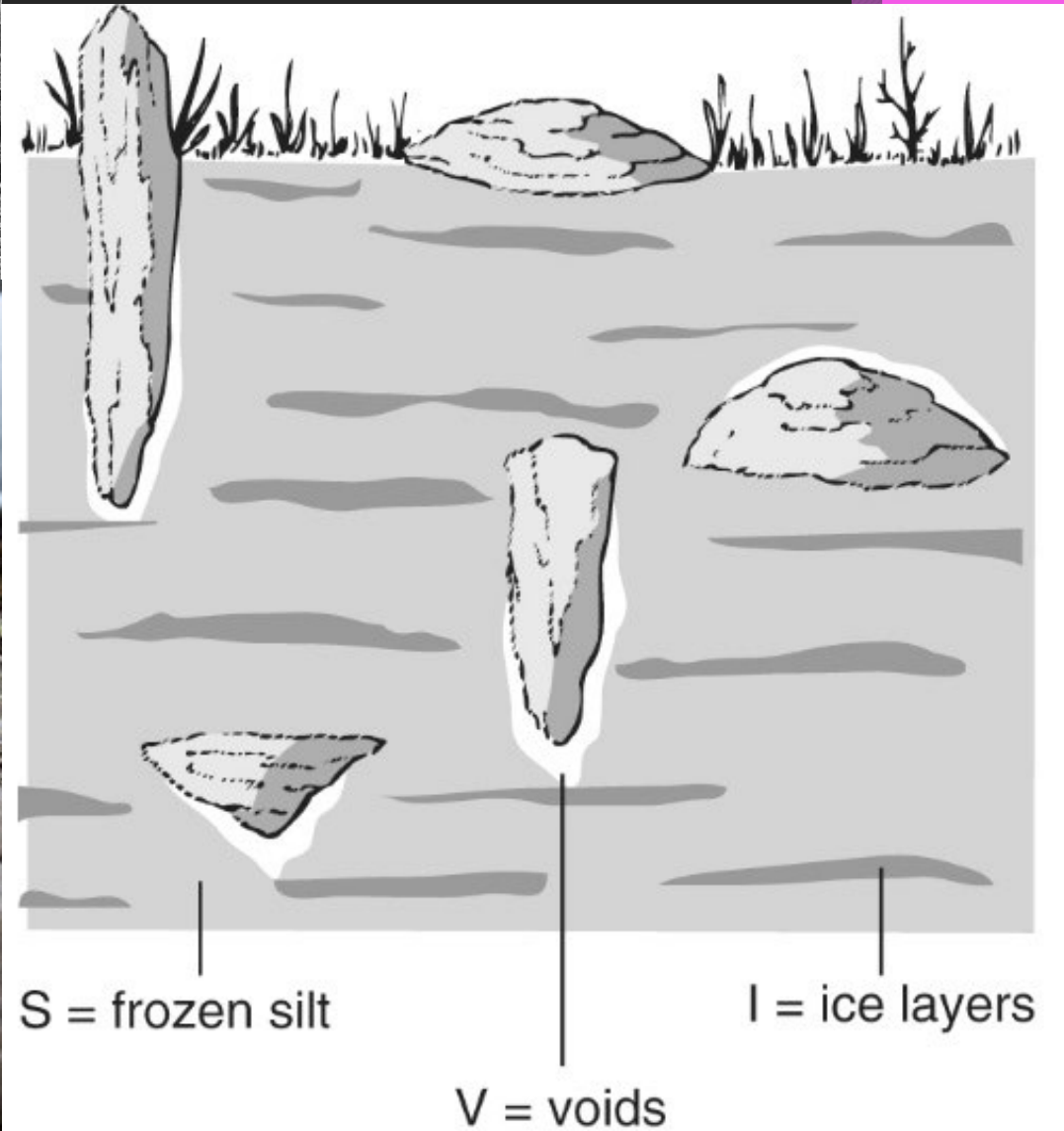


0 2
meters





Frost Sorting



Summer Field course June 23,24,25 T-Th

- Work to be at UNI ready to go by 8am
- Will meet at Latham Hall Room 111, our base camp
- Possibility of coming in a day early and staying in the dorms at your own expense about \$40
- Panther Village = Dorms
- Will provide parking tags
- Most food will be provided
- Will be sending a specific Itinerary asap...

Field course clothing

- Primary Proper Planning Prevents Piss Poor Performance
- Close-toed shoes
- Sun hat
- Long pants
- Light weight shirts
- Gloves
- Sunglasses
- Will provide safety glasses, vests, rock hammers, hard hats

Summer Logistics

Personal gear

- Water bottle
- Coffee travel mug
- Sunscreen, bug spray
- Snacks
- Notebook pencils

Will end Thursday June 25

- Check out of Panther Village around 7am
- Course will end around 4pm