

DIGITAL MAPPING TECHNIQUES 2025

The following was presented at DMT'25
May 18 - 21, 2025

The contents of this document are provisional

See Presentations and Proceedings
from the DMT Meetings (1997-2025)
<http://ngmdb.usgs.gov/info/dmt/>

The Oklahoma Geological Survey and the geology of Oklahoma

by Ken Johnson

Retired Geologist, OGS

Oklahoma was covered by shallow seas, starting about 515 mya



**Shallow seas covered much or all of Okla.
Intermittently for millions of years:**

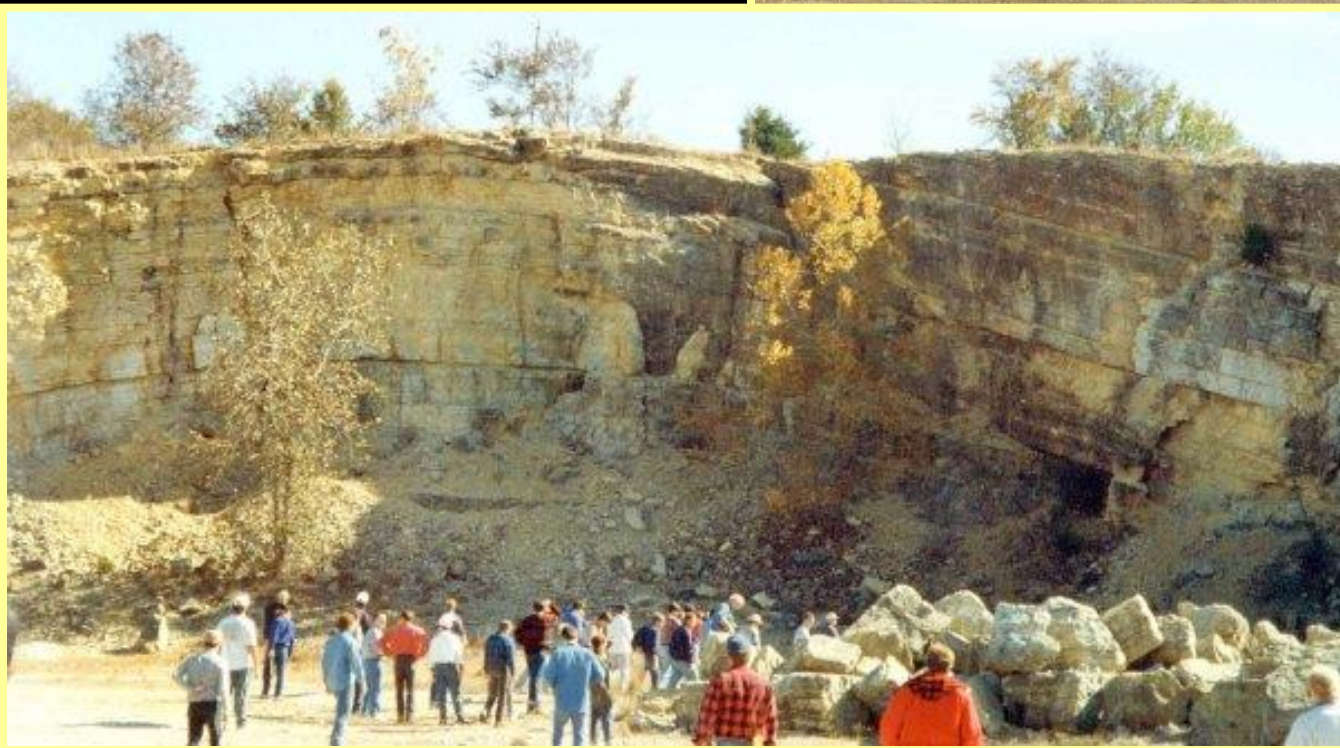
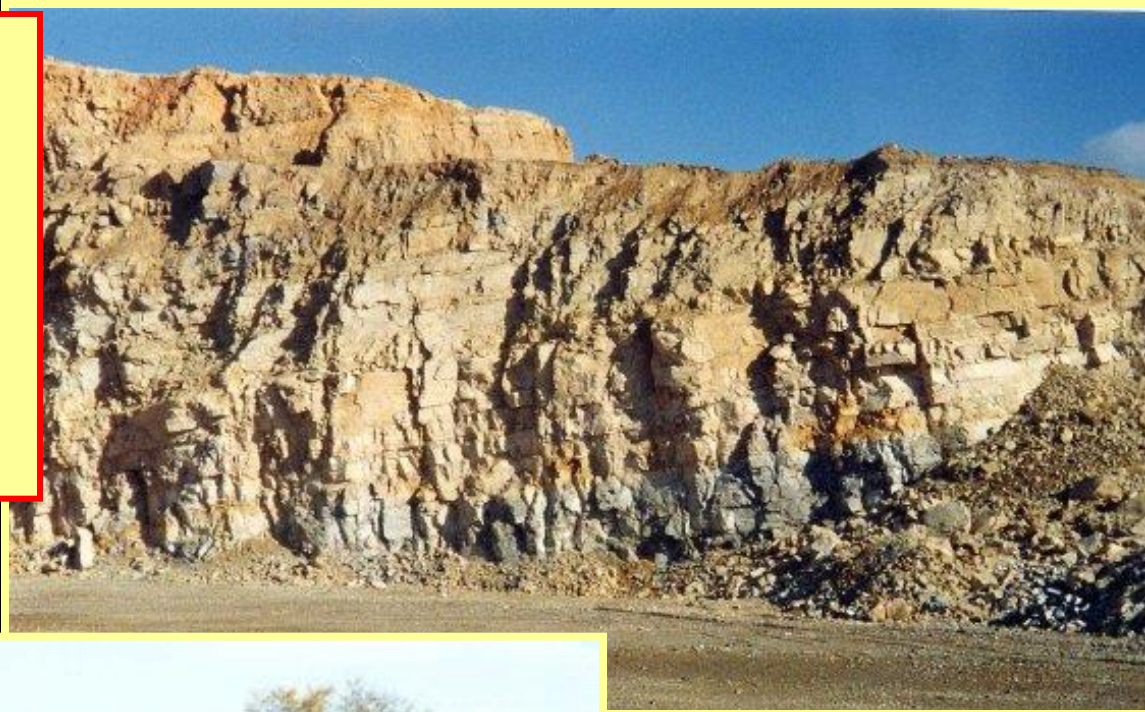


**Devonian Period, 400 mya
(trilobites, straight and
coiled nautilus, corals)**

**Devonian Period,
360 mya
(crinoids, star fish)**



Arbuckle Mts.
**Limestone
and dolomite
deposited in
shallow seas**



Arbuckle Mts.

Other sedimentary
rocks deposited in
shallow seas



Shale

Sandstone



**Let's look at the evolution of Oklahoma
during its geologic history.**

**At various times, OK was partly covered
by shallow seas, and partly was land.**

Early Ordovician, 485 mya

North American Plate

OK

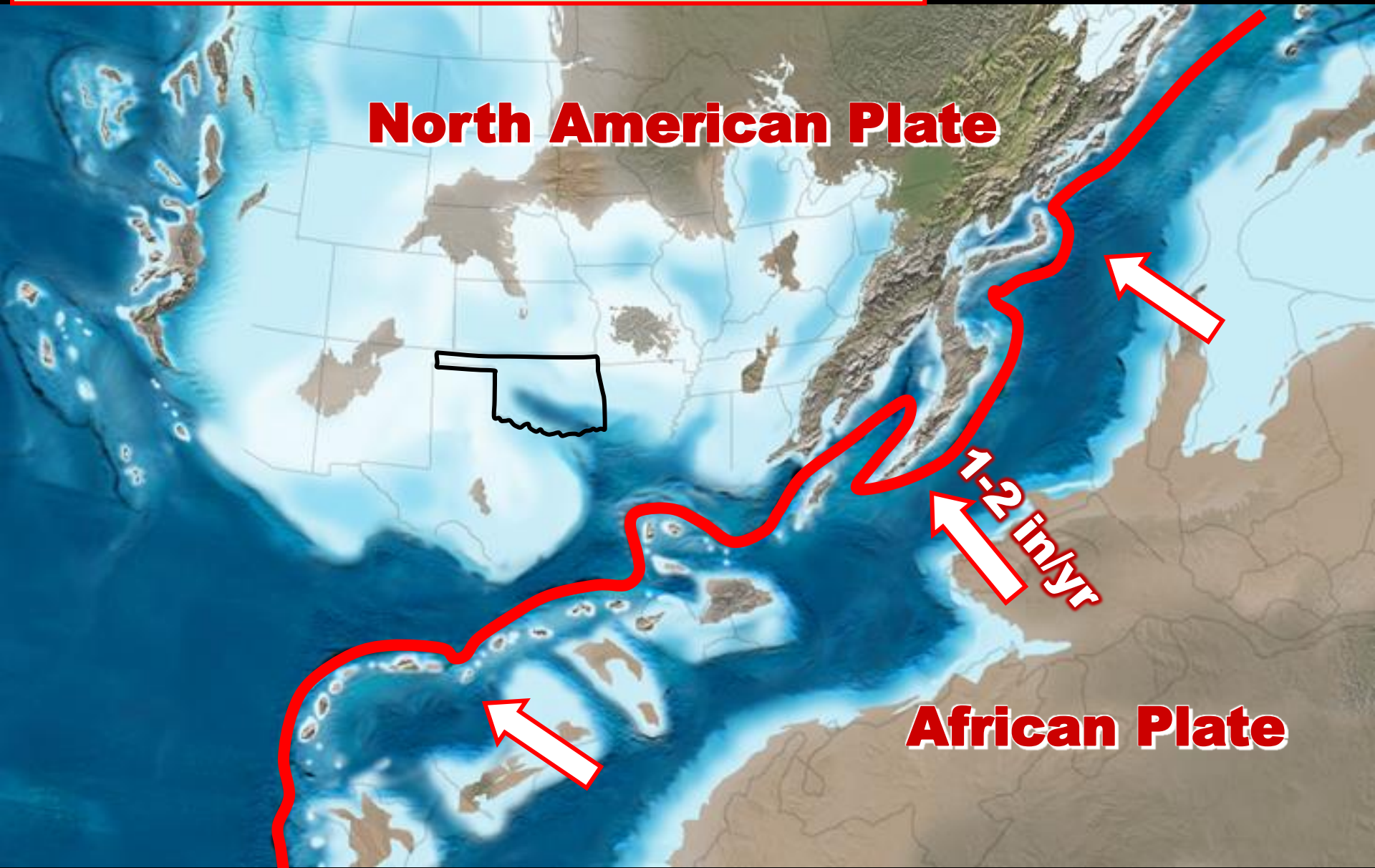
A paleogeographic map of the North American Plate during the Early Ordovician, approximately 485 million years ago. The map shows the continental landmasses in light tan and the surrounding oceans in deep blue. The North American Plate is the central focus, with its eastern margin extending into the Atlantic Ocean. A black outline of the state of Oklahoma is superimposed on the central part of the continent, with the letters "OK" inside. To the west, a line labeled "Eq" indicates the equator. In the lower right, a line labeled "30° S" indicates a southern latitude. The map illustrates the tectonic configuration and oceanic circulation of the period.

Middle Devonian, 385 mya



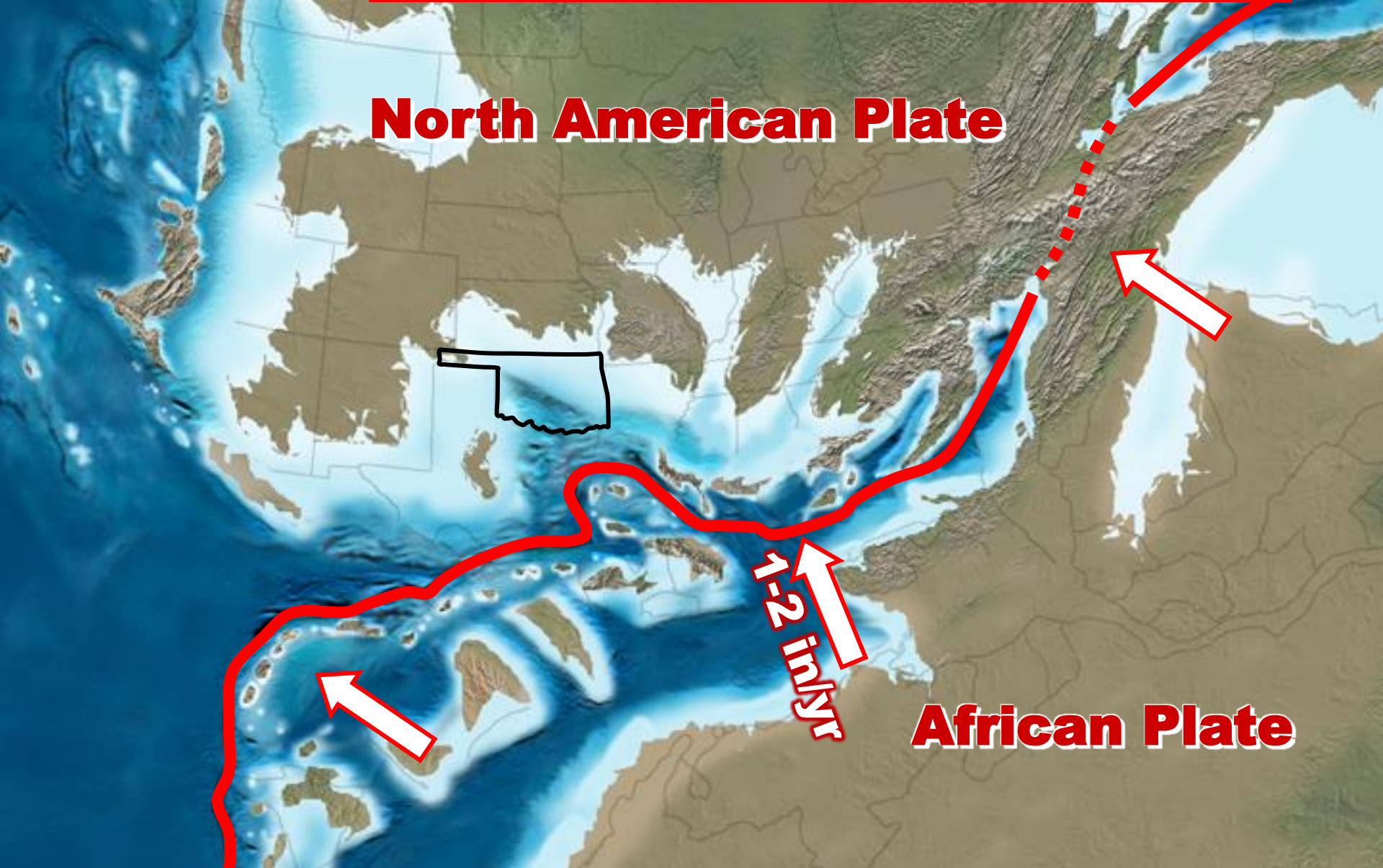
After: Ron Blakey, Univ. No. Arizona

Early Mississippian, 345 mya



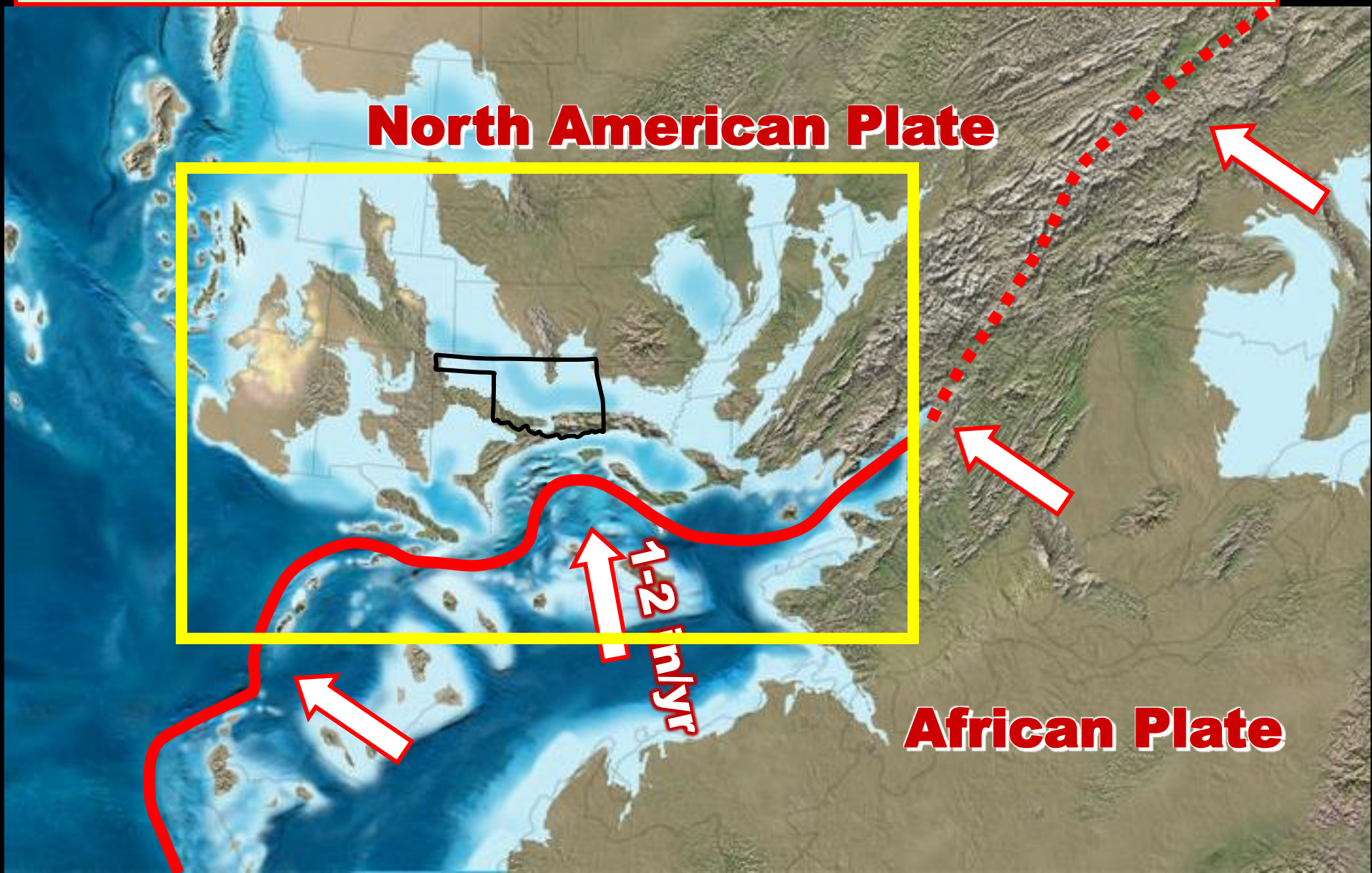
After: Ron Blakey, Univ. No. Arizona

Late Mississippian, 325 mya



After: Ron Blakey, Univ. No. Arizona

Early Pennsylvanian mountains, 315 mya



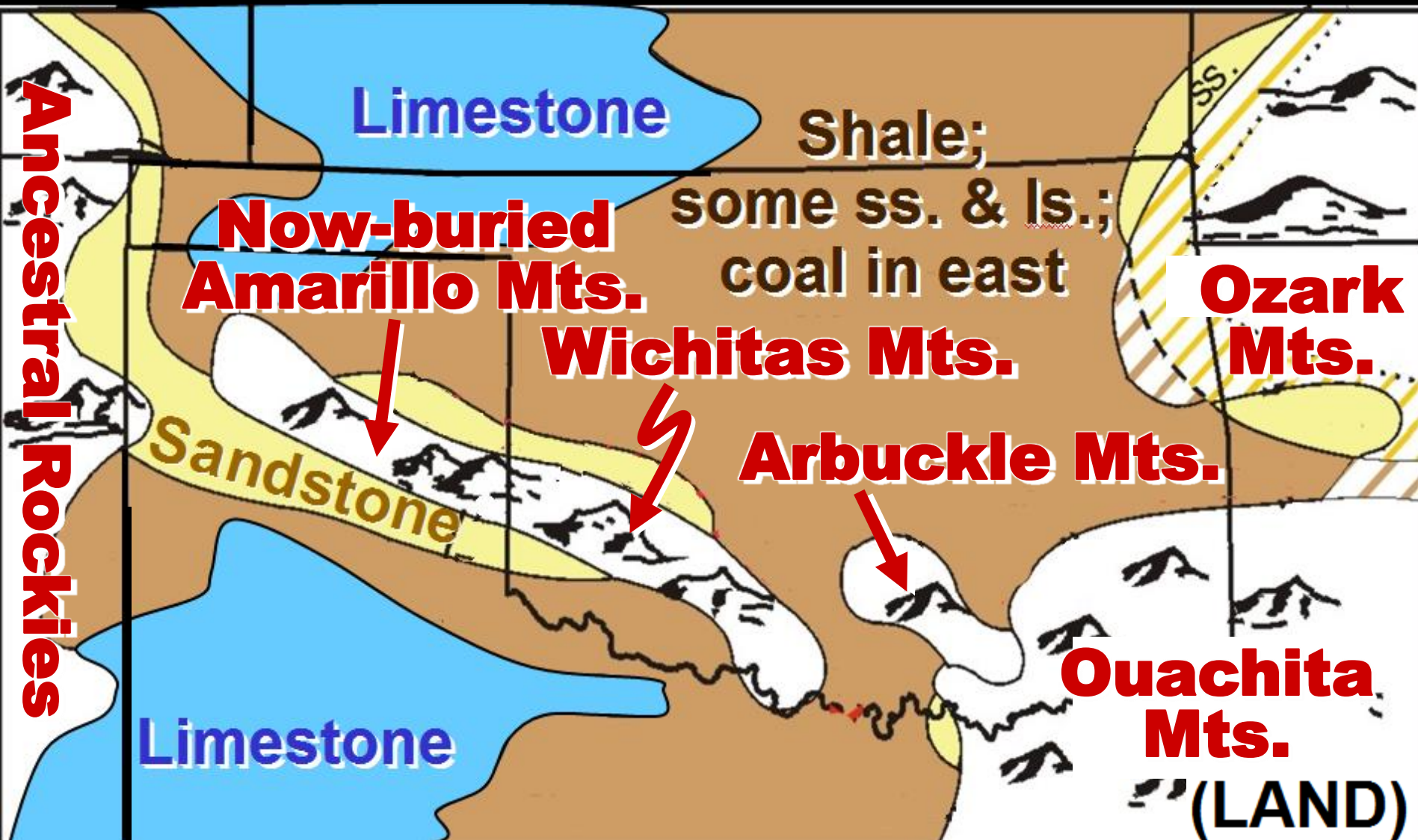
After: Ron Blakey, Univ. No. Arizona

Early Pennsylvanian mountains, 315 mya



After: Ron Blakey, Univ. No. Arizona

Mountain building in Oklahoma, 315 mya





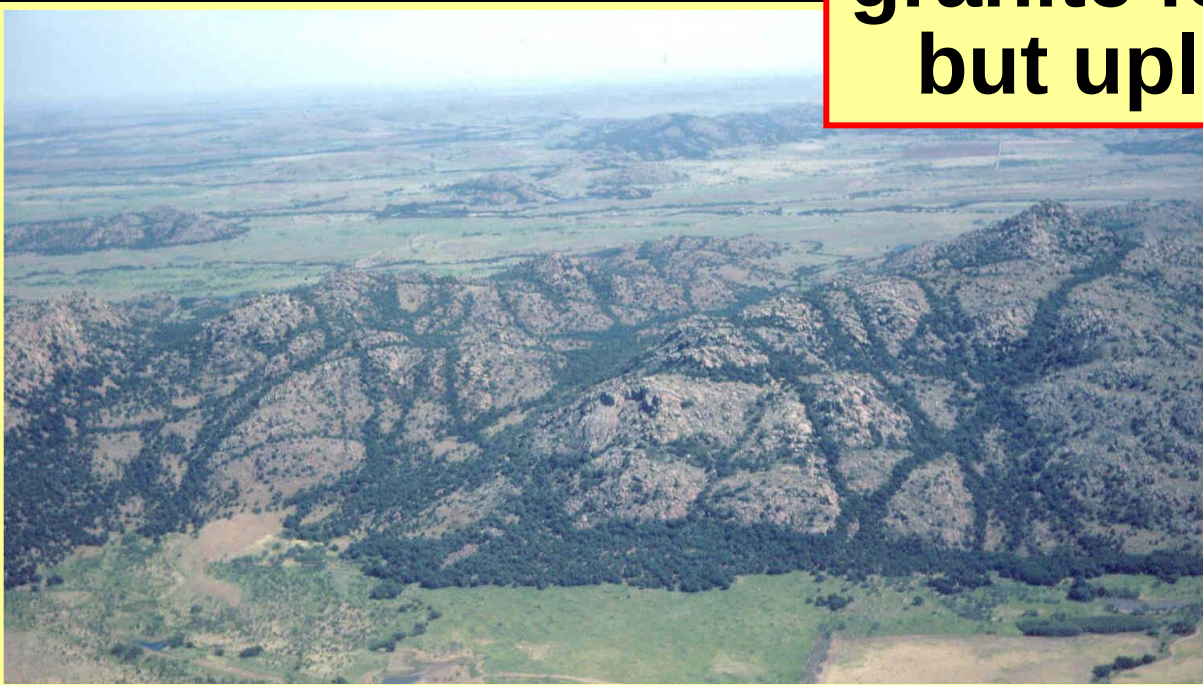
**Arbuckle Mts.
uplifted ± 315 mya**

**Limestone
outcrops and
tombstone
topography**



**Limestone layers
dip down
into the ground**

**Wichita Mts.:
granite formed ± 525 mya
but uplifted ± 315 mya**

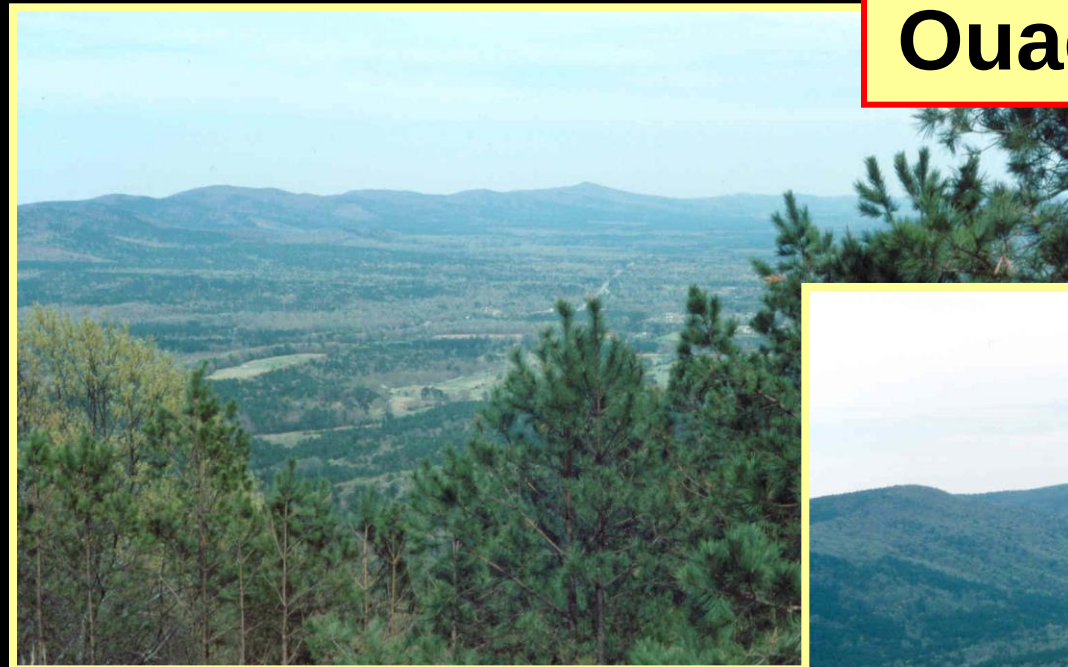


Ouachita Mountains (folded ± 315 mya)



With deep burial (high heat and pressure), rocks were squeezed and tightly folded.

Ouachita Mountains, OK

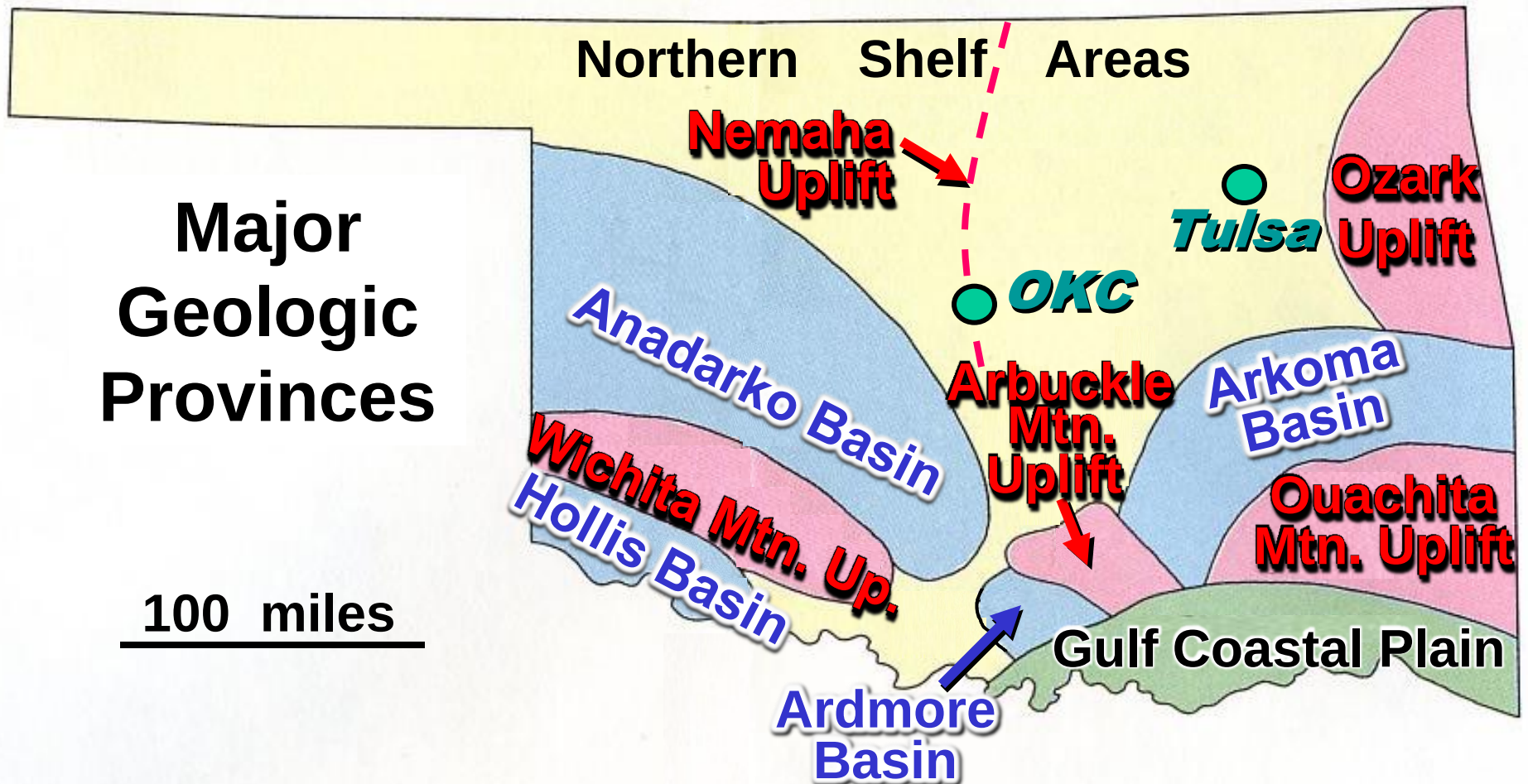


**Beautiful, wooded
mountains rise 500-1,500 ft
above adjacent valleys**

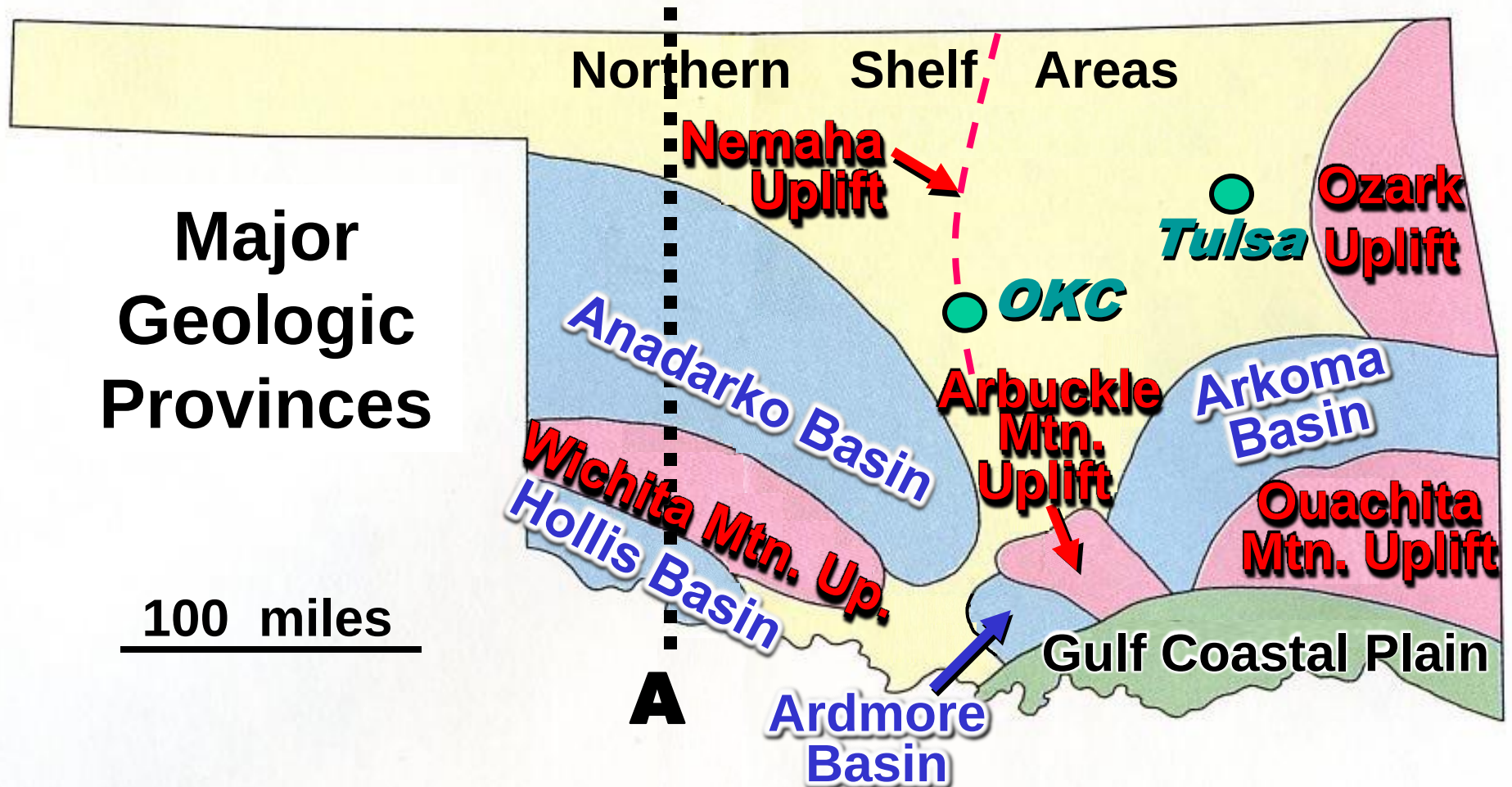
Major geologic provinces of Oklahoma

Major Geologic Provinces

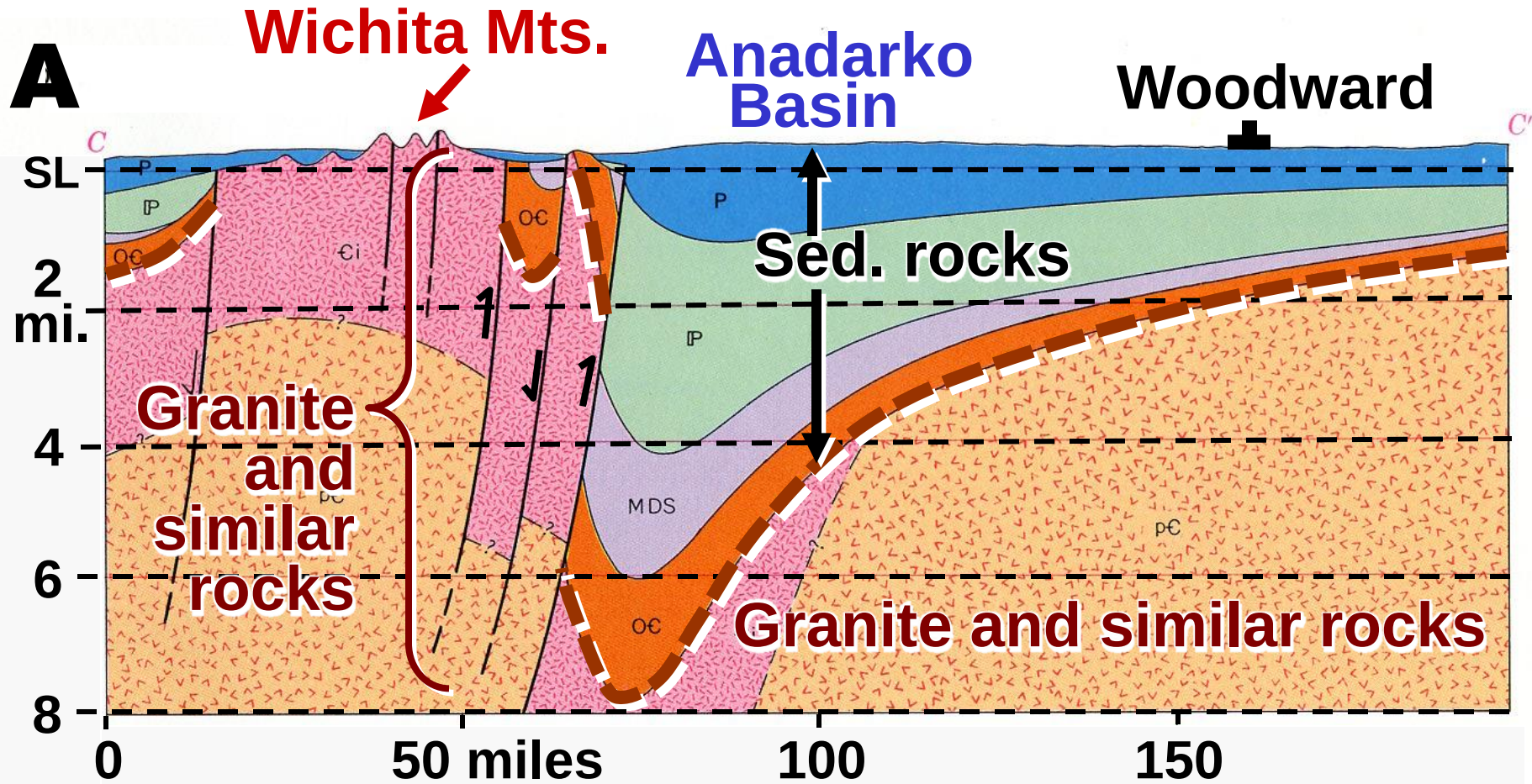
100 miles



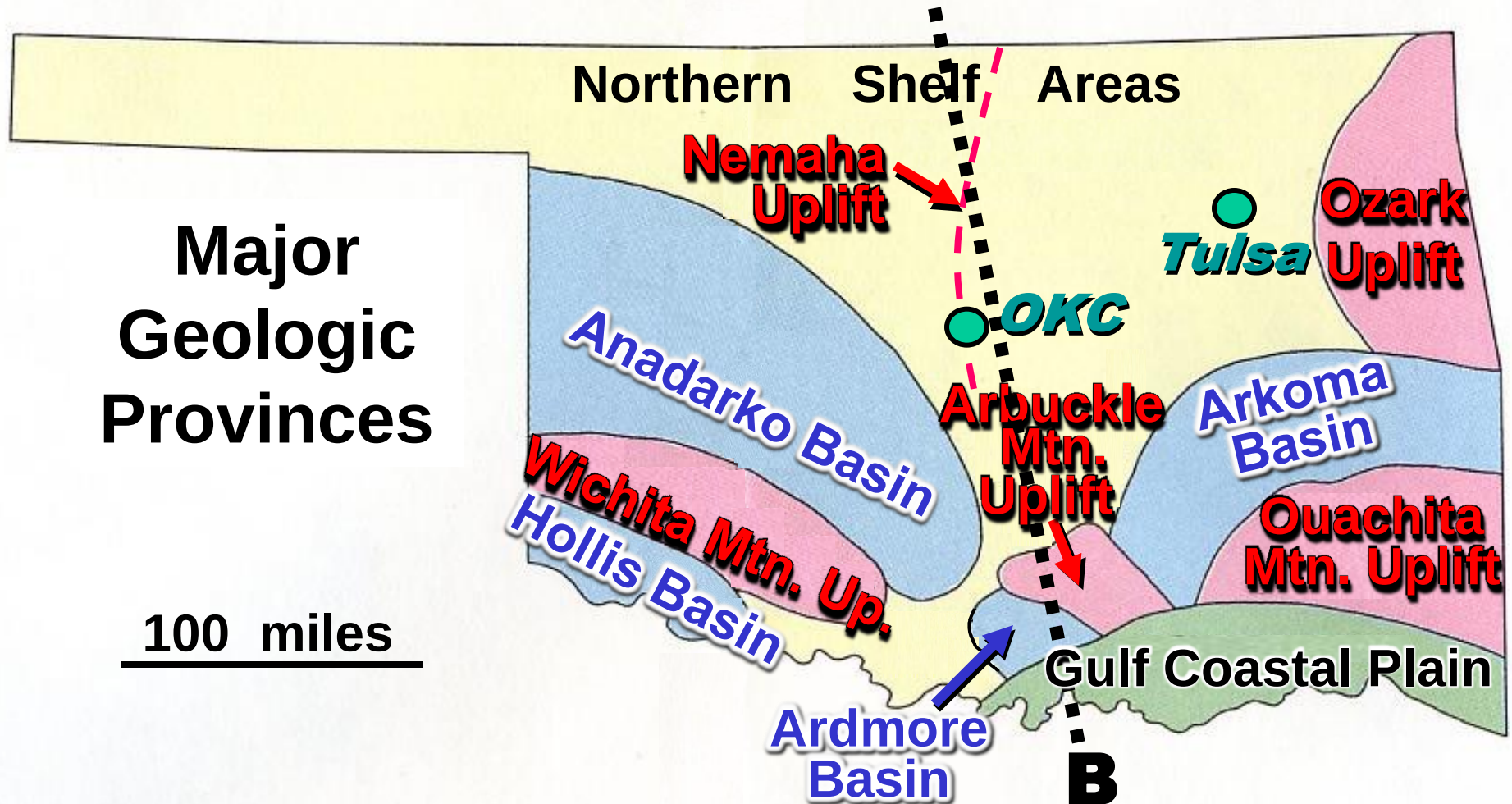
Cross section A: Wichita Mountains



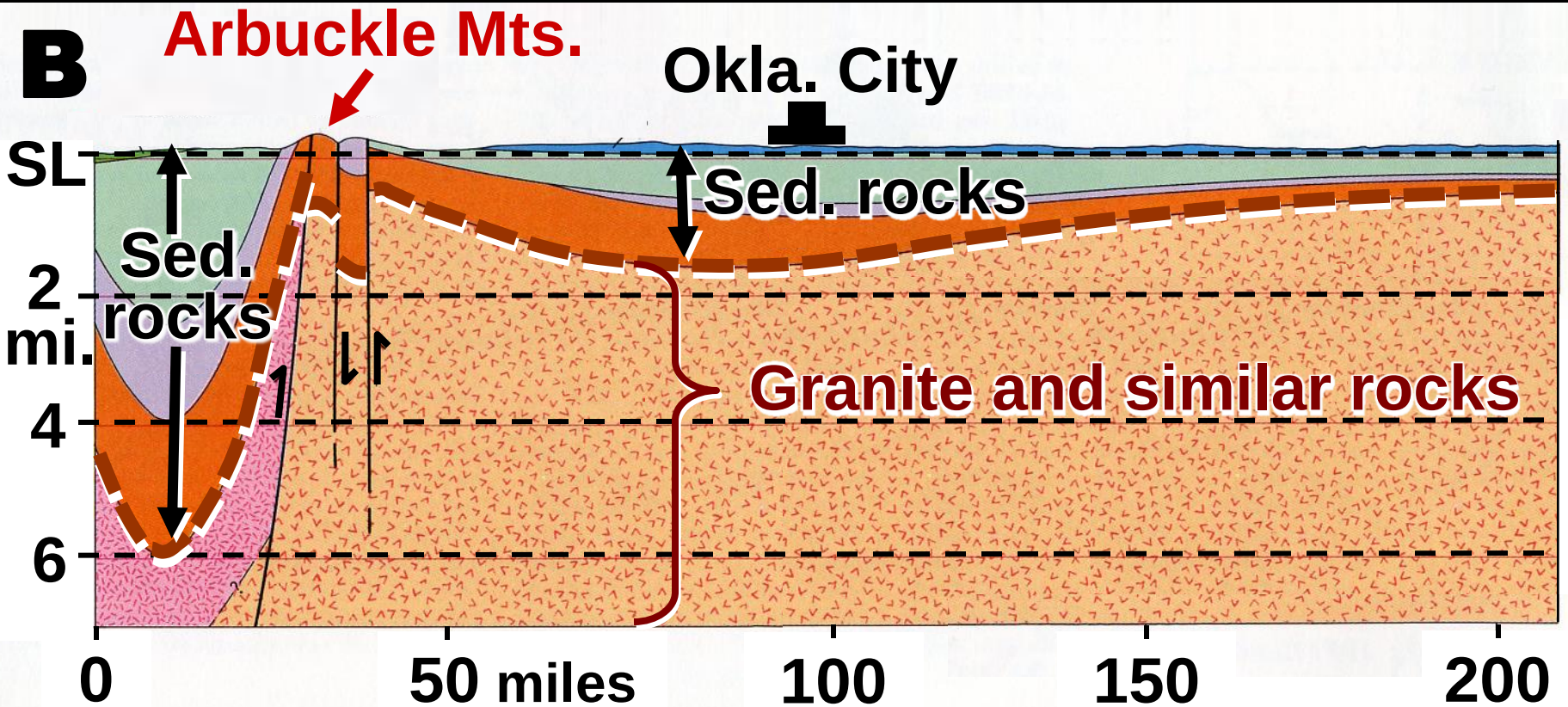
Cross section A; Wichita Mts.--Woodward



Cross section B: Arbuckle Mountains



Cross section B; Arbuckle Mts.—Okla. City



Late Permian, 265 mya

North American Plate

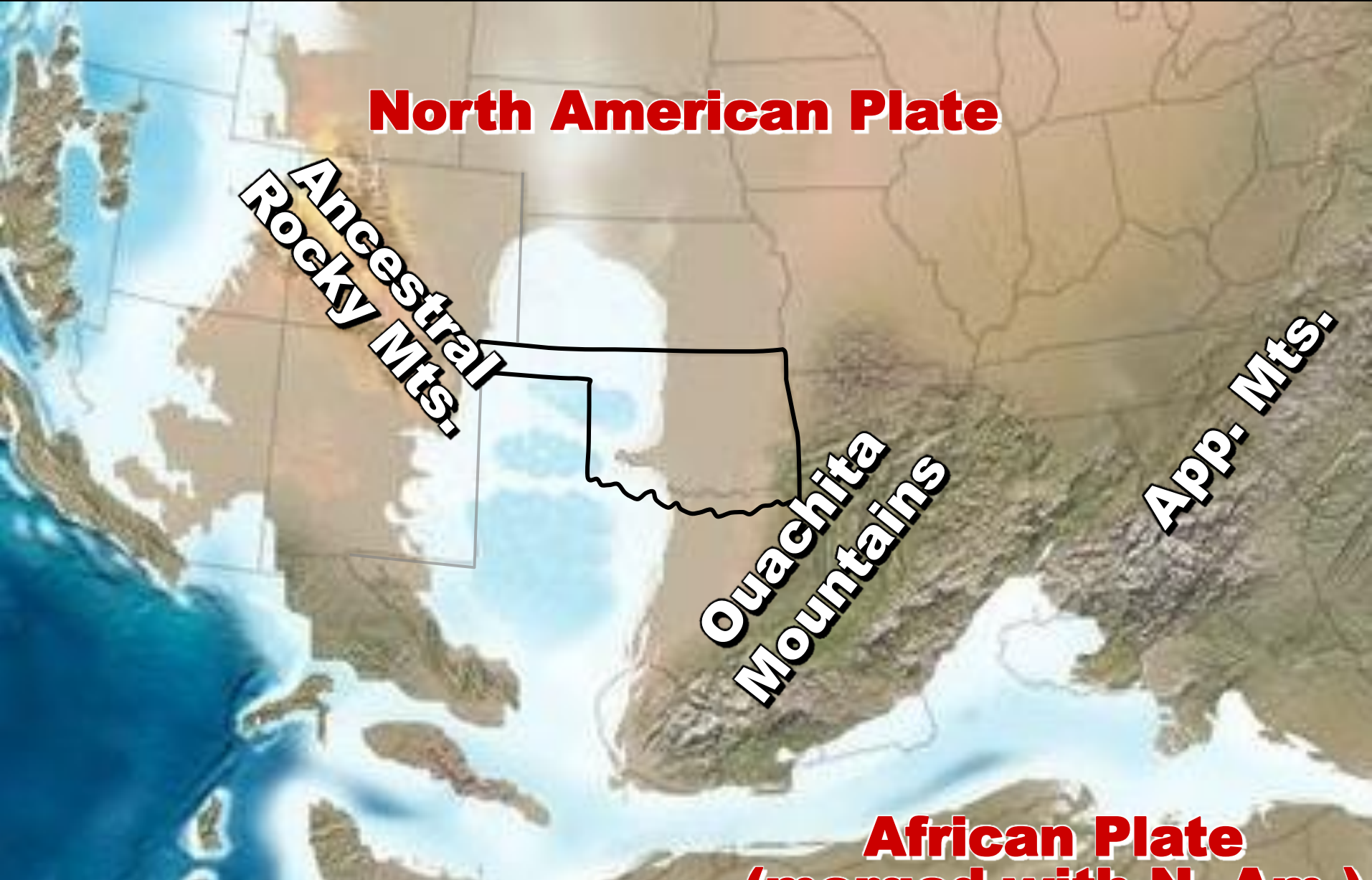
**Ancestral
Rocky Mts.**

**Ouachita
Mountains**

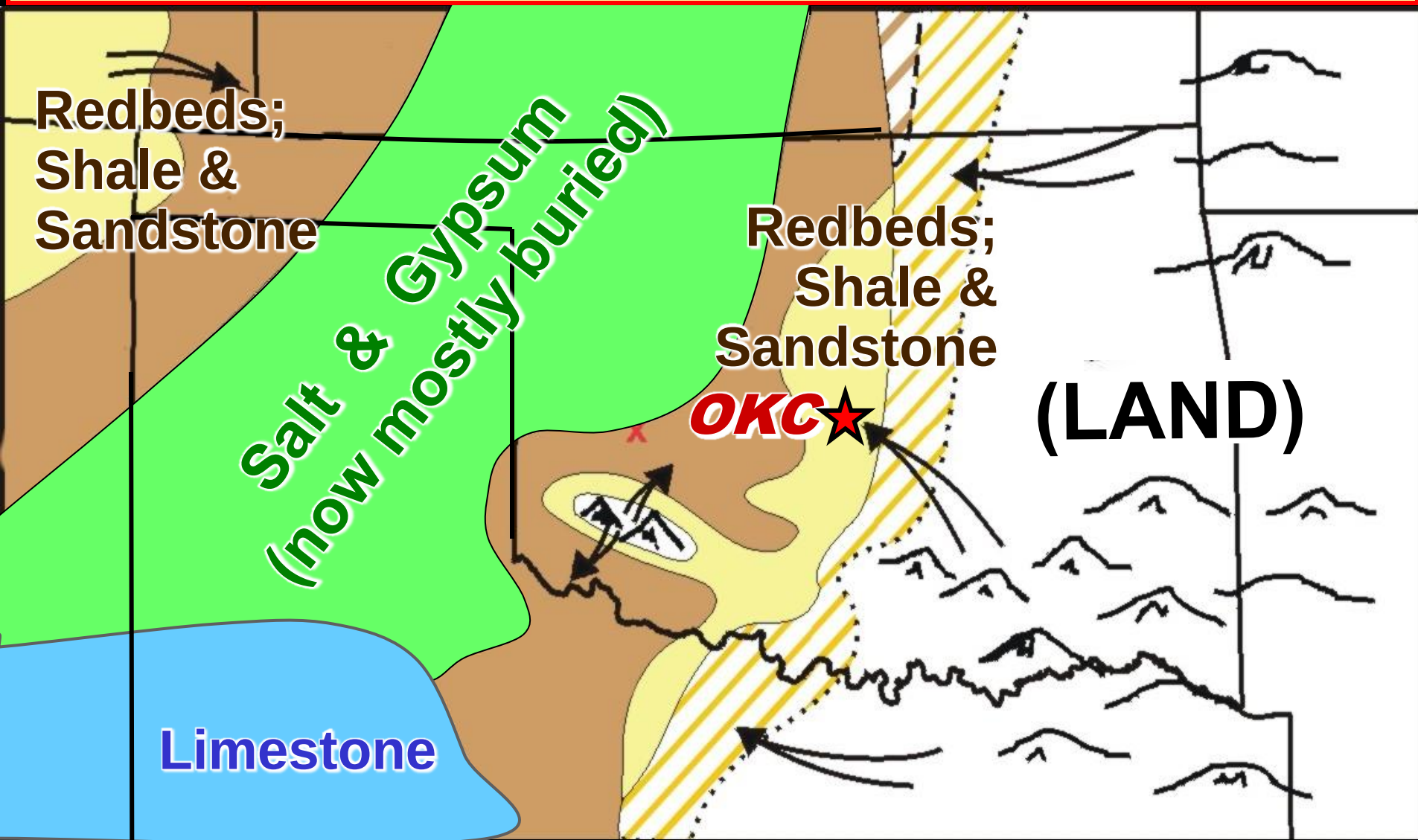
App. Mts.

**African Plate
(merged with N. Am.)**

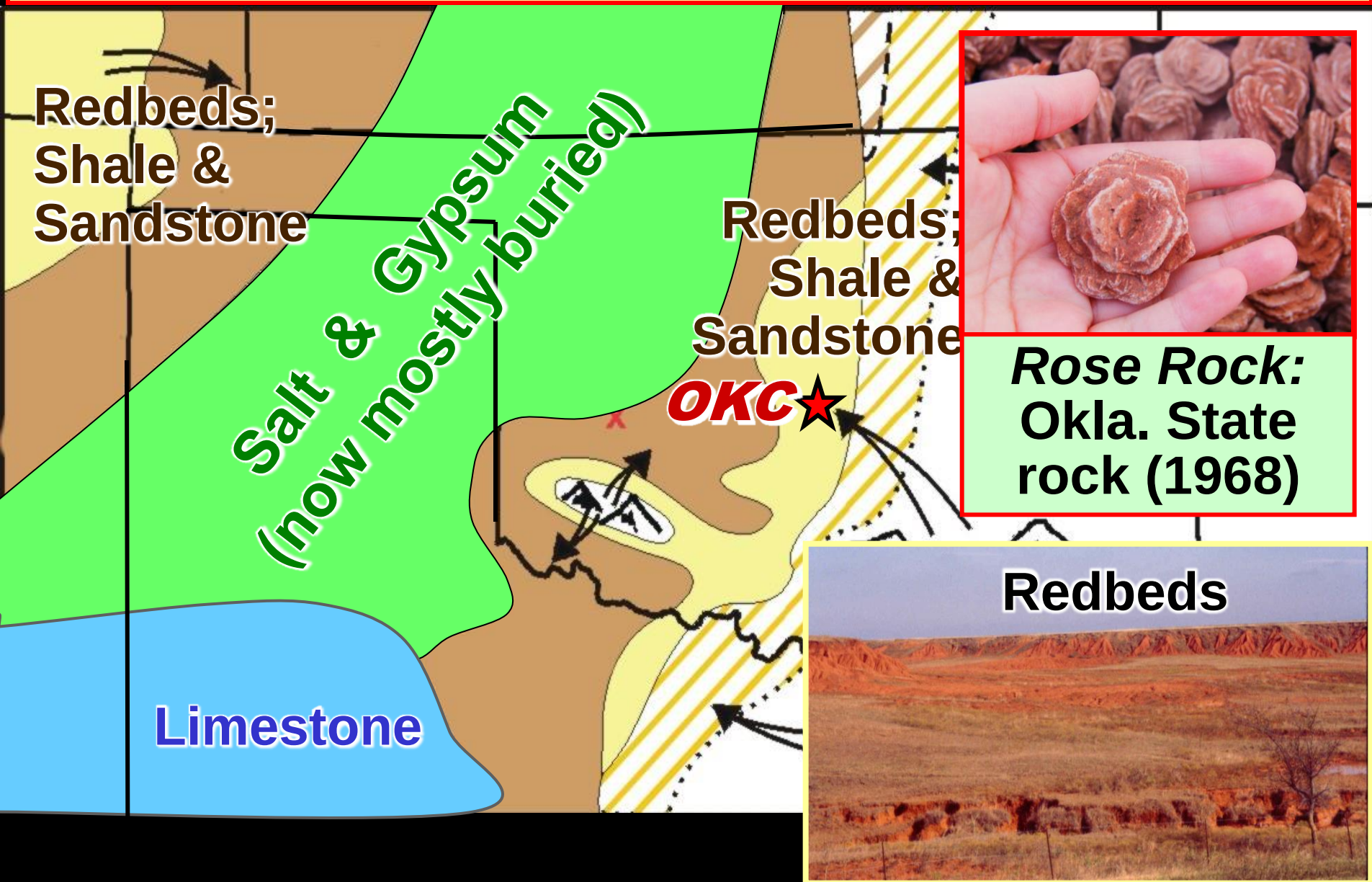
After: Ron Blakey, Univ. No. Arizona



Permian redbeds, salt, & gypsum; ± 265 mya



Permian redbeds, salt, & gypsum; ± 265 mya



Great Salt Plains, and digging for crystals



2 inches

*Hourglass
selenite:*
Okla. State
crystal (2005)



**GSP National
Wildlife Refuge**

Alabaster Caverns State Park, NW Oklahoma

Cave entrance

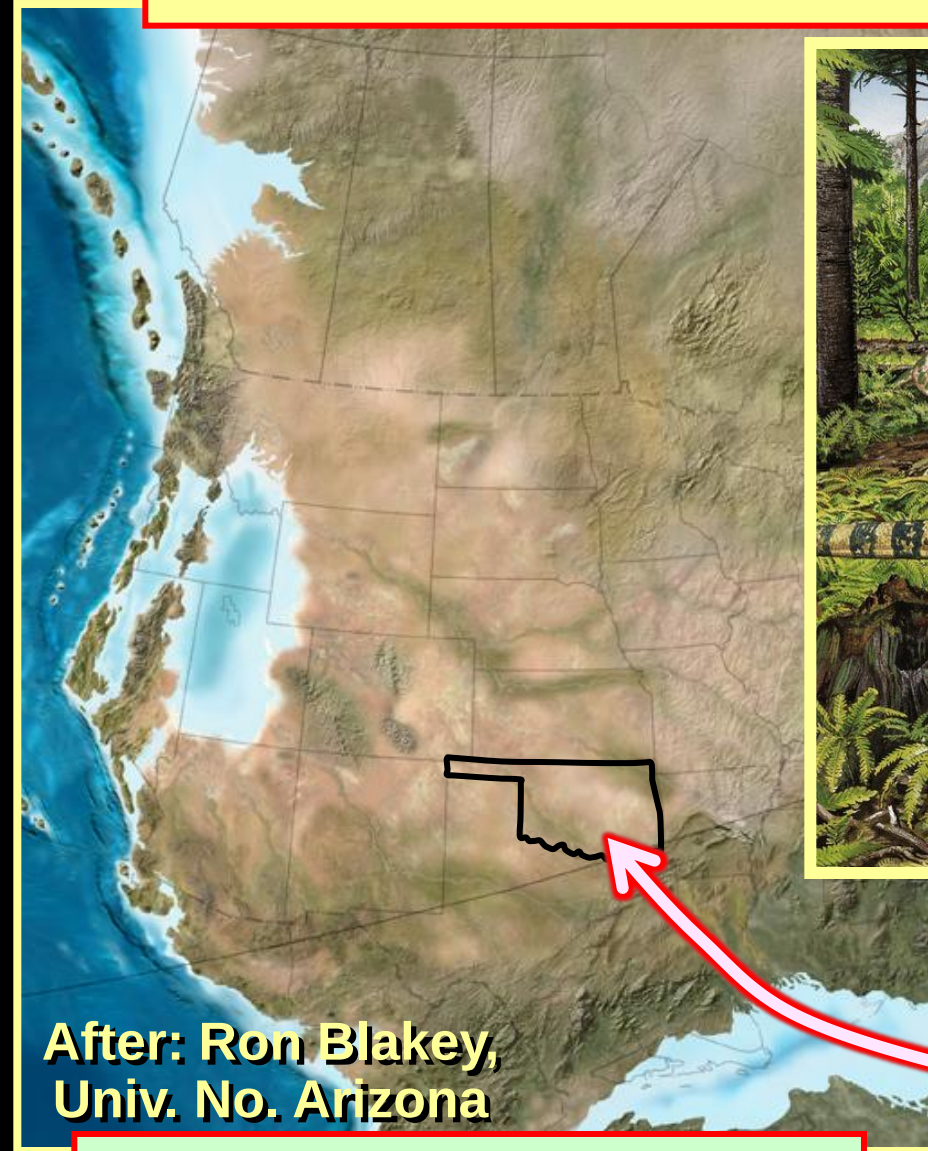


**Pathway through cave,
which is 2,300 ft long.**



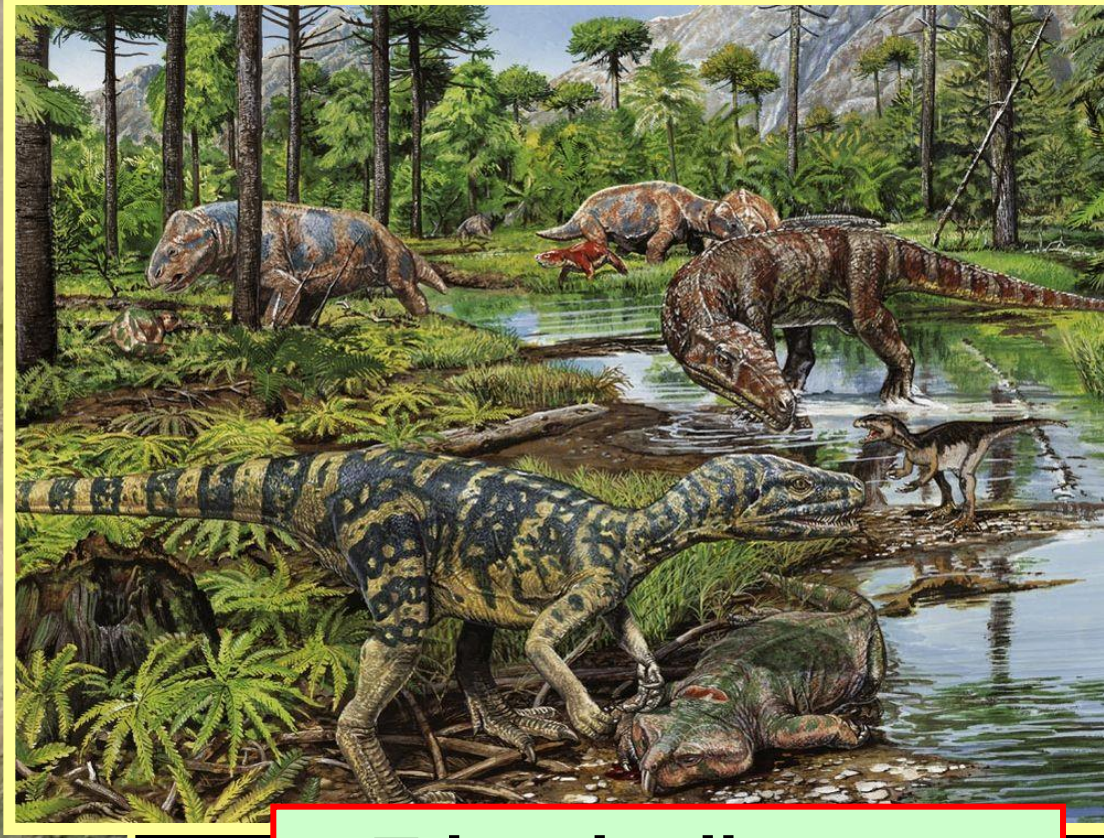
**Natural bridge;
collapsed 1992**

Mesozoic Era—the “Age of dinosaurs”



After: Ron Blakey,
Univ. No. Arizona

Triassic, 245 mya



Triassic diorama

OK geography = land,
lakes, rivers, & swamps

Mesozoic Era—the “Age of dinosaurs”

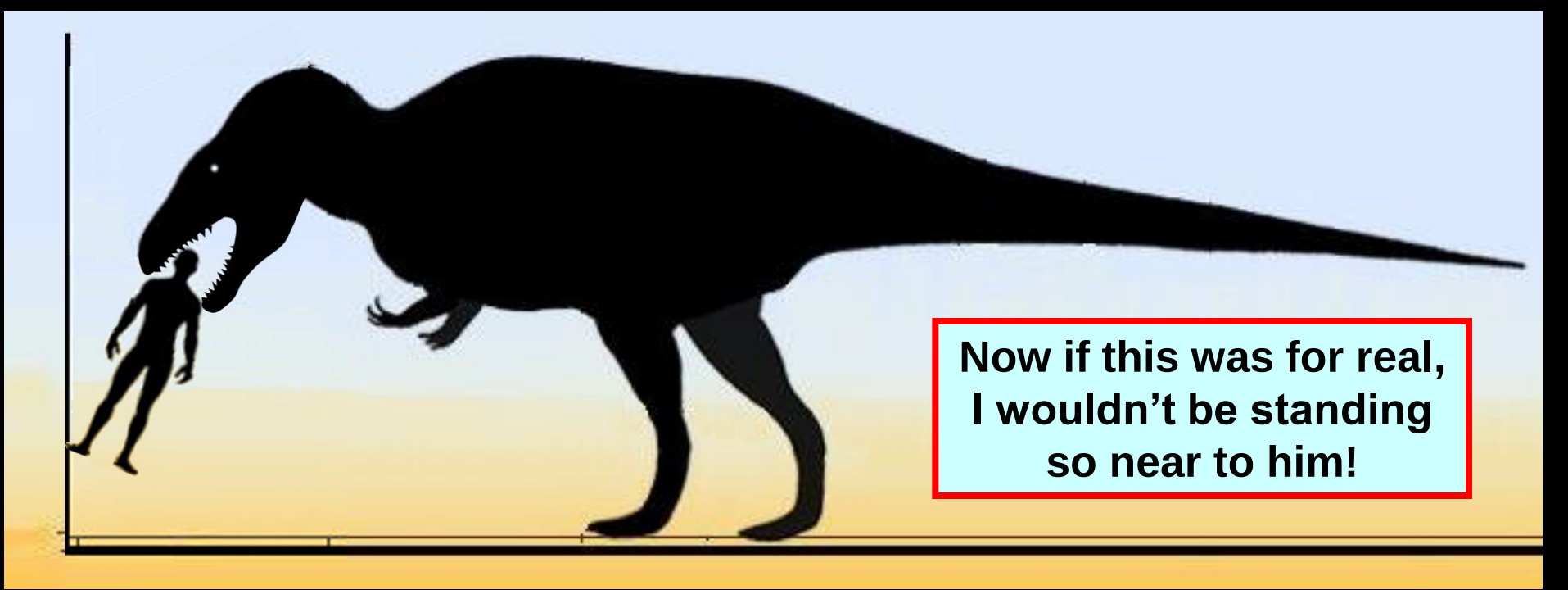
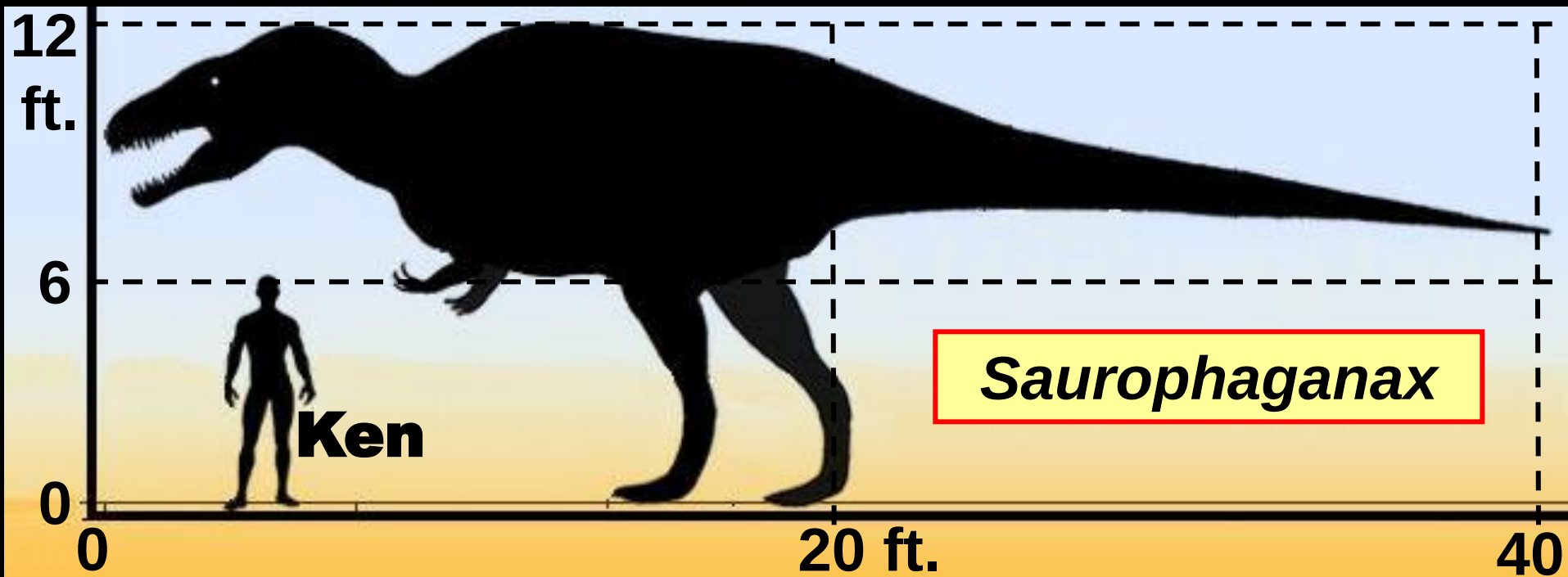


***Saurophaganax*:**
Okla. State fossil (2000)

After: Ron Blakey,
Univ. No. Arizona

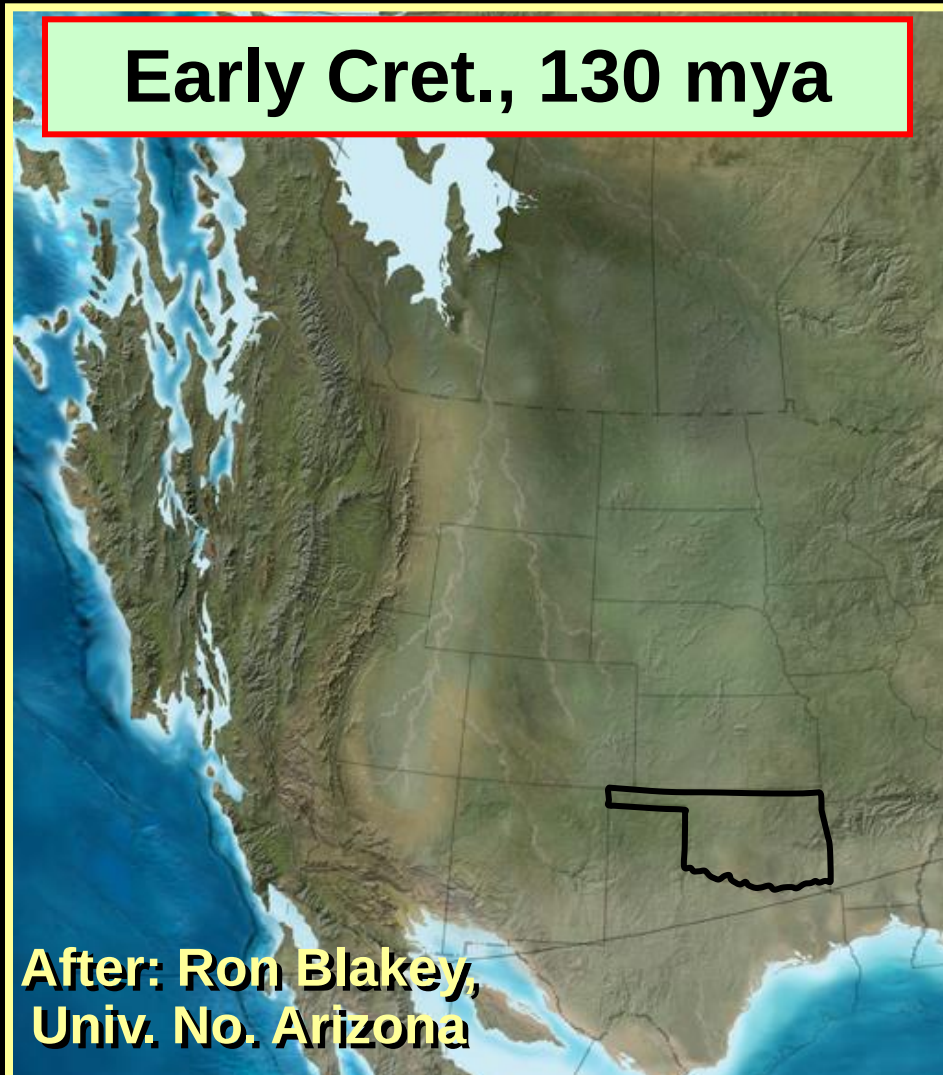
Jurassic, 170 mya

**OK geography = land,
lakes, rivers, & swamps**



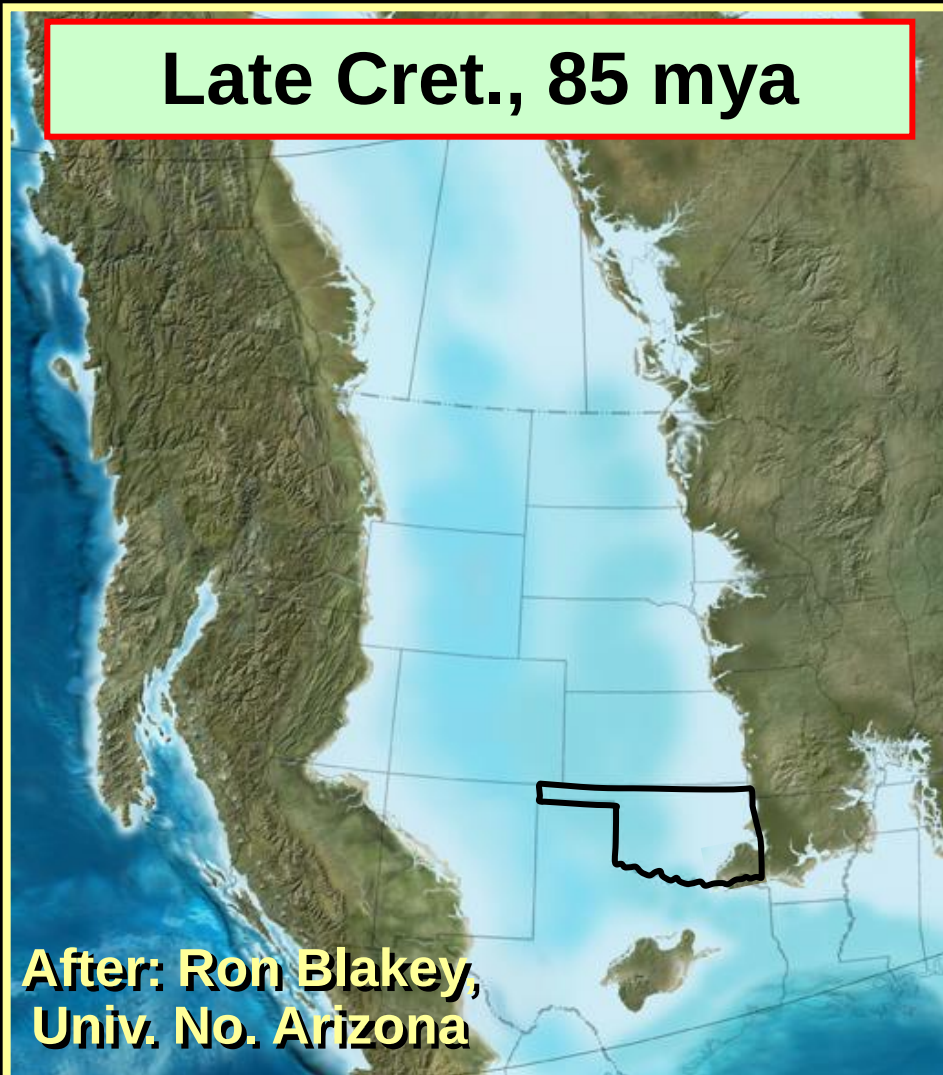
Cretaceous Period, 145 mya to 66 mya

Early Cret., 130 mya



OK geography = lakes, rivers, swamps, & land

Late Cret., 85 mya



OK geography = mostly shallow sea, land in SE

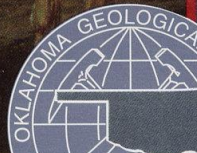
An illustration of a large, dark green Acrocanthosaurus atokensis standing in a lush, prehistoric forest. The dinosaur is shown in profile, facing left, with its mouth open, revealing sharp teeth. It has a large head, small eyes, and a long, powerful body. The background features tall trees and dense foliage, with a bright light source creating a misty atmosphere.

Acrocanthosaurus atokensis

**Cretaceous age,
about 110 mya;**

**Oklahoma's official
“State Dinosaur”
in 2006;**

**12-18 ft tall, 40 ft long;
like *Tyrannosaurus rex*;
probably unpleasant!**



Cenozoic Era—the “Age of Mammals”

66 mya to today

Miocene, 20 mya

Pleistocene,
2.6 mya to 11 kya



Pleistocene Epoch = “Great Ice Age”

Intermittently
2.6 mya to
11 kya

Glacial Ice Sheet

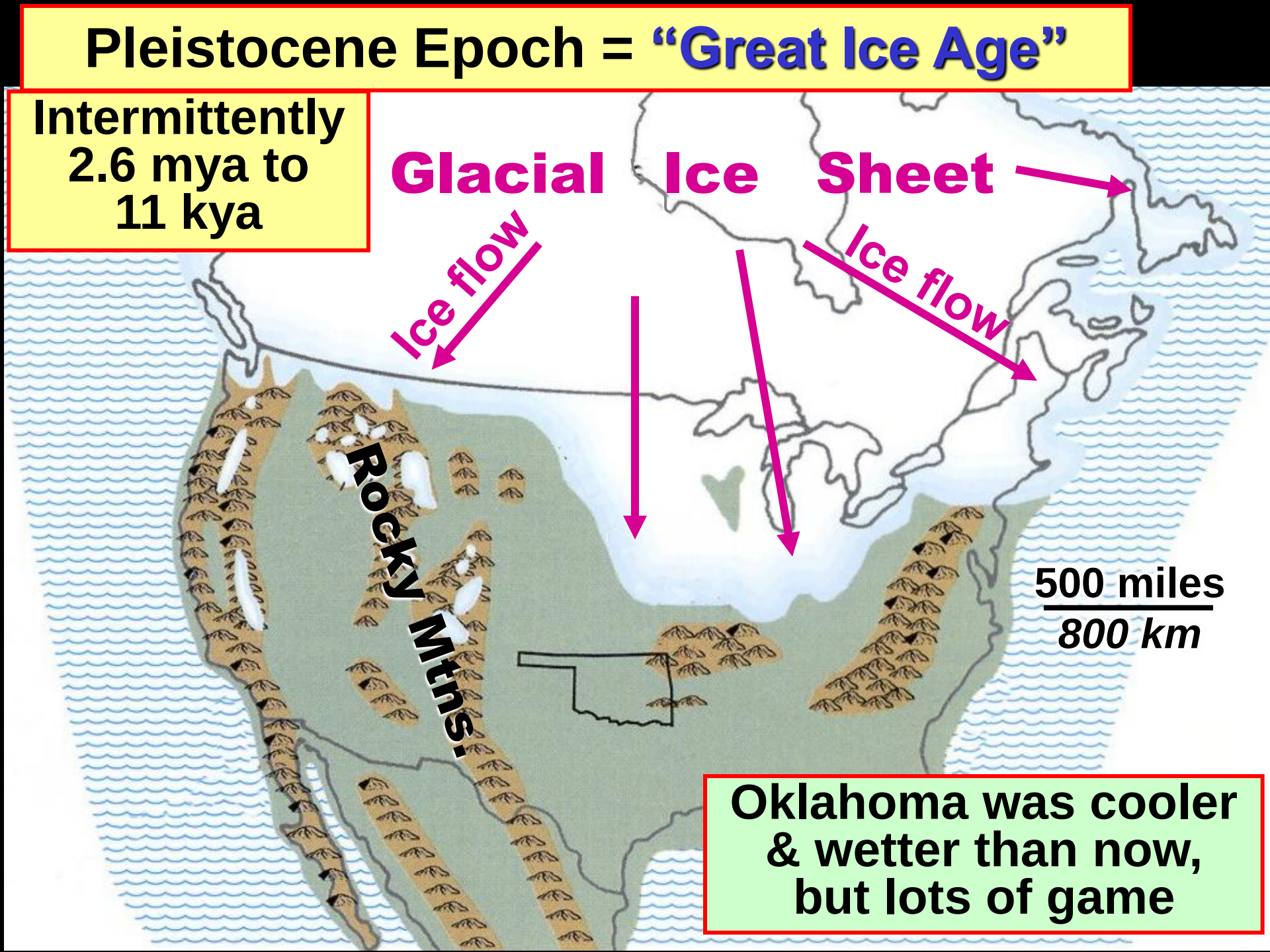
Ice flow

Ice flow

Rocky Mtns.

500 miles
800 km

**Oklahoma was cooler
& wetter than now,
but lots of game**



Paleo-Indians and mammoth in Oklahoma



Points and tools;
Domebo mammoth site,
Caddo County, OK
(11 kya)



Geological Surveys

U.S. Geological Survey (USGS) (1879)

An agency in the U.S. Department of Interior.

Studies of the nation's geological, water, and biological sciences to determine nation's natural resources and environmental problems.

State Geological Surveys

Every state has its own geological survey to study the geological, mineral, and water resources within their own state.

The first state survey was North Carolina (1823).

State surveys have ranged in size, from a single person to well over 150 employees, such as surveys of California, Illinois, and Texas.

Each survey is different: some are research only, others regulatory and research. Depends on how each state decides to have its survey function.

Oklahoma Geological Survey (OGS) (1908)

The Oklahoma Geological Survey is a state agency for research and public service.

**Located on the Norman Campus of
The University of Oklahoma and affiliated with
the OU Mewbourne College of Earth and Energy.**

The OGS was authorized in the State's Constitution.

Our charge is: “investigate the state's land, water, mineral, and energy resources, and disseminate the results of those investigations to promote the wise use of Oklahoma's natural resources consistent with sound environmental practices.”

OGS is for research only—no regulatory activities.

OGS currently has 35 employees.

Oklahoma Geological Survey (OGS) (1908)

Oklahoma statehood in 1907: State constitution called for a “State Geological and Economic Survey.”

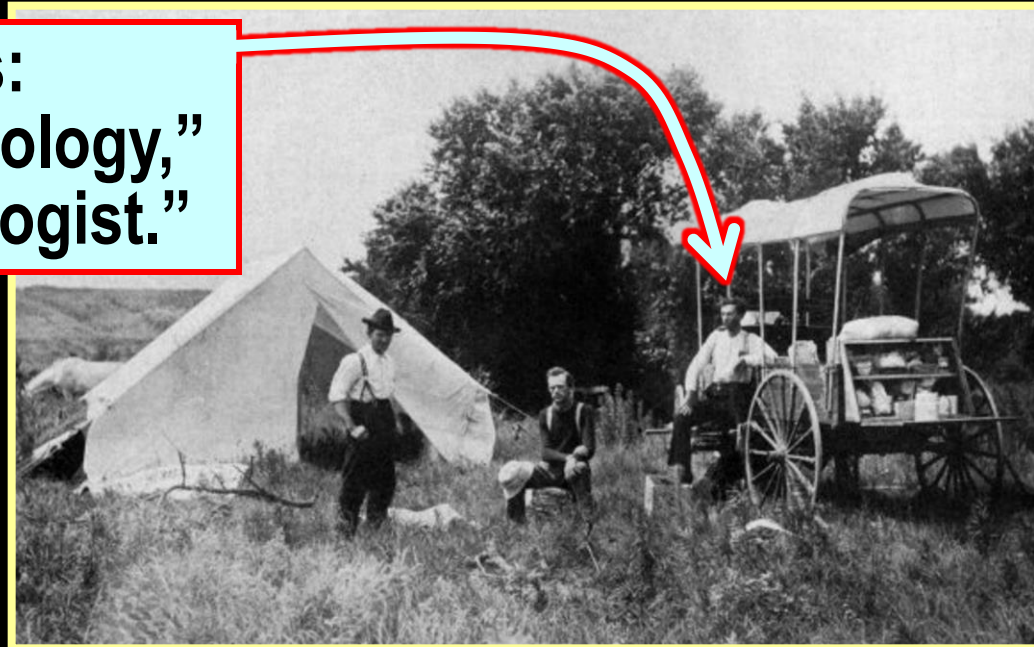
This new agency was to “study the geological formations of the State, with special reference to its mineral deposits.”

And to prepare and publish reports that give “descriptions of the geological structure and mineral deposits of the State.”

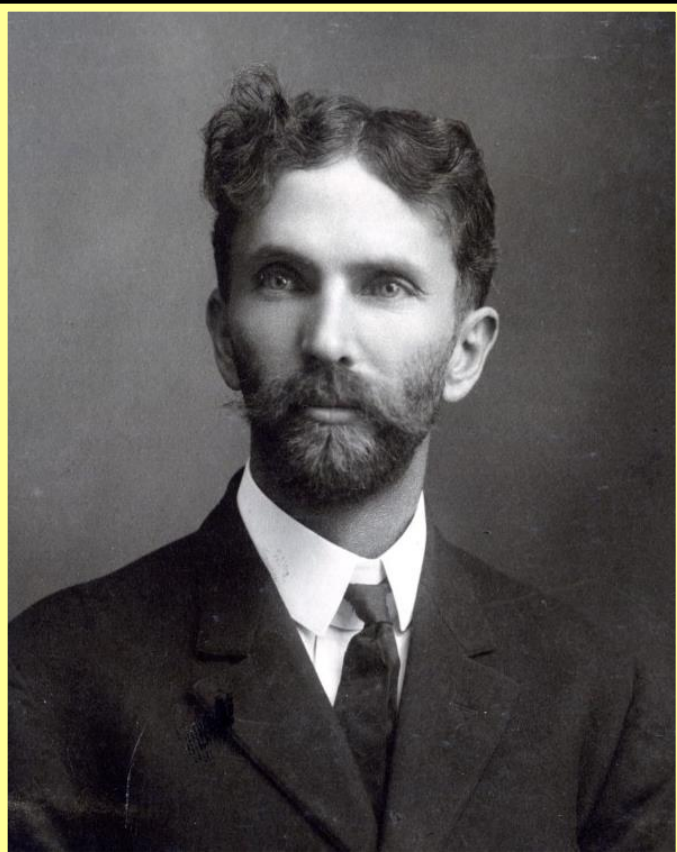
To be housed at State University; receive \$15,000 every 2 years.
First director was Dr. Charles N. Gould: 1908-1911 & 1924-1931.

Dr. Gould is known as:
the “Father of Oklahoma Geology,”
& as “Covered-Wagon Geologist.”

In first year, OGS had
9 parties doing field work



OGS Directors: Oklahoma State Geologists



Dr. Charles N. Gould
First Director
1908-1911,
1924-1931

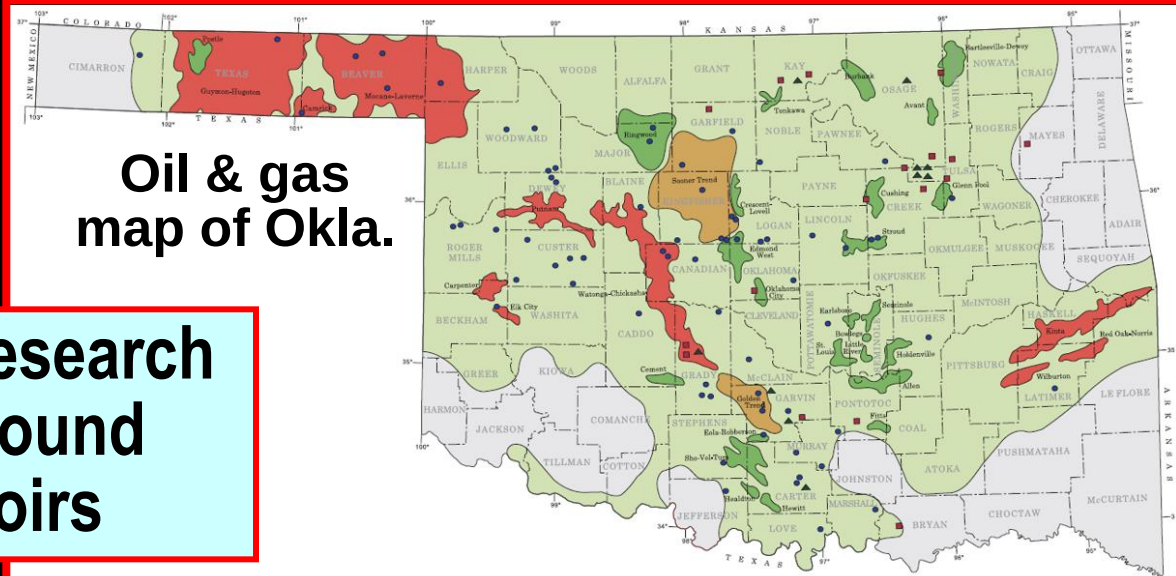


Dr. Nicholas Hayman
Current Director
and 9th Director
2020-????

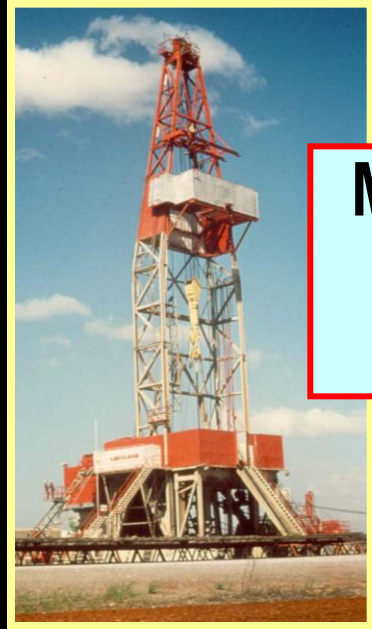
**Programs of
the Oklahoma Geological Survey**

Study oil and gas origin, distribution, and production

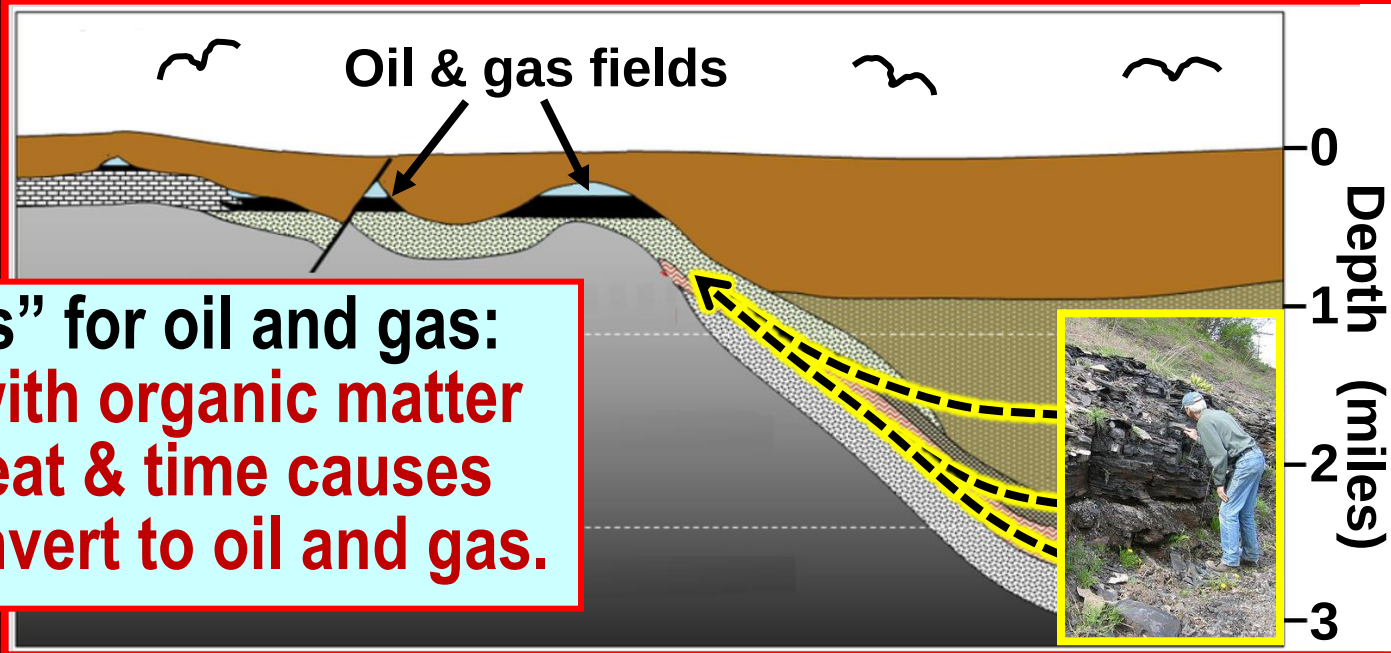
OGS Energy-Resource Studies



Map and research underground reservoirs

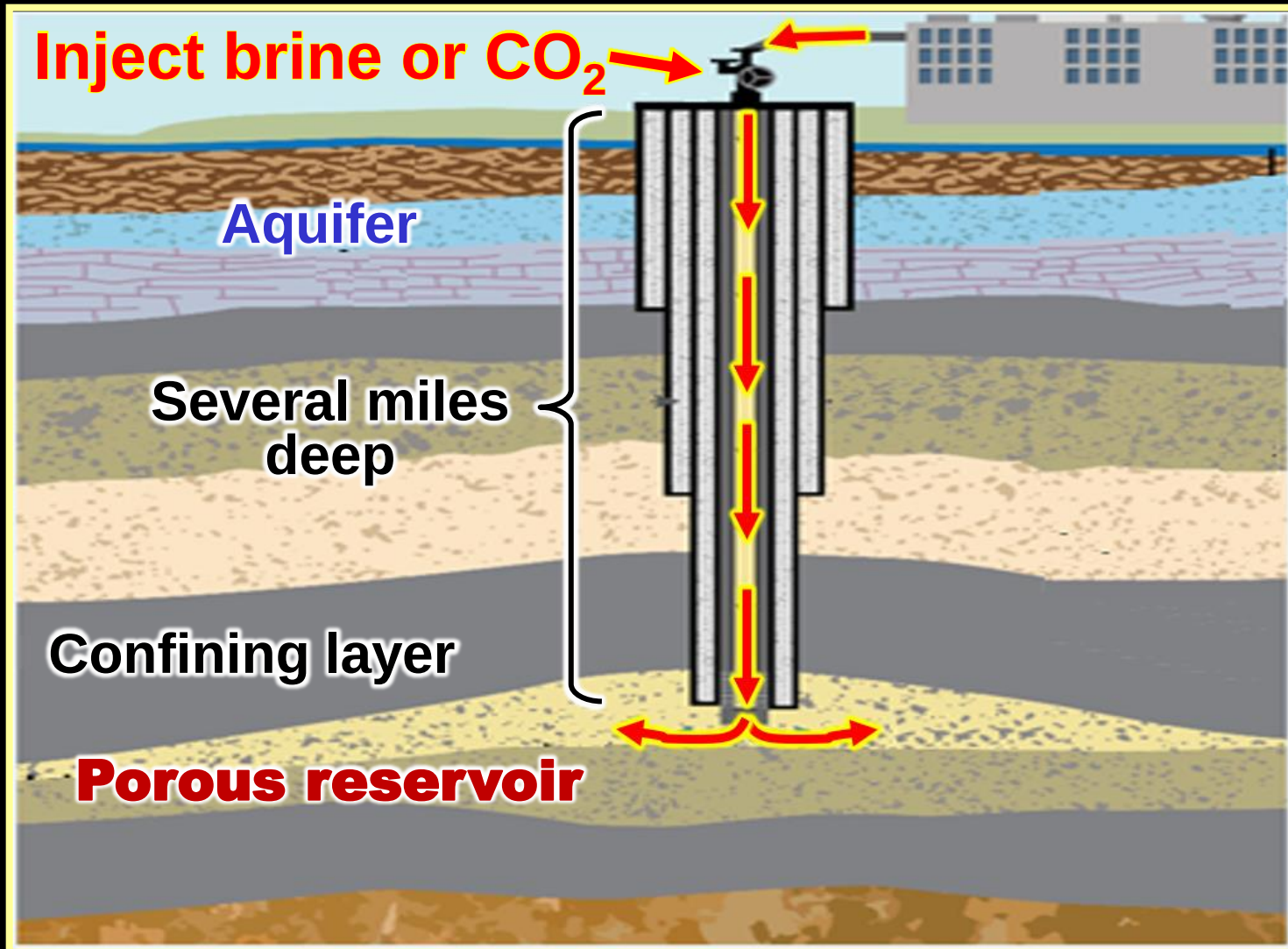


“Source rocks” for oil and gas: black shales with organic matter are buried; heat & time causes organics to convert to oil and gas.



OGS Energy / Environmental Studies

Storage / disposal of oil-field brines or carbon deep underground



OGS Critical-Minerals Program

17 rare-earth elements plus, i.e., cobalt, copper, lithium, silicon, tin, vanadium, etc.

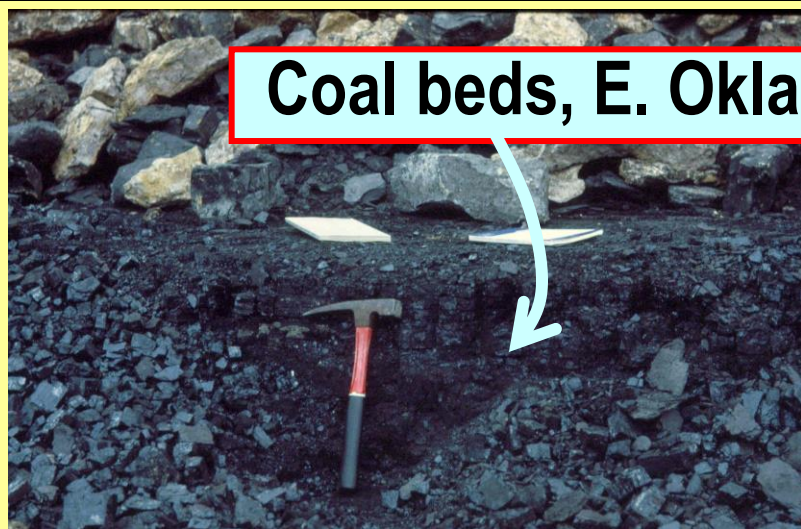


Chat piles from lead/zinc mines in Tri-State area

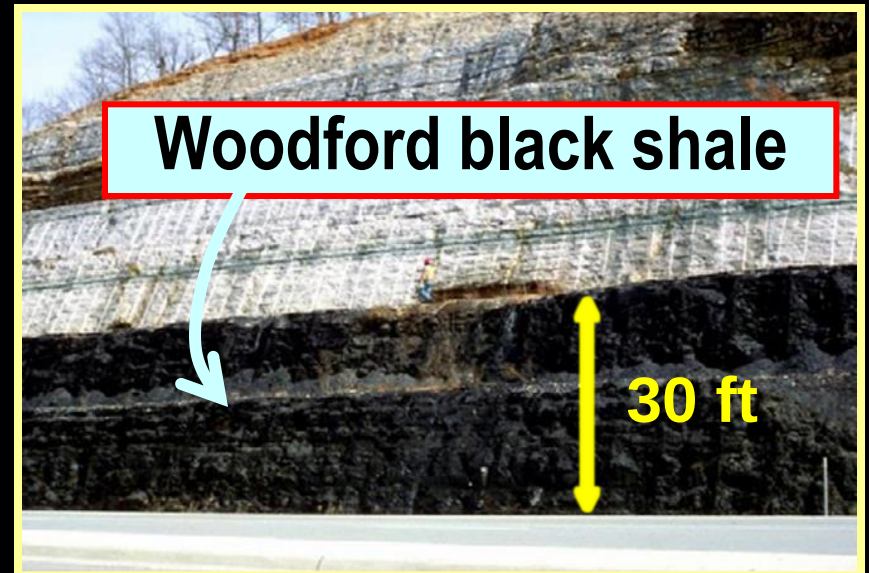


Igneous rocks: Wichita & Arbuckle Mtns.

Coal beds, E. Okla.



Woodford black shale



OGS Earthquake Research

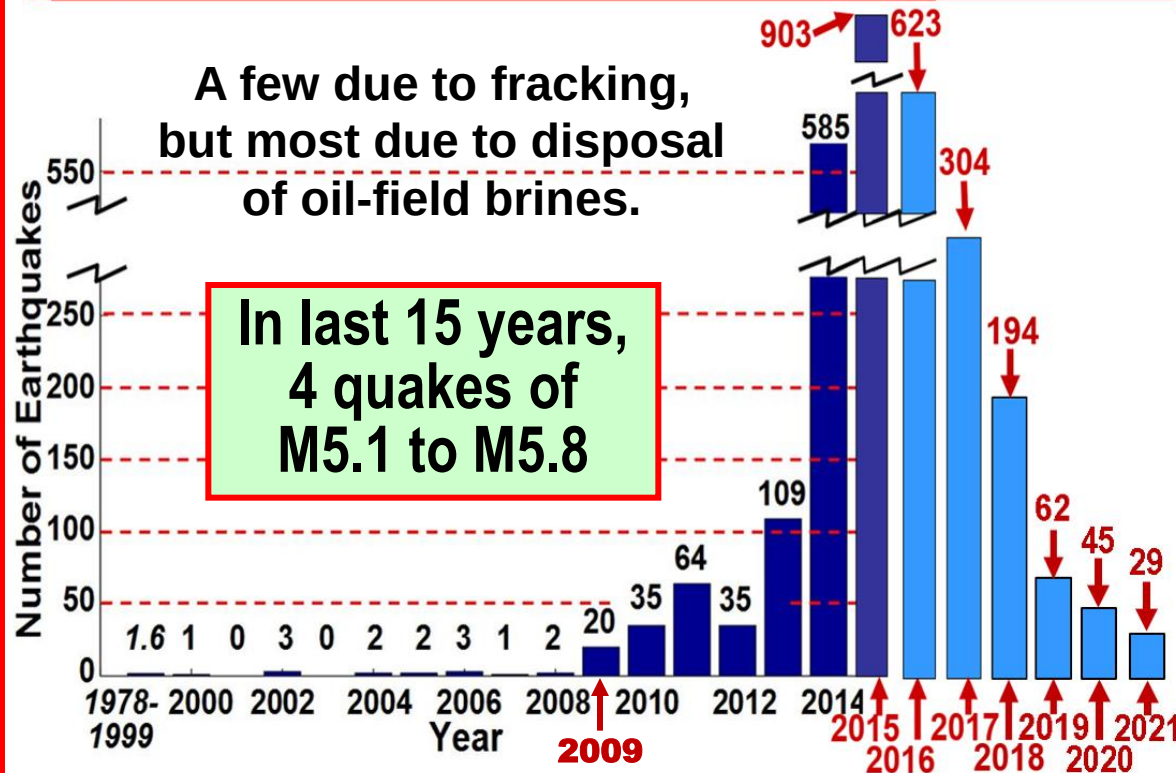
Earthquake damage



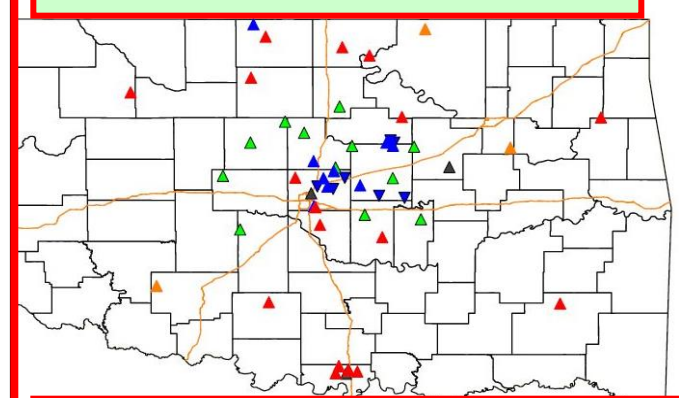
Oklahoma earthquakes of M3.0 or greater

A few due to fracking,
but most due to disposal
of oil-field brines.

In last 15 years,
4 quakes of
M5.1 to M5.8



Seismic network



±50 Seismographs

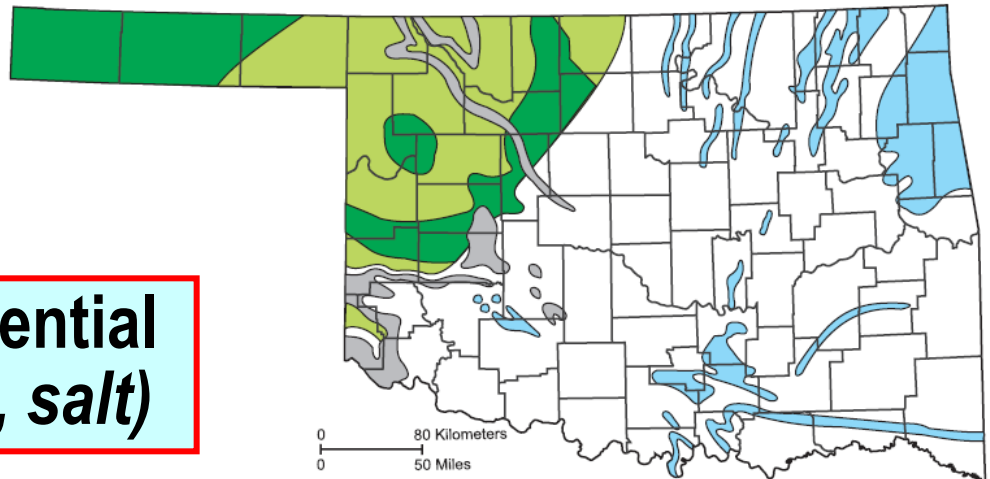
OGS Environmental Research

Two landslides in Cavanal Hil near Poteau, Oklahoma

Landslides and erosion

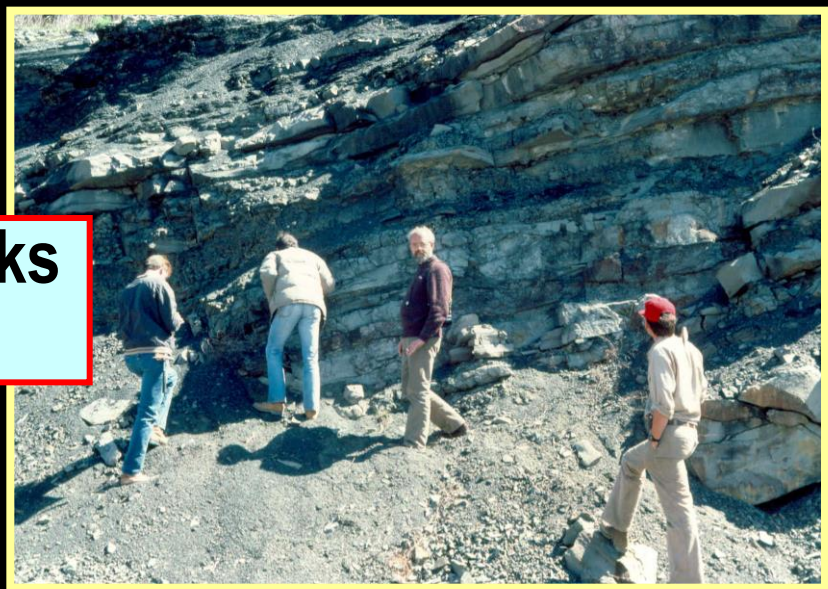
Karst, sinkholes, land subsidence

**Preliminary map of karst potential
in Okla. (*limestone, gypsum, salt*)**



OGS Field Studies

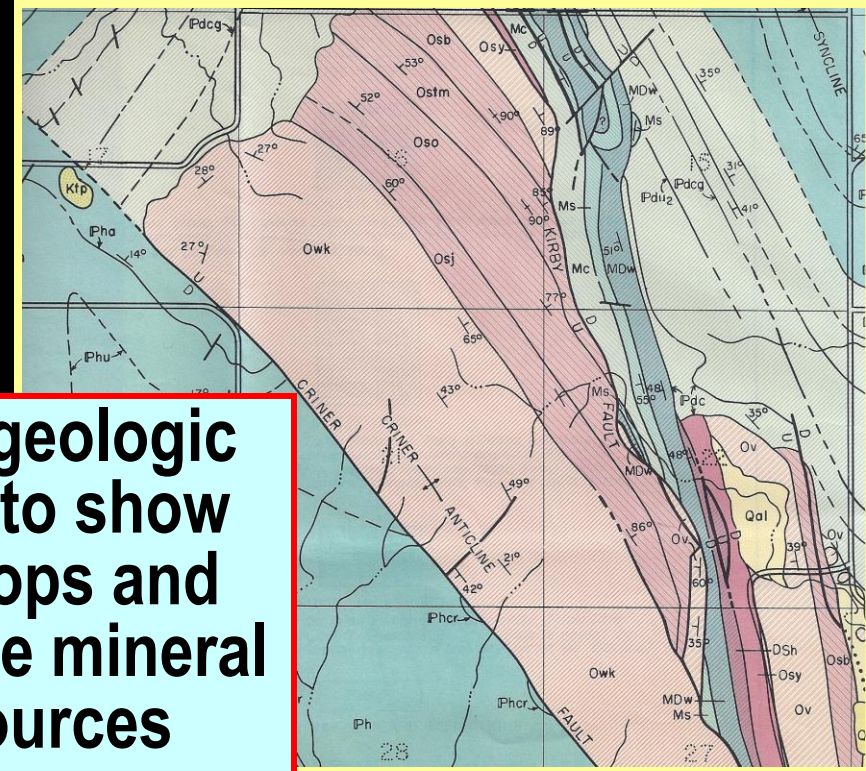
**Examine rocks
in the field**



**Collect samples
for analysis
(critical minerals?)**



**Make geologic
maps to show
outcrops and
possible mineral
resources**



OGS Education and Outreach

Provide geologic information to...

...industry...



...the public...



...schools.



Oklahoma Petroleum Information Center (OPIC)

Permanent archive of geological,
geophysical, and petroleum data...

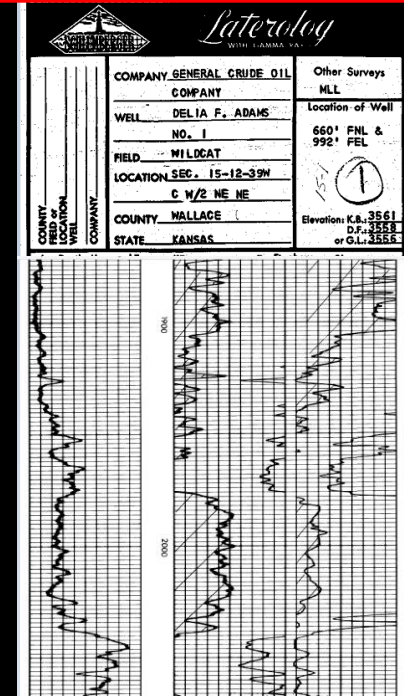
...geophysical logs,
of all the wells in OK.



...cores,
10K wells...



...borehole
cuttings,
50K wells...



GIS at OGS

Geologic, seismic, mineral, and energy data must be shown on maps, graphs, and other illustrations.

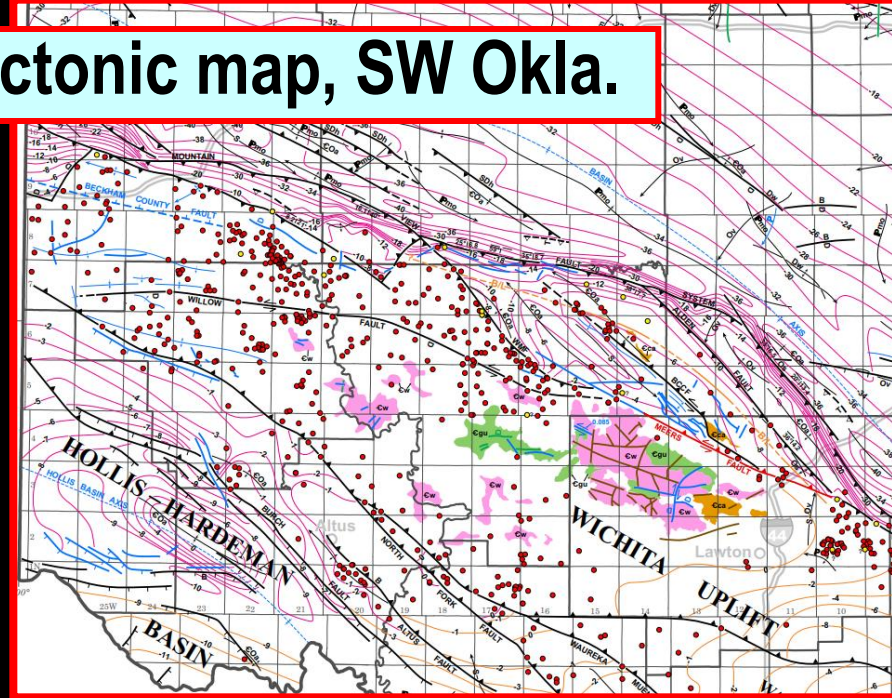


Personnel

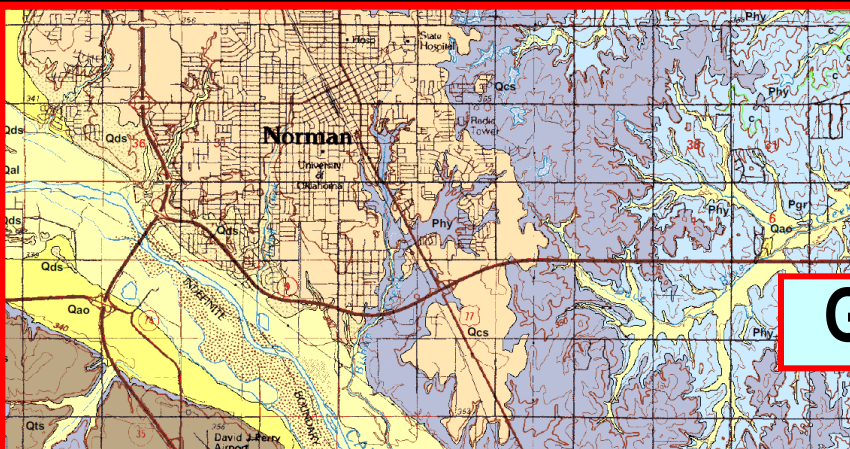


Creating maps

Tectonic map, SW Okla.



Geologic map, Norman area



In addition to providing free advice and consultation to other government agencies, companies, and the public, the Survey's lasting legacy is its publications.....

Bulletins and Circulars..... 277

Other published books/reports..... 311

Educational Publications24

Monthly or bi-monthly journal79 years

Papers in national/international journals ...hundreds