Wichita Mountains Geologic Field Trip for Earth Science Teachers

Figure 1. A view looking SW at the Wichita Mountain Uplift in silhouette.

Paul Pipes, John Shenk, Ralph Espach

A project of the Oklahoma City Geological Society "Partners for Earth Science" Education Committee

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A project of the Oklahoma City Geological Society Education Committee
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History of Mining in the Wichita Mountains

Prospecting for gold in the eastern Wichita Mountains began in the 1890's and a mining camp located near what is now Meers became a local hang-out for miners in 1901. It was named after a local prospector, Colonel Andrew Meers. In 1901, President McKinley created the Wichita Forest Reserve, from part of the Kiowa, Comanche, and Kiowa-Apache Indian reservation, and all persons had to move out of the Reserve, except for persons engaged in mining activity. Mining continued until 1905, when a University of Oklahoma geologist, working on behalf of the United States Geological Survey, prepared a report stating that there was insufficient mineralization to justify the mining of ore. After this report became public knowledge, mining activity declined. Neither gold nor any other precious minerals are known to have been found in the area.

Prospectors were also active in the western Wichita Mountains at about the same time. The illegal town of Wildman, located about four miles southeast of Roosevelt on the southwest side of the Glen Mountains (a continuation of the Wichitas) existed for only a year or two before homesteaders drove the miners out. These miners didn't find any gold, but because of Legends that the Spanish found gold in the vicinity around 1650, prospecting has continued sporadically ever since.

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Introduction

This Field Trip is designed to guide Earth Science Teachers to locations in the Eastern Wichita Mountains that illustrate common geologic principles with specific examples in Oklahoma, and to outcrops where samples of typical igneous and sedimentary rocks may be collected for classroom use.

The trip begins at Oklahoma City Community College, SW 74th and May Avenue, Moore, Oklahoma in the north parking lot just east of Exit 114 on I-44 (west of May Ave. and east of the airport.) Travel southwest on I-44 (H.E. Bailey Turnpike) past Chickasha and two toll booths to rendezvous at the Loves Store on highway 49, Exit 45, with others from south and western Oklahoma. The detailed road log begins at the Loves Store. We will be in the Ft. Sill Military Reservation and the Wichita Mountains Wildlife Refuge most of the day. Rock hammers and alcoholic beverages are not allowed in either place, BUT small rock samples may be collected in the Refuge if you are accompanied by an OCGS geologist with the appropriate Permit in his possession.

The round trip distance from Oklahoma City and return is approximately 250 miles and will take about ten hours. Restrooms are available at Loves Store and various stops in the Refuge. This trip is planned around individuals bringing a sack lunch and liquid refreshments. We will pass through Meers late in the day where there is a reputation for comestibles, and somewhat later we will pass Ann's Kitchen. Prolonged stops for refreshments at these places will extend the duration of the trip.

Avoid intimacy with the wild animals and Poison Ivy in the Refuge. Park well off the right-of-way, and exit and enter vehicles with care. Before leading a field trip of your own, be sure to have a signed release of liability from each participant.

Throughout this trip, field trip leaders will emphasize the SCIENTIFIC METHOD: Conclusions remain open to empirical testing and potential modification/rejection

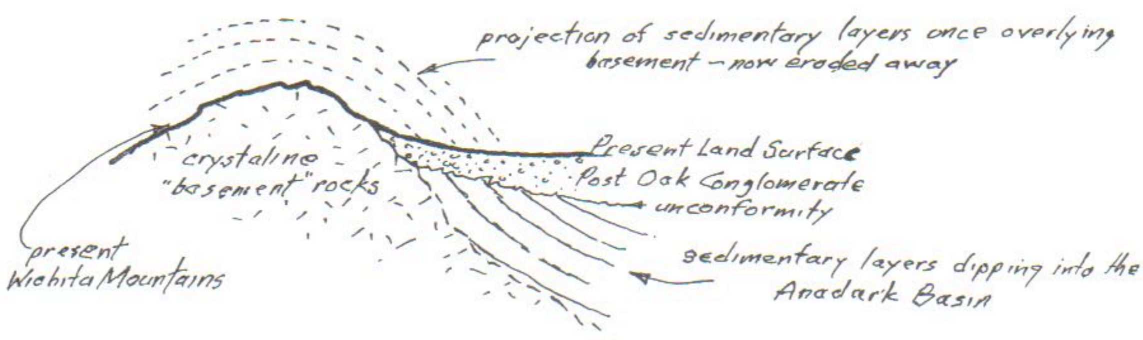
Our first Guidebook, *Arbuckle Mountains Geologic Field Trip for Earth Science Teachers*, dealt almost exclusively with SEDIMENTARY rocks and structures. This Guidebook deals almost exclusively with rocks that solidified from molten magma (IGNEOUS Rocks). These rocks form crystals as they cool, so they are also called "crystalline rocks," or sometimes "basement rocks" because they are usually the "basement" on which sedimentary rocks are deposited.

In both Guidebooks we emphasize that SCENERY is the product of weathering and erosion acting on the rocks: that is to say that landforms (topography) reflect geology.

Wichita Mountains Geology

The geology exposed in the Wichita Mountains consists mainly of what is known as "basement rocks," generally igneous rocks (granite, rhyolite, gabbro, diabase) that typically underlie the younger sedimentary rocks that were deposited over most of Oklahoma. These igneous rocks were emplaced in a gigantic "crack" in the earth's crust that trended west-northwest across southern Oklahoma during the early Cambrian geologic period between 520 and 570 million years ago. They were pushed to the surface during a period of mountain building about 300 million years ago. The overlying sediments were then removed by erosion. The Cambrian "basement" rocks are presumably underlain in turn by much older, pre-Cambrian metasediments known only from deep well cuttings, and /or older granites like those that crop out on the eastern side of the Arbuckle Mountains some 60 miles to the southeast

The outcrops we will observe on this field trip are granites cut by a few diabase dikes and rhyolites (both are very fine grained granitic type rocks deposited on or near an old surface), gabbros (dark blue-gray crystalline rocks), quartzites and limestones, all of Cambrian age. The youngest rock formation we will see is the Post Oak Conglomerate of Permian age, (260 million years old), consisting of debris of the older rocks eroded from the basement after the Wichita Mountains formed. The rock record that is missing between the 520 million year old Cambrian rocks and the 260 million year old Permian is called *lacuna* and results in an *unconformity*



Some Definitions

Weathering: The chemical and physical processes that destroy rocks.

Erosion: The processes of removal, carrying away the weathered debris. Wind and water are the principal agents of erosion; the ultimate cause of erosion is Gravity.

Geologic Section Exposed in the Wichita Mountains

AGE	SYSTEM	FORMATION	ROCK TYPE
Record of 270 Million Years is MISSING here			Unconformity: Present Land Surface
270 Million	Permian	Post Oak Conglomerate	Conglomerate of granite and Limestone debris
270 Million	Permian	Garber Sandstone	red, shaley Sandstone
Record of 330 million Years is MISSING here			Unconformity
500 Million	Cambrian to Ordovician	Arbuckle Group	Limestone & Sandstone
510 Million	Cambrian	Timbered Hill Group	Limestone & Sandstone
~520 Million	Cambrian	diabase	Dikes intruded in granite
~520 Million	Cambrian	Wichita Granite Group	Quanah & Mount Scott Granites
~520 Million	Cambrian	Carlton Rhyolite	Rhyolite
~570 Million	Cambrian	Glen Mountains Layered Complex	Gabbro
~??? Million	????	Meers Quartzite	Metamorphosed quartz sandstone

Some more Definitions

Granite: Any light-colored coarsely crystalline igneous rock consisting of quartz, various colored feldspars, and some mafic ("black) minerals. Cooled slowly, deep in the earth's crust.

Rhyolite: The fine-grained extrusive equivalent of granite. Cooled rapidly at or near the earth's surface.

Gabbro: a dark-colored coarsely crystalline igneous rock composed mostly of black or blue-black feldspars. Often weathers light-gray. Cooled slowly deep in the earth's crust.

Diorite: a dark-colored intrusive (commonly in sills and dikes in other rocks) rock, a relative of gabbro. Diabase is also a close relative.

Geologists define these kinds of rock largely on their mineralogy and texture, Pretty esoteric!

GEOLOGIC FIELD TRIP TO WICHITA MOUNTAINS FOR EARTH SCIENCE TEACHERS

Detailed Road Log starting from Love's Country Store, north edge of Lawton at intersection of State route 49 and US 62, 281, 271

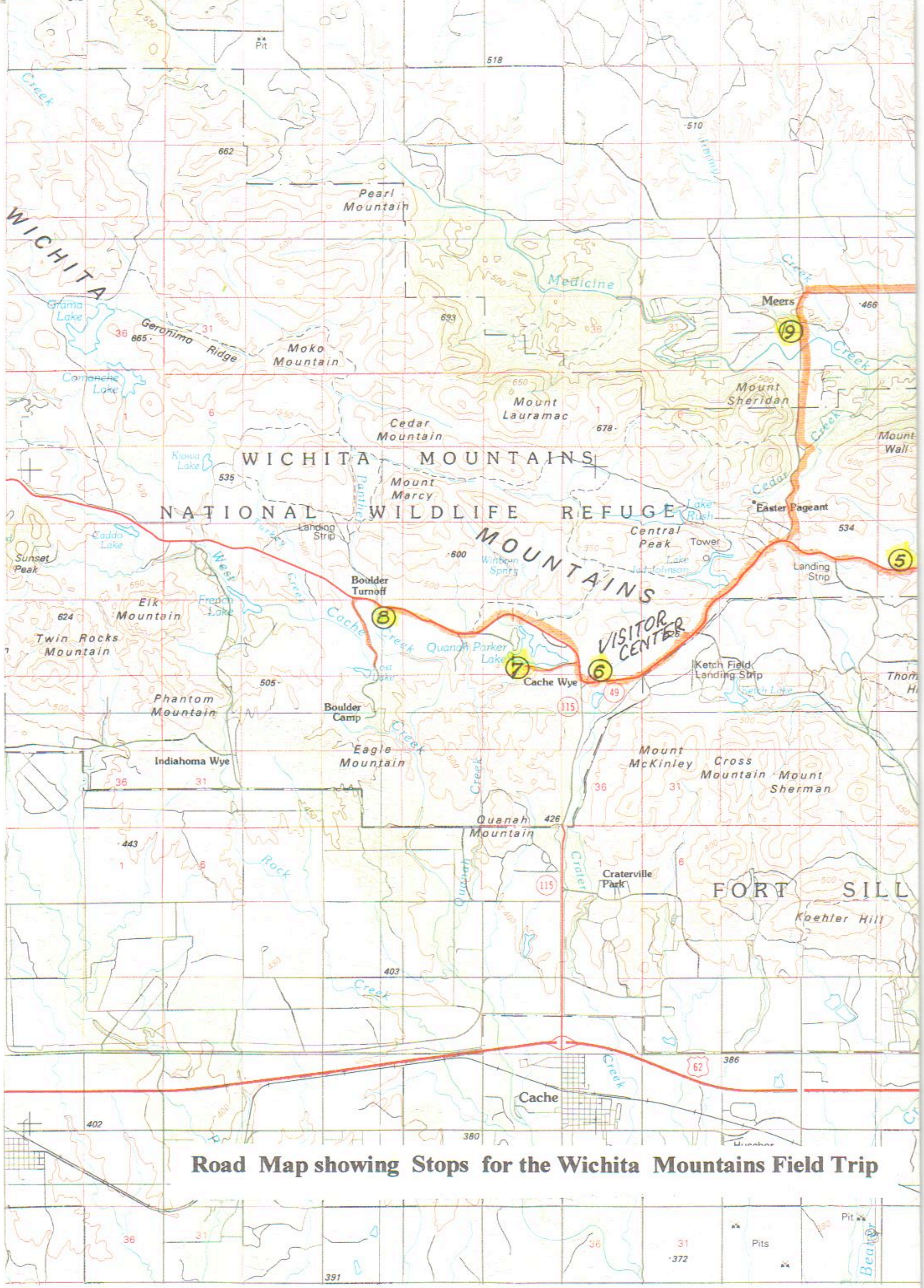
Stop	Mileage	Route and Description	Your Notes
	-0-	Love's Country Store, State Highway 49, exit 45 from I-44 (H.E. Bailey turnpike). Review maps, depart headed south on I-44.	
	4	Exit 41, main gate (Key Gate) to Fort Sill, turn left, go east across hiway to S. Boundary Road, turn rt, cross E. Cache Creek.	
	6.7	Take first paved road to the left.	
1.	7.3	Fort Sill Tar Pit National Historic Site. This is a natural oil seep flowing from the Permian age Garber sandstone The Wichita Mountains can be seen to the west. Return to Key Gate.	
	13.4	Entrance to Fort Sill, turn right onto Randolph Road.	
	13.8	Fort Sill Boulevard light, turn right onto Fort Sill Boulevard, going north, left onto Kings Road, right on Baterman Road north, cross Cache Creek, turn left onto Punch Bowl Road.	
	16.9	Turn left, Fort Sill archery range and Medicine Bluffs Historic Site.	
	17.1	Turn Left to Medicine Bluffs.	
2.	17.5	Medicine Bluffs on Fort Sill. This 300' wall of Carlton Ryolite exhibits columnar jointing. Also note that local topography is the result of erosion by a superimposed stream.	
	17.9	Cross paved road, continue north on gravel road.	
	18.8	Turn north onto Apache Gate Road (paved).	
	21.6	Intersection of state highway 49 and 62. Leave Fort Sill, turn left onto highway 49.	
	25.1	Junction state highway 49 and 58	
	26.2	Cannonball house on right – rounded granite cobbles used in walls are "tors" characteristic of local granite weathering.	
	27	Cross Medicine Bluff Creek	

EARTH SCIENCE TEACHERS FIELD TRIP – Road Log

Stop	Mileage	Route and Description	Your Notes
	27.1	Lake Elmer Thomas sign	
	28	Enter Wichita Mountains Wildlife Refuge	
	28.1	Turn left onto gravel road.	
3.	28.4	Lake Elmer Thomas damsite. Exposure of Mt. Scott granite cut by a black diabase dike. Retrace route to highway.	
	28.7	Highway, turn left.	
	30.2	Toilets in picnic area on left.	
	30.7	Mt. Scott entrance, turn right.	
	32.9	Cross boulder "stream" composed of large rounded granite boulders.	
4.	35.5	Top of Mt. Scott, elevation 2465', WPA marker, 1940. Outcrops of Mt. Scott Granite – views of Wichita Mountains – note gabbro-granite contact in mountains to west. Return to hiway.	
	38.4	Turn right onto state highway	
5.	40.1	Turn right, park in parking lot. Quetone Point, buried topography of granite and rhyolite, covered by Permian Post Oak Conglomerate.	
	40.4	Turn right onto state highway 49	
6.	44.4	Turn right into Visitors Center.	
	44.7	Turn right onto Cache Road	
	45.3	Turn left to damsite of Quanah Parker Lake.	
7.	46	Damsite, Quanah Parker Lake. Observe the coarse grained Quanah granite that is younger than the Mt. Scott granite. Return to the highway.	
	46.8	Turn left onto state highway 49.	
	50.3	Turn left on paved road to Lost Lake	
8.	50.7	Turn left, down hill to Burford Lake, then right on dirt road. Observe contact of granite above gabbro. Return to paved road and turn left.	

EARTH SCIENCE TEACHERS FIELD TRIP – Road Log Continued.

Stop	Mileage	Route and Description	Your Notes
	51.6	Lost Lake picnic grounds, lunch stop. Return to highway.	
	52.9	At state highway 49, turn right	
	55.6	Intersection of Cache Road and state highway 49, turn left (east) onto 49.	
	58.9	Meers turnoff, turn left (north).	
	60.7	Leave Wichita Mountains Wildlife Refuge.	
	61.4	Cross Medicine Creek; exposure of gabbro rocks. Stop for collecting samples.	
(9.)	61.7	Meers Quartzite, stop on side of road – CAUTION, blind hill.	
	61.9	Gabbro exposure	
	62	Meers store, seismic station, famous Meersburger, turn right (east).	
	66.2	Intersection with state highway 58 – on east side of road is Ann's Kitchen (yum!), Turn left onto state highway 58.	
(10)	67.4	Intersection with east-west section line road. Pull off onto dirt road, be careful of traffic. View the Meers fault to the west; you are standing on the fault trace at this point.	
(11)	68	Roadside exposue of Arbuckle Group Fort Sill limesone. Pull off road – be careful of traffic.	
		Return to Love's Country Store and H E. Bailey turnpike via highway 48 and 49 – approx 8 miles.	



Road Map showing Stops for the Wichita Mountains Field Trip

Chandler Creek
Tower
Edgewater Park
Ellsworth
Canyon Creek
Lakeside Village
Rock Creek
Porter Hill
Mount Scott
Ketch Creek
Quarry
Lime Creek
Lake Lawtonka
Richards Spur
H E BAILEY TOLL TURNPIKE ROAD
Mount Scott
Mount Cummins
Medicine Park
Duhringe Pass
Elmer Thomas Lake
LOVE'S store
Fish Hatchery
Landing Strip
Rabbit Hill
Pratt Hill
OLD MIL RES BDY
Ridley
Jones Ridge
Medicine Creek
Mount Hinds
Beef Creek
Dodge Hill
March Ridge
Medicine Bluffs
West Lake
Carlton Mountain
Signal Mountain
Towers
Flat Top Hill
MILITARY RESERVATION
Fort Sill
Gruber Hill
McKenzie Hill
Kerr Hill
Henry Post Airfield
Feigel Point
Lake George
Landing Strip
Wrattan Creek
FORT SILL INDIAN SCHOOL RESERVATION
West Branch
East Cache
Memorial Hosp
Oil Field
Tower Taupa
Cameron University
Lawton
BURLINGTON NORTHERN
Southwestern Hosp

Stop 1 – Fort Sill Tar Pit National Historic Site

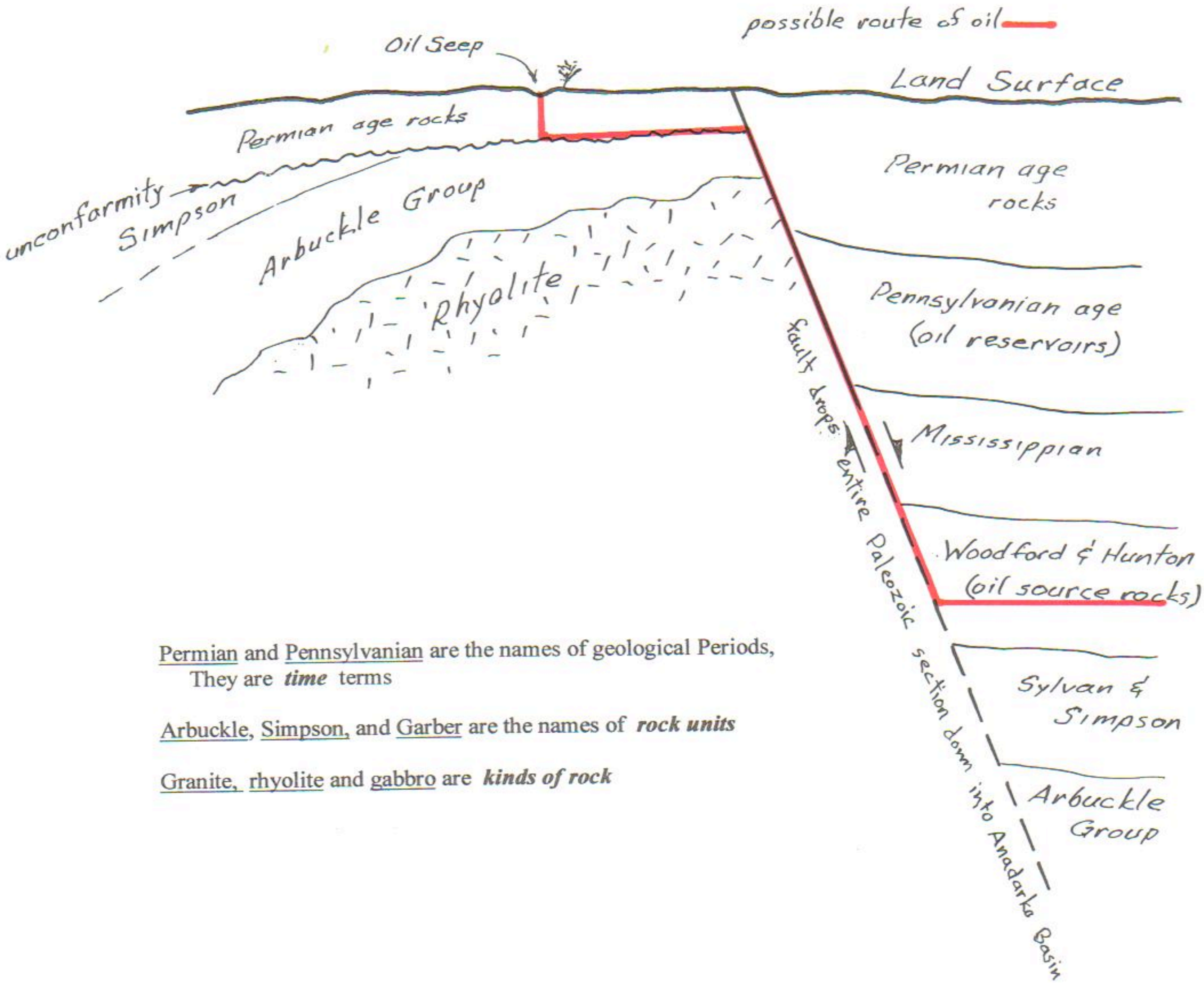
Why are we making this stop?

Observe Active Oil Seep from the Garber Sandstone.

What can we learn from this stop?

Standing on the surface you can view oil flowing out of the Permian age Garber sandstone at this active oil seep. The Garber sandstone we stand on here is the same Garber sandstone that is at the surface in Oklahoma City and other parts of Central Oklahoma and is a major aquifer for Central and Western Oklahoma. Notice the small pond that drains to the south and the washed-out gully that it forms. As the pond overflows, the oil drains down through the gully staining the rocks. Below the Garber sandstone here at the Tar Pit are eroded older formations, probably Cambrian age Arbuckle and Timbered Hills group limestone, with the Carlton Rhyolite at about 500'. To the east is the Anadarko Basin where depths to the basement rocks exceeds 30,000 feet. The source of the oil in this seep is probably in the Anadarko Basin. Permian age oil production occurs to the east at depths of 600 to 900 feet.

Fort Sill Tar Pit



Permian and Pennsylvanian are the names of geological Periods,
They are ***time*** terms

Arbuckle, Simpson, and Garber are the names of ***rock units***

Granite, rhyolite and gabbro are ***kinds of rock***

Stop 2 – Medicine Bluffs Historic Site on Fort Sill

Why are we stopping here?

1. Examine the Carlton Group Rhyolite – look closely at the rock
2. Columnar jointing in the rhyolite.
3. Erosion and surface topography controlled by rock type and local structure

What can we learn from this stop?

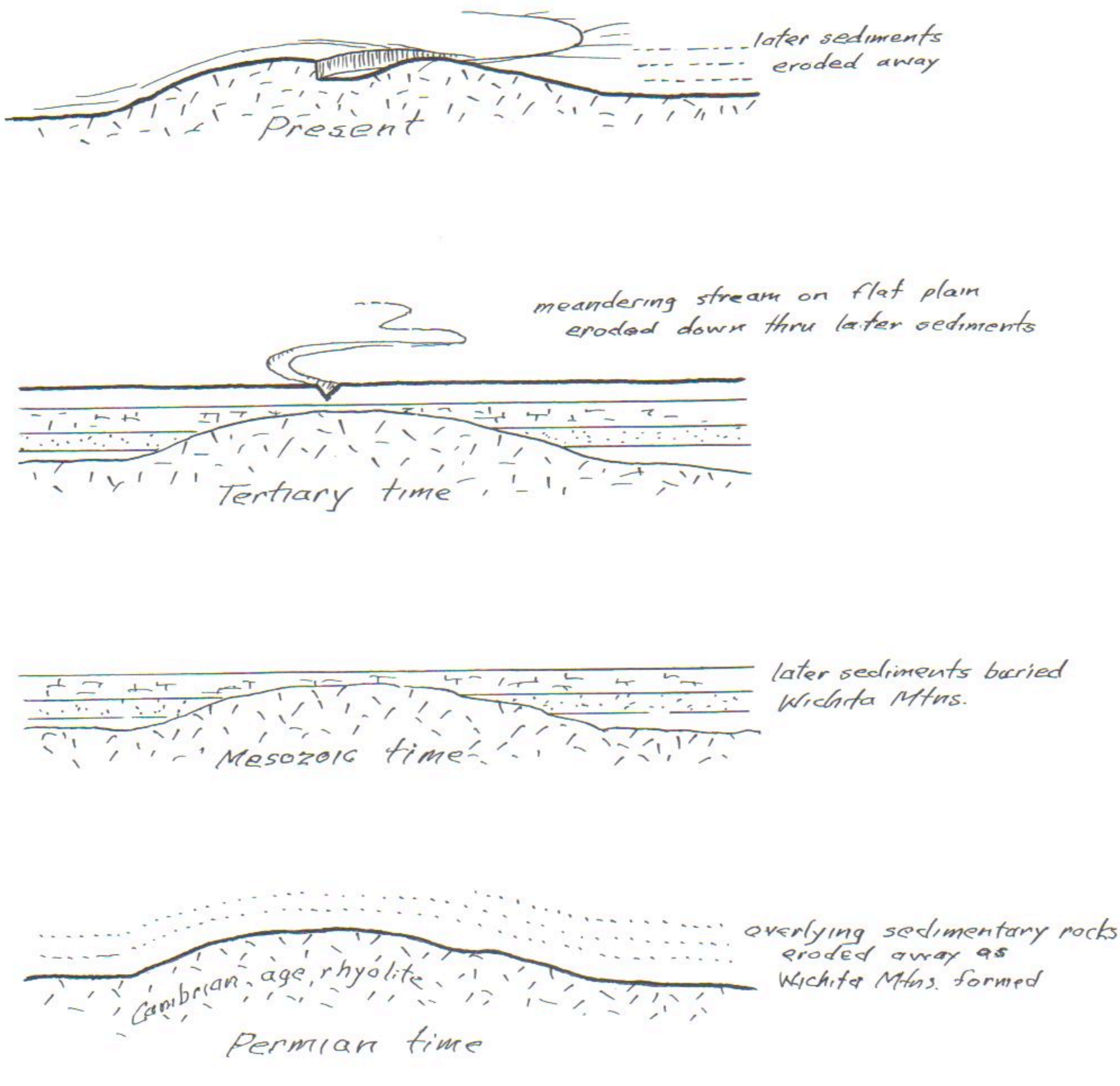
The 300 foot high bluff formed of Carlton Rhyolite shows vertical columnar jointing, characteristic of igneous rocks that cool rapidly at or close to the surface. The jointing facilitates weathering and erosion. Notice the notch at the top of the fluff. A diabase dike cuts through the rhyolite there. The diabase cooled more slowly forming a coarser crystalline texture that is not as hard as the rhyolite allowing the diabase it to weather more easily. The notch is a small scale example of differential weathering

The bluff is part of the old land surface that formed after the overlying sedimentary rocks were eroded from the rising Wichita mountains in Permian time. Later sediments buried the mountain range and developed a flat plain on which a meandering stream flowed. As those later sediments were eroded away in turn, the stream maintained its course, cutting its meanders down into the rhyolite. Because Medicine Creek's course was established on rocks above the rhyolite, geologists call it a *superimposed stream*.

Looking south at Medicine Bluffs

A *superimposed stream* (Medicine Creek)

carved this striking topography at Medicine Bluff



Stop 3 – Lake Elmer Thomas dam site

Why are we making this stop?

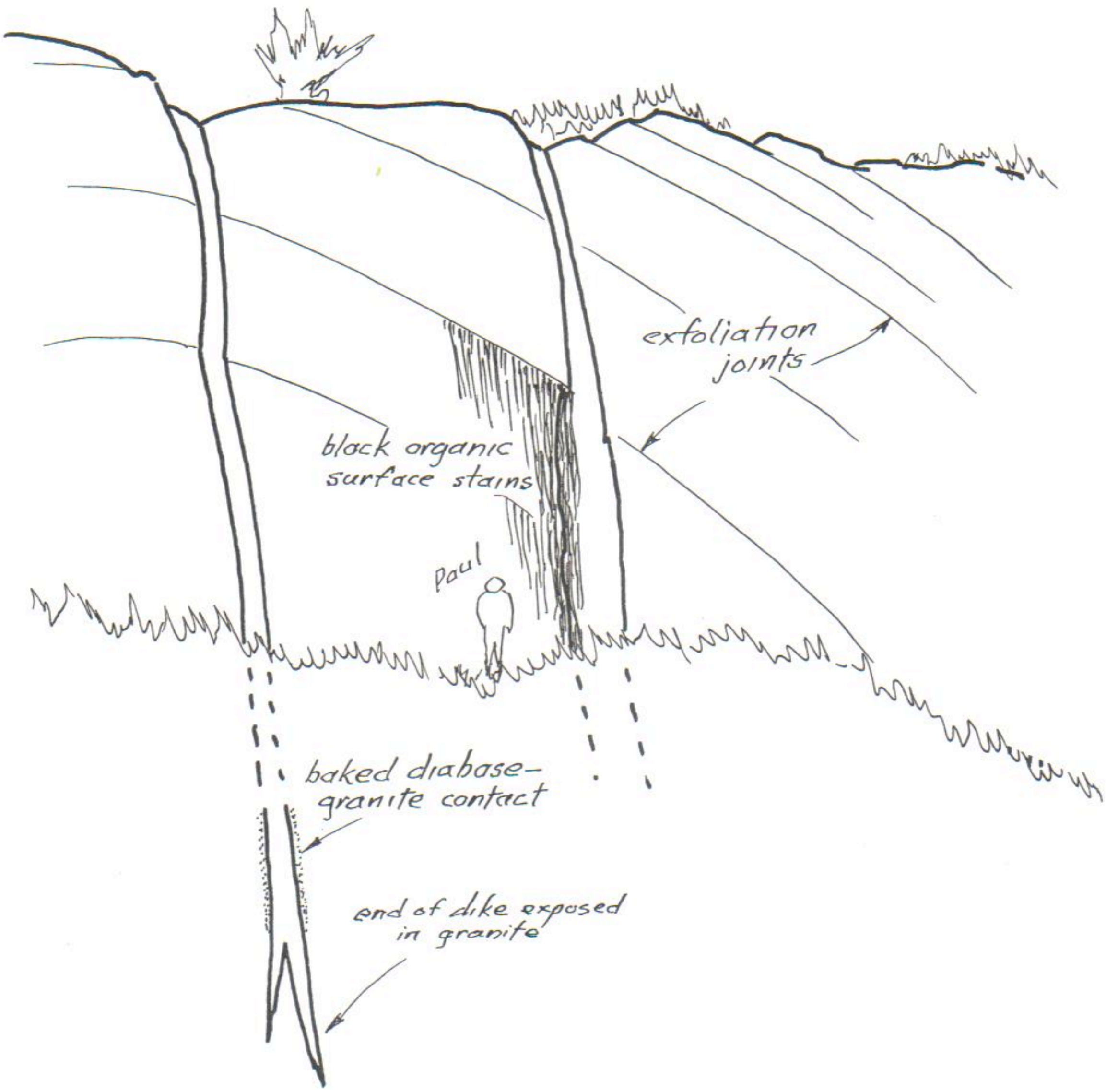
Observe a diabase dike that cuts the Mt. Scott granite – note the contact between the two rock types. Pick up a hand specimen of granite.

What can we learn from this stop?

Here you can see the scarp where the hillside was quarried to use as fill for the original dam that was replaced in 1993. All of the reddish brown rock is the Mt. Scott granite. The black rock cutting the granite is diabase that intruded the granite not long after the granite was formed. Notice the contact zone of the diabase dike and the granite where the granite is discolored. This color change is evidence that the diabase dike melted the granite wallrock. Note the termination of the dike near the lake shore. At the the top of the cliff face, an erosional notch similar to the one seen at Medicine Bluffs is forming where the diabase dike is eroding at a faster rate than the granite. The granite has numerous joint fractures that contribute to weathering in a pattern of scaling-off of slabs of rock called *exfoliation*.

Closeup of dike margin

Looking north at granite cliff face



Another Definition

exfoliation: concentric "shells" of rock spall from the surface of large rock masses. Caused by differential stresses related to weathering as the chemical or physical environment of the rock mass changes.

Stop 4 – Road up Mt. Scott and summit of Mt. Scott

Why are we making this stop?

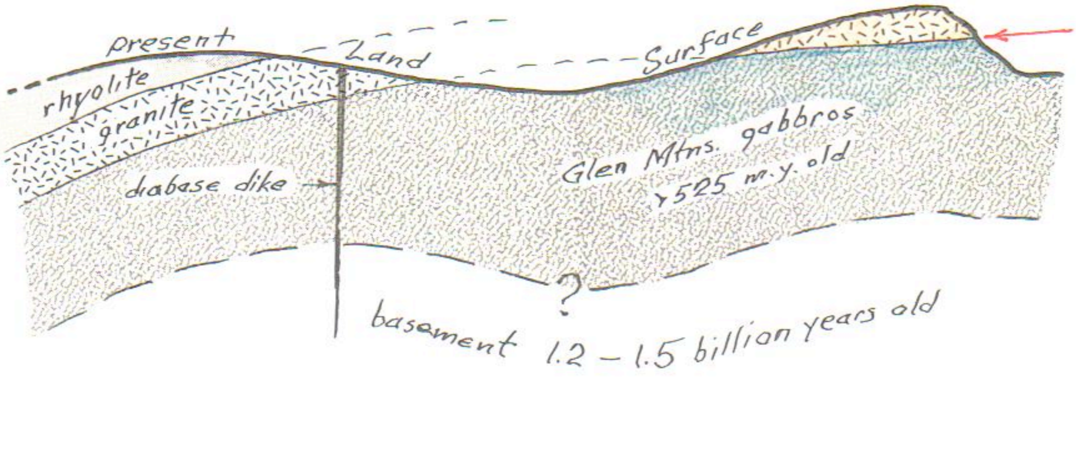
1. View "boulder stream" composed of Mt. Scott granite boulders
2. Overview of surrounding geology with emphasis on mountains to west.

What can we learn from this stop?

As you drive up Mt. Scott, slow to observe the *boulder stream* coming down from the summit. As water enters cracks and joints on the granite surface and freezes and thaws over the years, it weathers the resulting blocks into *TORS*, the name geologists give these rounded boulders. This is an example of mechanical weathering (freeze and thaw). The "cannonballs" we saw in the walls of the house on highway 49 are *tors* in advanced condition. Formation and movement of this *boulder stream* was accelerated during earlier cold geologic times when there was much more ice and water present; the stream is not moving perceptively now.

View Looking north up the Boulder Stream

From the summit of Mt. Scott, at 2465 feet above sea level, you see the nearly level plain of Oklahoma below to the east at an elevation of about 1200 feet. Look to the west; on the side of Mt. Wall notice the lower slopes covered with dark green vegetation and a distinct line separating those tree and shrub covered slopes from the upper barren light-colored rock on the peak That line is the contact between the Glen Mountains gabbro below and the overlying Mt. Scott granite. The vegetation grows preferentially on the gabbro because it weathers into a rich soil.



Modified from Gilbert, et al, 1994, Basement Rocks of Southern Oklahoma

Stop 5 – Quetone Point

Why are we making this stop?

View Permian topography covered by the Post Oak Conglomerate.

What can we learn at this stop?

The Post Oak Conglomerate you are standing on is a Permian age formation, here composed of granitic rocks, and is an indicator of the uplift and rapid erosion of the Wichita Mountains. Farther away to the north, the Post Oak is composed of pieces of Arbuckle limestone eroded from the mountains.

The Wichita Mountain area was a "high" area exposed to erosion for a considerable amount of time during the Pennsylvanian and Permian Periods. A varied topography developed on the exposed crystalline basement, and the erosional debris was deposited in the Anadarko basin to the north. Post Oak sediments were deposited much later, burying that topography. Note that the Post Oak sediments across the road are nearly horizontal in undeformed layers that fill the gullies in the underlying eroded basement rock. This relationship indicates that much of the present topography in the Wichita's was carved long ago in the Permian Period, before the Post Oak was deposited and is presently being exhumed.

View looking southwest across the road at exhumed topography

Stop 6 – Visitors Center of the Wichita Wildlife Refuge

Why are we making this stop?

1. Visit the center and see the exhibits and history of the Refuge
2. Restroom Break

What can we learn at this stop?

Notice that within the Visitors Center the exhibits display the wide variety of mammals, reptiles, insects, and plant life that can be seen in the Refuge. Very little is mentioned about the varied rock exposures, the topography, and the geologic history of the Refuge. Why is this?

Photo of Bison grazing near the entrance to the Visitors Center.
Note the visitor endangering his/her life.

Stop 7 – Dam site at Quanah Parker Lake

Why are we making this stop?

1. Visit canyon cut into granite
2. Examine the Quanah granite, notice difference from the older Mt. Scott granite

What can we learn at this stop?

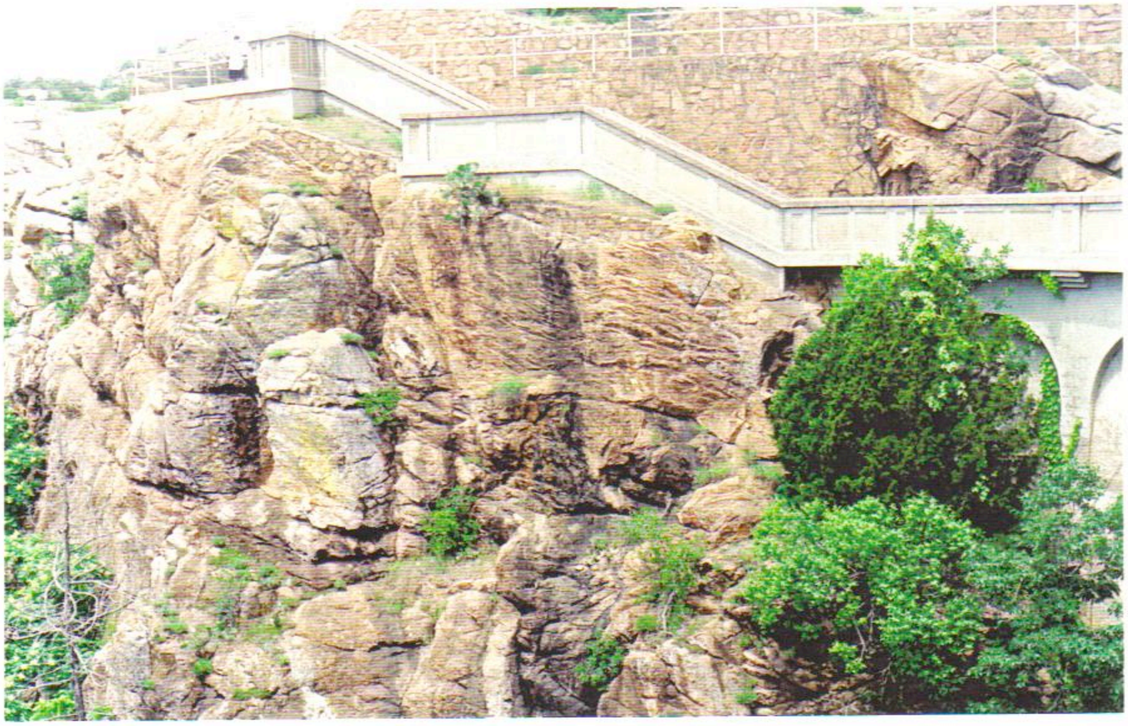
See the deep canyon cut in the granite. This rugged topography is the result of the long period of erosion of the basement rocks as the Wichita mountains formed during the Pennsylvanian and Permian Periods. Do you think this topography is related to the landforms we saw at STOP 5?

The rock here is the Quanah Granite. It is somewhat younger than the Mt. Scott granite and can be distinguished from it because the Quanah granite is more coarsely crystalline. Compare it with the hand specimen of Mt. Scott granite you collected at STOP 3. Most of the Quanah granite is within the Refuge boundary so it is not available to be commercially quarried.

Quanah granite

Mt. Scott granite

Stop 7 – Continued



Looking west at canyon wall exposure of Quanah granite.

Looking southwest at Exhumed Permian topography

Stop 8 – Burford Lake

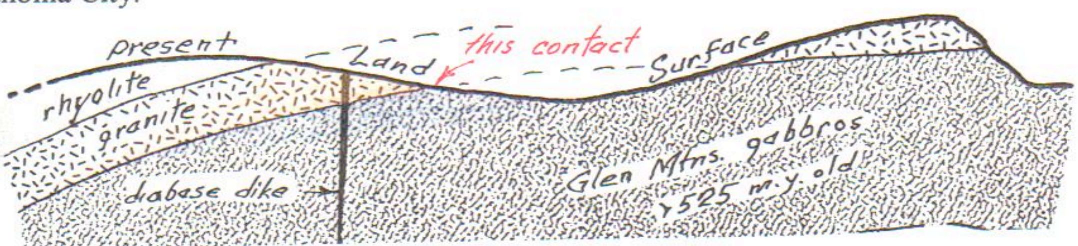
Why are we making this stop?

To see the gabbro of the Glen Mountains Layered Complex at its contact with the overlying Quanah granite.

What can we learn at this stop?

The orange-red Quanah granite is exposed uphill from the road. Look at how it weathers into coarse granite rubble that is then easily eroded. Downhill, in the trees, the dark gray gabbro crops out in large boulder-like masses. The contact between these two very different rocks is concealed and probably lies under the road. Grasses and other sparse vegetation grow on the granite whereas the gabbro weathers into a richer soil that supports trees and bushes.

The gabbro is the oldest igneous rock we will see today. It underlies the granites and rhyolites throughout the Wichita mountains. Close inspection of the gabbro may show small needle-like crystals (inclusions) of the iron-rich mineral *magnetite* that may deflect a magnet (compass). The principle mineral in the gabbro is *Labradorite*, a dark blue-black mineral that shows a rich play of colors when polished. An example of polished labradorite can be seen in the walls of the telephone company building at the corner of Dean McGee and Broadway streets in Oklahoma City.



Diagrammatic Cross Section of Stop 8

Gabbro from the Glen Mountains Layered Complex

Stop 9 – Meers Quartzite

This is a dangerous stop! Be very careful getting in and out of cars and crossing the road. We do not recommend this stop for children.

Why are we making this stop?

View an exposure of the Meers Quartzite, a metamorphic rock.

What can we learn at this stop?

This is a good exposure of the rare and enigmatic Meers Quartzite, a metamorphosed quartz sandstone. Its age is unknown, but pieces of it have been found included in the Glen Mountains gabbro so it is older than the gabbro and is the oldest rock we will see today. Its age, source and relationship to the other rocks is a mystery … we are visiting the "twilight zone."

Quartzite is a metamorphic rock that was once a quartz sandstone that has been altered by heat, pressure, and solutions into a rock so hard that it fractures *through* quartz grains when broken. The Meers Quartzite contains the minerals chlorite, mica, sillimanite, and other interesting metamorphic minerals that indicate the rock has been subjected to very high heat and pressures. It weathers into hard, angular, blocky pieces.

When we leave this stop and proceed north we will turn at the renowned Meers store, home of the "Meersburger," and a defunct seismic station that was used to monitor seismic activity on faults in and around the Wichita Mountains. The original mining town of Meers was about a quarter of a mile south of here, on Medicine Creek.

Close up of Meers Quartzite at Stop 9

Stop 10 – Intersection of section line road and highway 58.

Why are we making this stop?

View of the Meers Fault (or a fault "happening!")

What can we learn at this stop?

We are standing on the trace of the **Meers Fault**, the best known surface expression of *recent* faulting in the eastern United States. It can be traced for about 37 miles on the ground (see the topographic map on the next page) and in the subsurface for more that 100 miles. It last moved only 1100 year ago (makes you feel young, doesn't it) and may have caused a magnitude 7 earthquake, then.

Look to the west-northwest and find the notch on the skyline. That is the spot where the fault crosses a hill. The south side is downthrown about eight feet there. In the subsurface to the east of this stop, geologists think the fault may have more than a mile of vertical displacement and several miles of horizontal displacement, something like the well-known San Andres fault in California. The Meers Fault is almost certainly a very old break in the earth's crust that has been rebroken, reused many times over geologic time to relieve stresses in the crust. It effected depositional patterns in rocks of the Pennsylvanian Period, 300 million years ago. The fault can be traced along the surface because it is a narrow zone of crushed rock where the ground surface is several feet lower on the south side of the fault than on the north side (see topographic map – opposite page).

View looking west-northwest alone the strike of the Meers Fault

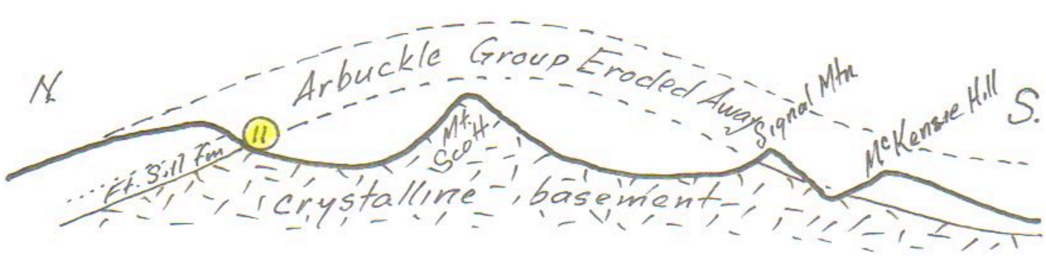
Stop 11 – Roadside exposure of Arbuckle Fort Sill limestone

Why are we making this stop?

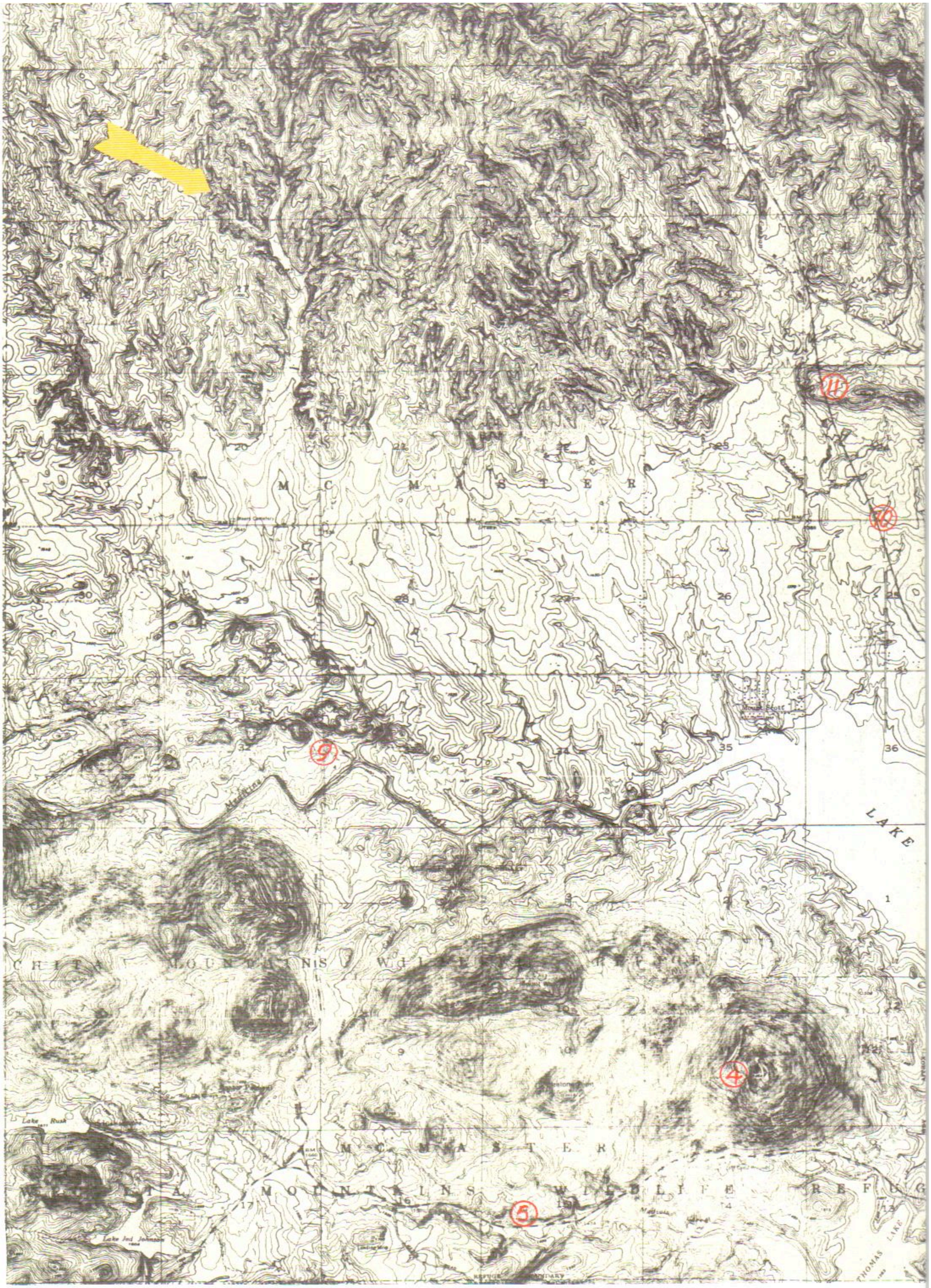
1. View steeply dipping beds in Fort Sill limestone
2. Collect hand specimens of the limestone.
3. Pacify geologists on the trip needing a "sedimentary rock fix."

What can we learn at this stop?

This is a good exposure of the Cambrian age Fort Sill limestone, part of the Arbuckle Group. This formation is in the lower part of a very thick (5000 to 7000 feet) limestone sequence that covered much of the eastern United States 500 million years ago. The type locality of this unit is on McKenzie Hill and Signal Mountain in the Fort Sill Military Reservation where it occurs as remnants of the sedimentary cover that once completely covered the crystalline basement of the Wichita Mountains. The Fort Sill limestone at this stop is dipping steeply to the north on the north side of the mountains.



Photograph and diagrammatic cross section of Stop 11



M C M A S T E R
M C M A S T E R
LAKE
Lake Rush
Lake Jed Johnson
11
10
9
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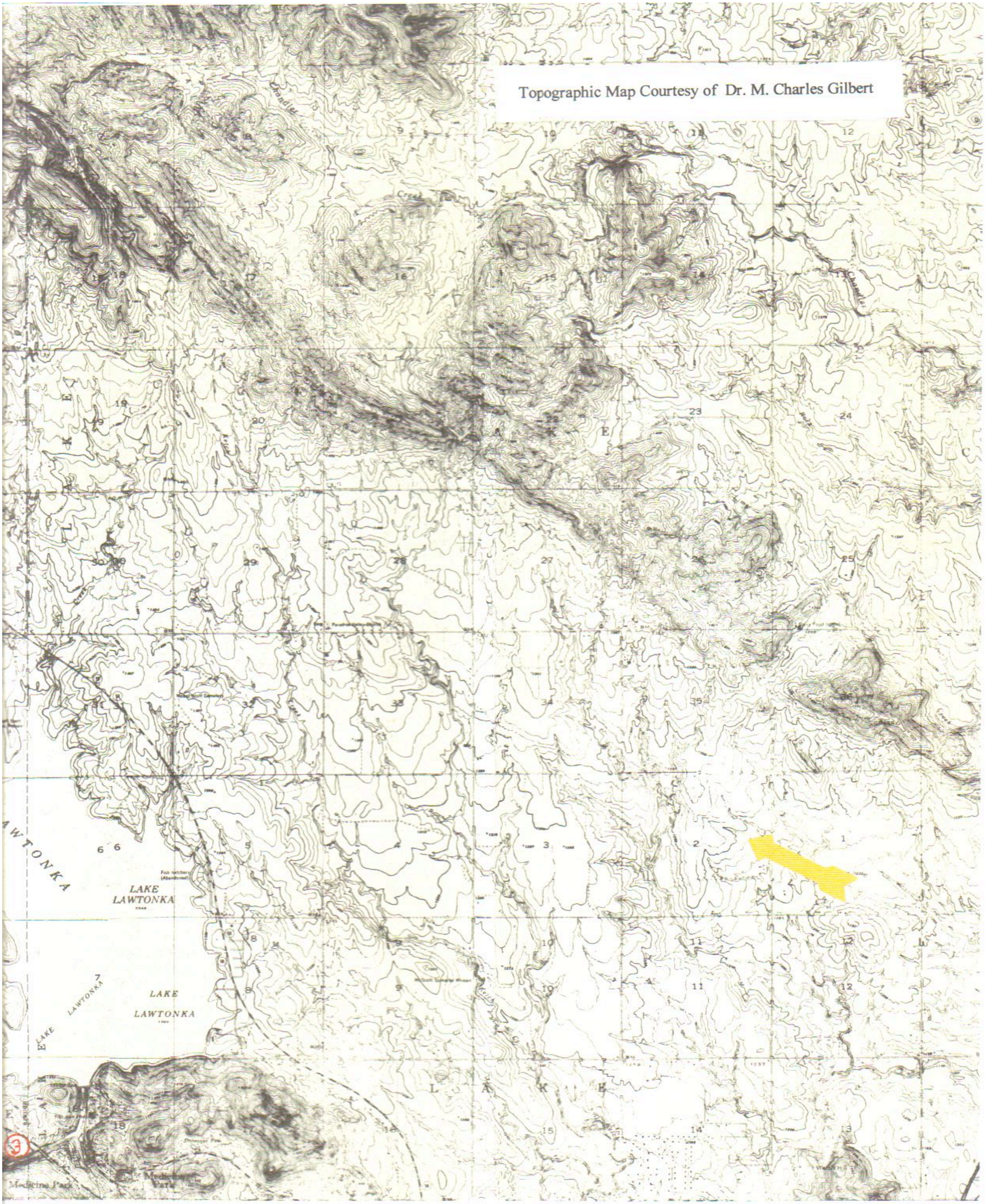

Topographic Map Courtesy of Dr. M. Charles Gilbert
LAKE LAWTONKA
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References

Publications

Gilbert, M. Charles and Donovan, R. Nowell, editors, 1982, Geology of the eastern Wichita Mountains, southwestern Oklahoma, Oklahoma Geological Survey Guidebook 21, 160 p.

Luza, Kenneth V., Madole, Richard F., and Crone, Anthony J., 1987, Investigation of the Meers fault, southwestern Oklahoma, Oklahoma Geological Survey Special Publication 87-1, 75 p.

Jones-Cecil, Meridee, Donovan, R. Nowell, and Bradley, Lee-Ann, 1995, Structural Framework of the Meers Fault and Slick Hills Area, Southwestern Oklahoma, Based on Magnetic Data, in Strucutral Styles in the Southern Midcontinent, 1992 Symposium, Johnson, Kenneth S., editor, Oklahoma Geological Survey Circular 97.

USGS 7 ½ minute Series (Topographic) Maps of Meers, Arbuckle Hill, Ft. Sill, Mount Scott, and Quanah Mountain Quadrangles, $6.00 ea.

Oklahoma generalized geologic time scale, James R Chaplin, 1999, Oklahoma Geological Survey Educational Publication 6, 22X34-in poster

Reading Topographic Maps, James R. Chaplin, 2001, Oklahoma Geological Survey Educational Publication 7, 82 p.

Geological Information Series #1 & #2 cost 25 cents each, #6 cost $1.00 (see list of Available Publications, Oklahoma Geological Survey for details)

Note: The Maps and Publications above can be purchased at the Oklahoma Geological Survey Publications Office located at:

2020 Industiral Blvd, Norman, OK (one mile north of Robinson Street and one block east of old highway 77 in north Norman) Telephone 405-360-2886.

Selected Earth Science resources on the Web:

Oklahoma City Geological Society – http://www.ccgs.org/default.asp
Oklahoma Geological Survey – http://www.ogs.ou.edu/
U.S. Geological Survey Home Page – http://www.usgs.gov
U.S.G.S. Water Resources of Oklahoma – http://csdokokl.cr.usgs.gov/
Earth Science Website List - http://www.rockdetective.org.website_resources.html