

The Arbuckle Mountains as a Laboratory for Geological Education*

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Abstract

When a recent graduate of an engineering college signs on with Halliburton Energy Services in Duncan, Oklahoma, he or she begins their career with a 6-month training program. For more than two decades now, that training program begins with a day of geological instruction followed by a day-long field experience in the Arbuckle Mountains. The authors have built that field experience around outcrop exposures of formations that, at depth, are either source rocks or reservoirs, or both, such as the Oil Creek Sandstone and the Woodford Shale. We look at structure, study stratigraphy, visit both dead quarries and working quarries, and examine rocks of every age from Precambrian to Permian. The Arbuckle Mountains of South-Central Oklahoma are the only place between Laredo, Texas, and Duluth, Minnesota (along I-35) where rocks of the entire Paleozoic can be examined on the surface. Along the way we discuss geological age, section-township-range, stratigraphic columns, cross sections, and the “three F’s”: folding, faulting, and fried pies. Come see what fun we have had and share in our varied experiences in the last 20 years!

Reference Cited

Ham, W.E., M.E. McKinley, et al., 1954, Geologic map and sections of the Arbuckle Mountains, Oklahoma: Oklahoma Geological Survey, Map GM 31 (revised by K.S. Johnson, 1990).

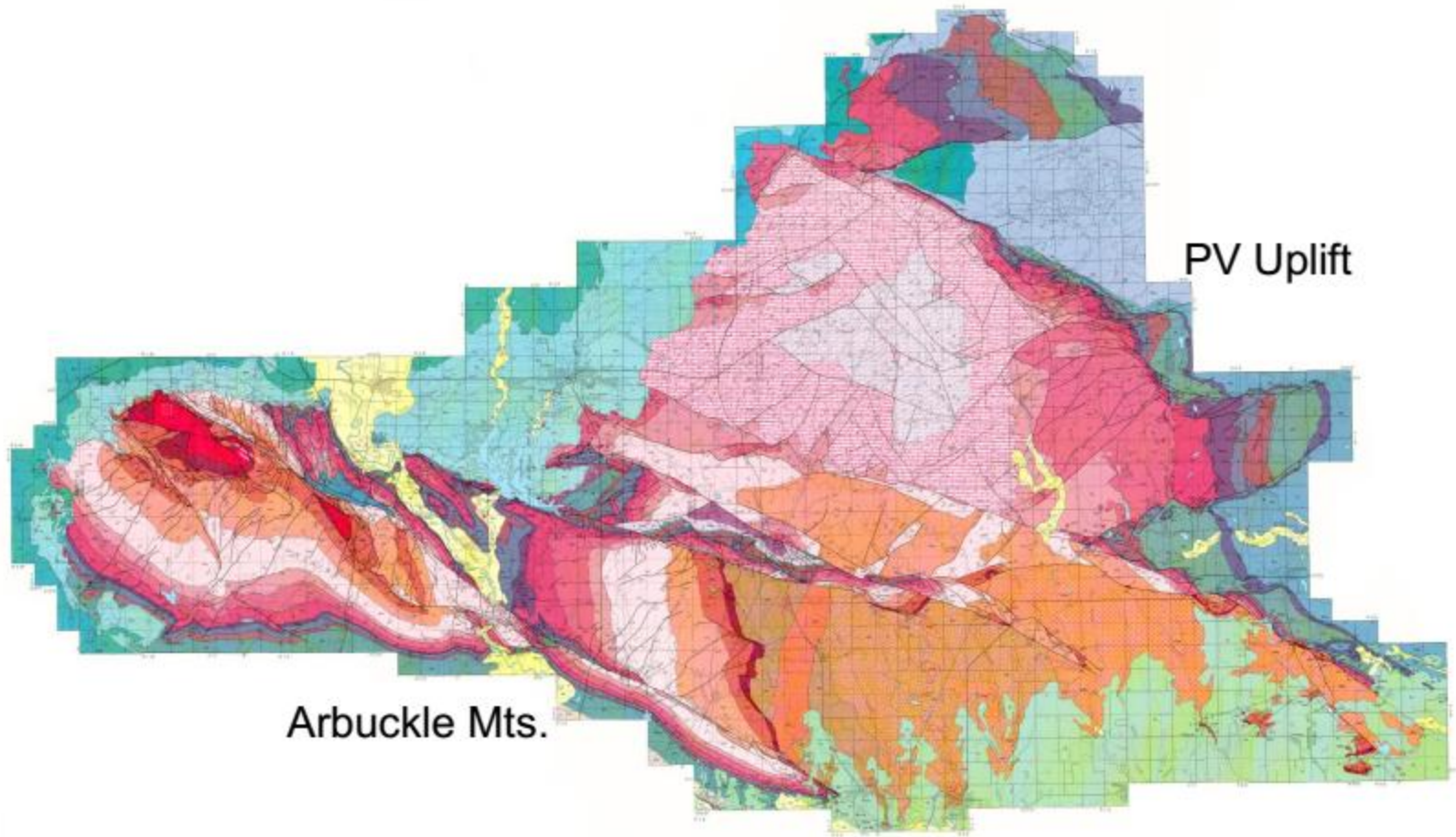


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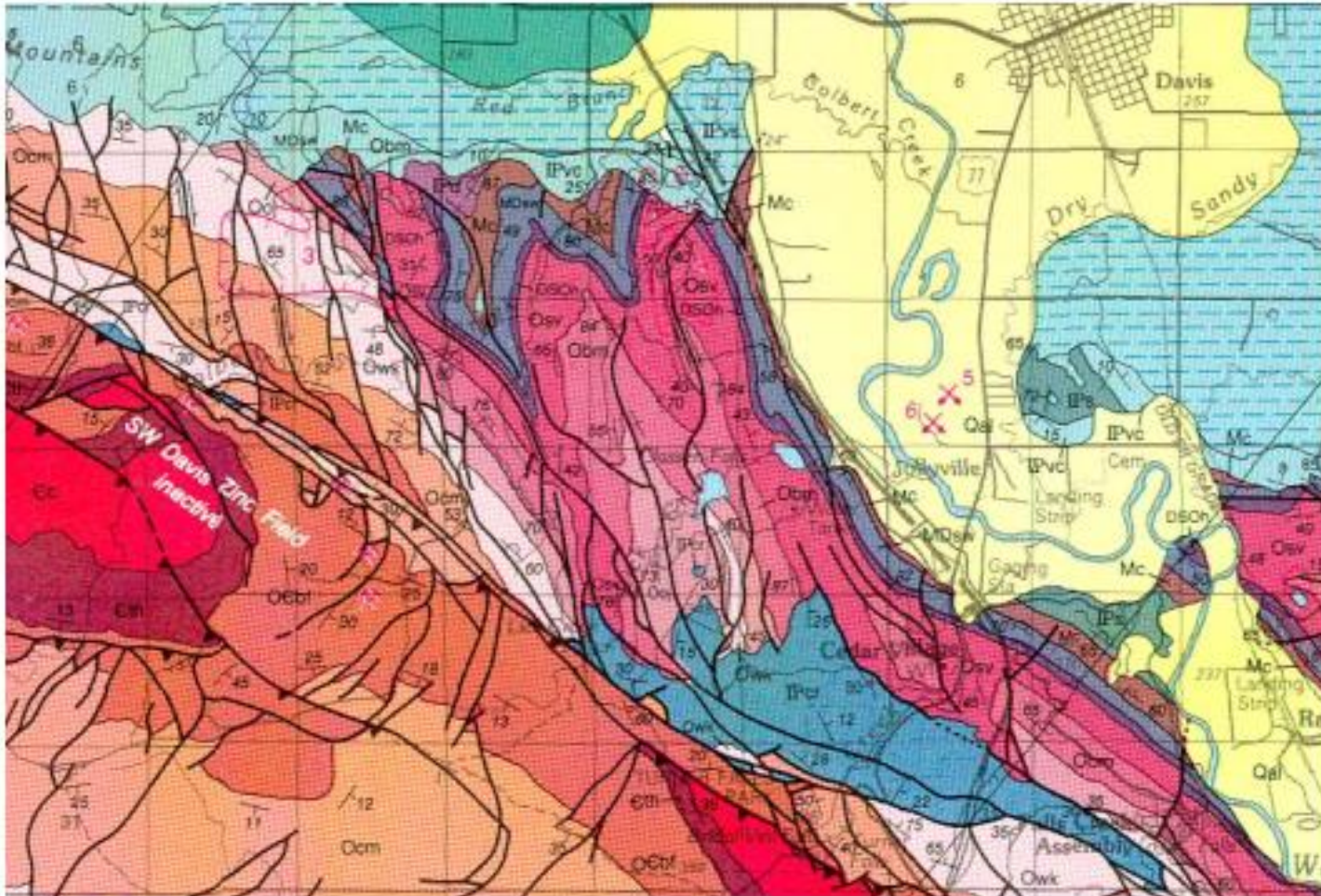
THE ARBUCKLE MOUNTAINS AS A LABORATORY TO TEACH FIELD GEOLOGY
ARDMORE GEOLOGICAL SOCIETY SEPTEMBER 14, 2017
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When a recent graduate of an engineering college signs on with Halliburton Energy Services in Duncan, OK, he or she begins their career with a 6-month training program. For more than two decades now, that training program begins with a day of geological instruction followed by a day-long field experience in the Arbuckle Mountains. The authors have built that field experience around outcrop exposures of formations that, at depth, are either source rocks or reservoirs, or both, such as the Oil Creek and the Woodford. We look at structure, study stratigraphy, visit both dead quarries and working quarries, and examine rocks of every age from Cambrian to Permian. The Arbuckle Mountains of South-Central Oklahoma are the only place between Laredo, TX, and Duluth, MN (along I-35) where rocks of the entire Paleozoic can be examined. Along the way we discuss geological age, section-township-range, stratigraphic columns, and the "three F's": folding, faulting, and fried pies. Come see what fun we've had and share in our varied experiences in the last 25 years!

In South-central Oklahoma, the Pauls Valley Uplift lies just northeast of the true Arbuckle Mountains



T 1 S - R 1 E & W/2 R 2 E
Geology of the Arbuckle Mountains
Map GM 31
Oklahoma Geological Survey



Arbuckle Mountains offer complex geology

Geologic Correlation Chart

SYSTEM	MILLIONS OF YRS.		GROUP	FORMATION	MEMBER	
	DURATION	AGO				
Quaternary	0.01	2.5	Recent		Alluvium	Cenozoic
			Pleistocene		Not present	
Tertiary	4.5	65	Pliocene		Not present	
	19		Miocene		Not present	
	12		Oligocene		Not present	
	15		Eocene		Not present	
	11		Paleocene		Not present	
Cretaceous	71	136		Goodland Ls	Present in SE OK.	Mesozoic
Jurassic	54	190			Not present	
Triassic	35	225			Not present	
Permian	55	280				
Pennsylvanian	45	325	Pontotoc	Vanoss	Collings Ranch Cgl	Paleozoic
			Cisco			
			Hoxbar (2500')	Hoxbar	Zuckerman Ls	
					Daube Ls	
					Anadarche Ls	
					Crinerville Ls	
					Confederate Ls	
			Deese (5700')	Deese	Natsy Ls	
					Williams Ls	
					Rocky Point Cgl	
					Arnold Ls	
					Devils Kitchen Cgl	
			Dornick Hills (5885')	Big Branch	Pumpkin Creek Ls	
				Lake Murray	Frensley Ls	
					Lester Ls	
					Bostwick Cgl	
				Golf Course	Otterville Ls	
					Joliff Ls	
					Primrose Ss	
			Springer (5000')		Lake Ardmore Ss	
					Overbrook Ss	
					Rod Club Ss	

Stratigraphic column for southern Oklahoma. Continued on next slide

Correlation Chart Continued

SYSTEM	MILLIONS OF YRS. DURATION		AGO	GROUP	FORMATION	Paleozoic (cont.)
Mississippian	20	345		Caney Sh (425')		
				Sycamore Ls (370')		
				Woodford Sh & Chert (290')		
Devonian	50	395	Hunton (250')	Pine Top Chert		
				Frisco Ls		
				Bois D'Arc Ls		
Haragan Marl						
Silurian	35	430		Henryhouse Marl		
				Chimney Hill Ls		
Ordovician	70	500	Viola (684')	Sylvan Sh (305')		
				Fernvale Ls		
				Trenton Ls		
			Simpson (2330')	Bromide Ls & Sh		
				Tulip Creek/3rd Bromide Ss		
				McLish Ls & Sh		
				Basal McLish Ss		
				Oil Creek Ls & Sh		
				Basal Oil Creek Ss		
				Joins Ls & Sh		
			Arbuckle (6722')	West Spring Creek Ls		
				Kinblade Ls		
				Cool Creek Ls		
				McKenzie Hill Ls		
				Butterfly Dolomite		
				Signal Mountain Ls		
Royer Dolomite						
Fort Sill Ls						
Cambrian	70	570		Timbered Hills	Honey Creek Ls (155')	
					Reagan Ss (105')	
					Colbert Rhyolite (Porphyry)	
Precambrian	3930	4500		Tishomingo Granite		
				Troy Granite		
Total Thickness				30,721'		

Stop 1. Vendome Well, Arbuckle-Simpson Aquifer, Sulphur, OK

Vanoss Conglomerate, Pennsylvanian

Brief aqueous geochemistry

Artesian wells





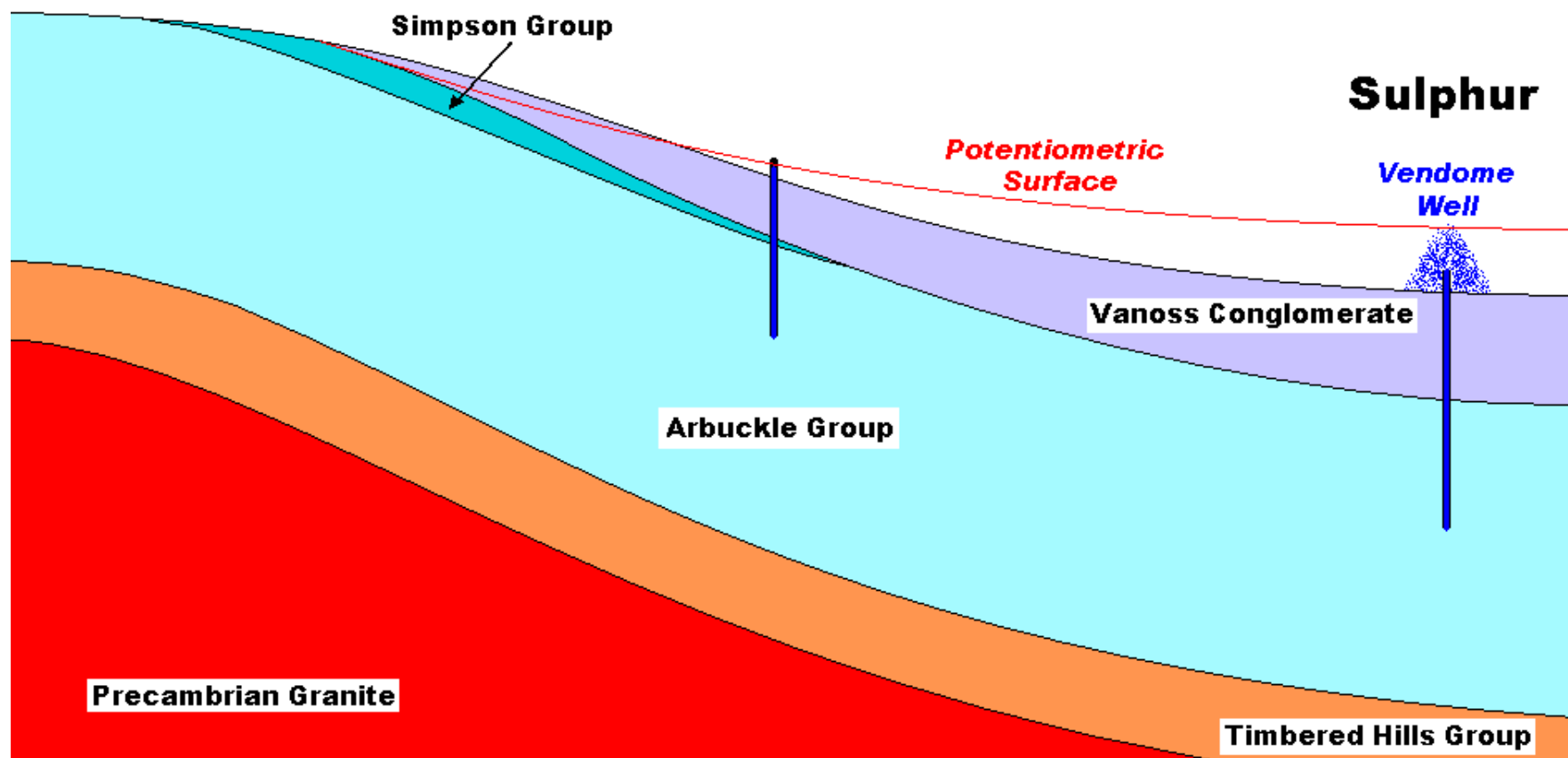
Limestone Conglomerate facies of the Vanoss Formation, Pennsylvanian

EAST

WEST

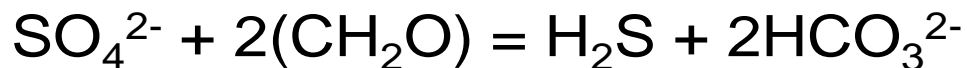
Hunton Anticline

Aquifer Recharge Area



The Origin of Hydrogen Sulfide at Vendome Well

Reaction:



Sulfate + Organic Matter + Sulfate-Reducing Bacteria



Hydrogen Sulfide + Bicarbonate

Geochemistry of the Vendome Well

Sampled November 5, 2002

Calcium	83 mg/L	Carbonate	2 mg/L
Magnesium	36.4 mg/L	Bicarbonate	346 mg/L
Sodium	330 mg/L	Sulfate	33.2 mg/L
Potassium	9.23 mg/L	Chloride	593 mg/L
Dissolved solids	1310 mg/L		
Methane	40 µg/L		
Carbon Dioxide	25 mg/L		
Nitrogen (gas)	25.9 mg/L		
Dichlorodifluoromethane	0.0 pg/kg		
1,1,2-Trichloro-1,2,2-trifluoroethane (pg/kg)	0.0 pg/kg		

Stop #2. Ordovician Basal Oil Creek

Introduction to hand lens and geologic hammer

Sorting, grain size, porosity, permeability

Light hydrocarbons have escaped leaving heavy bitumen

When mixed with Viola LS containing bitumen, a “natural asphalt” is made

E-W trends in this formation

15 miles E of here, US Silica mines Ooc for its purity

15 miles W of here, the formation produces oil.



They are each to collect some of this. Some ask if it will burn if ignited.
My answer: "Try it!"



Vanoss Conglomerate visible in upper far-right of picture





Grains of Oil Creek weathering free from bitumen

The Oil Creek is about as close to “oil” as the field trip gets.

For those of you in the audience that have oil flowing in your veins, remember:

My formula for success:

Rise Early, Work Hard, Strike Oil—Jean Paul Getty

And Golda Meir said:

Let me tell you something we Israelis have against Moses.
He took us 40 years through the desert in order to bring us
to the one spot in the Middle East that has no oil.

Stop 3. Goddard Youth Camp and Museum, Sulphur, OK

Museum: Quartz, Rose Rock, Trilobites, and “Fran”

Styrofoam diorama of Cross-Section: East Davis Field

In the theater we “get acquainted” and Bob Allen displays some of his Cross-Sections.





Bob Allen congratulating Bernardo Montell on his U.S. Citizenship

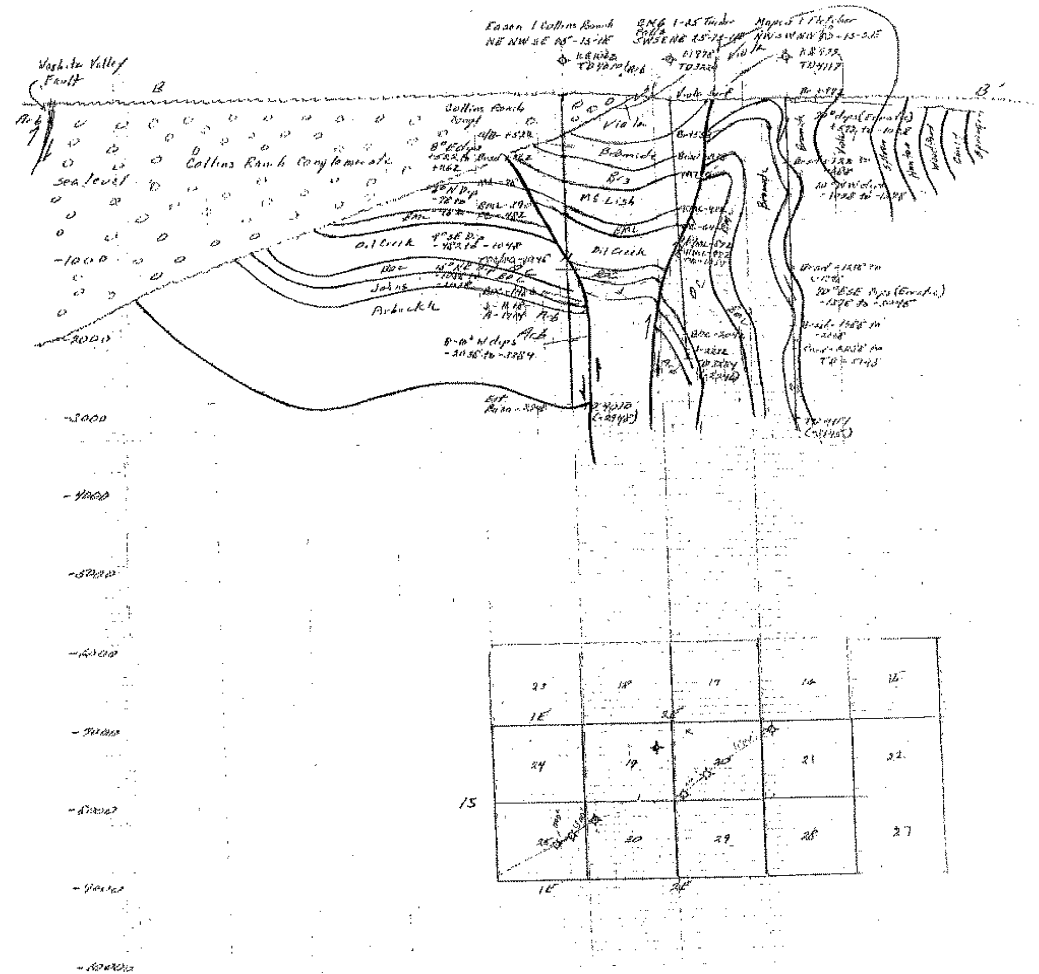


Bob Allen lectures on the finer points of drawing a cross-section by hand

S. 20, 1S, 2E

WV fault and the Collings Ranch Conglomerate

In NW part of slide





Focal point of Goddard Museum: High-density foam cast of
Acrocanthosaurus atokensis.
Early Cretaceous. Found Near Atoka, OK.
Her name is Fran



Diorama is made of styrofoam with embedded fossils.



Bob Allen gives Bernardo Montell of Halliburton details of diorama

Our 4th and last stop before lunch is the Woodford Fm. We visit the Woodford in one of two places. Depending upon weather, hunting season, permission to get on private property, and sometimes other factors, we visit the “Hunton Quarry Anticline” just west of the Goddard Museum, or go to a good exposure of the Woodford near Exit 51 off of I-35.

These pictures will be from the highway stop near Exit 51. They show the Woodford uplifted such that we are viewing the bedding planes. We usually take a Geiger counter with us to show increased (above background) radioactivity, and look for (and sometimes find) phosphate concretions, typical of the Formation.

The Woodford outcrops are common in the Arbuckle Mtns, but these are two of the best locations to examine the shale.



We have had lunch, and its off to U.S. 77 south of Davis

Stop 5: West Spring Creek Dolomite / Tombstone Topography. U.S. 77

Ardmore Geological Society Signs along U.S. 77

Differential erosion of limestone/dolomite beds

Stromatolites

Strike / dip

ARBUCKLE-WEST SPRING CREEK LIME

TOMBSTONE TOPOGRAPHY-FOLLOW THESE THIN BEDS TO THE EAST & SEE THE STRIKE OF THE BED. THE DIP (TILT) IS TO THE SOUTH AT ABOUT 60 DEGREES. THE BROWN ZONE, NAMED FOR THE MYRTLE BROWN LEASE IN THE HEALDTON ARBUCKLE FIELD, IS THE LOWER, 500 FEET OF THIS UNIT. THIS IS A MAJOR OIL PRODUCING INTERVAL IN SOUTHERN OKLAHOMA. THESE ROCKS ARE FOUND AT A DEPTH OF BELOW 22,000 FEET AT ARDMORE.



ARDMORE GEOLOGICAL SOCIETY

Signs soon to be replaced with ones that are newer and more easily understood by the lay traveler along U.S. 77.

15 miles south of this point, this formation is 22,000 feet below Ardmore, OK.



West Spring Creek Fm contains stromatolites. South flank Arbuckle Mtns
Looking west across U.S. 77.



Weathering stromatolite, West Spring Creek Fm



Stromatolites in Ordovician-age West Spring Creek Dolomite



Tombstone
Topography
Murray County
U.S. 77
Arbuckle Mtns



They always like to pose for a group picture

Stop 6: Turner Falls Overlook

Honey Creek

“Growing “ Waterfall

Igneous Cambrian-age Colbert Rhyolite

More Stromatolites

Ordovician Cool Creek Fm (On geologic map it is identified as Ocm,
Ordovician Cool Creek-McKenzie Hills without differentiation.)



Stromatolites in walkway from parking lot to observation deck

You should like stromatolites: fossilized blue-green algae colonies partly responsible for the presence of oxygen in early atmospheres.



Close up of mottled pattern of stromatolite in walkway

Spring-fed
Honey Creek,
rich in dissolved
Ca and Mg ions,
precipitates a
patina of
Travertine over
Ordovician
Cool-creek LS.

Except in times
of flood, this
results in a
“growing”
waterfall.

Owned by the
City of Davis.



To the south of
this waterfall is
a mountain of
Cambrian-age
rhyolite called
“Signal
Mountain”.
You can
recognize it by
all the
transmission
towers on the
top.

Signal Mountain. Timbered hill of Colbert Rhyolite (Cambrian)



Notice the alternate form of energy on the horizon.

Stop 7. Washita Valley Fault Plane

Pennsylvanian Collings Ranch Conglomerate

Displacement of Thousands of Feet

Safe place to stop. Hairpin curve below TF Overlook

Second conglomerate of the day.



Collings Ranch Conglomerate



Faulting resulting in Ordovician/Pennsylvanian contact. Hairpin Curve U.S. 77 near Turner Falls



More contact of Ordovician Cool Creek and Pennsylvanian Collings Ranch



Afternoon Break: Exit 51 (I-35) Fried Pie Shop

Stop 8. “Fried Pie Outcrop” (so named by Joel Alberts)

From south to north (or oldest to youngest):

From the Viola Group

Sylvan Sh, Upper Ordovician, contains selenite & pyrite.

And from the Hunton Group:

Chimney Hill, and Henryhouse Fms (Silurian), contains oolites.

Haragan Marlstone Fm (Devonian)

The rest of the Hunton Group is missing from this site.



Sylvan shale (Viola Group, Upper Ordovician)



Steeply dipping Sylvan Shale & Hunton Group limestones/marlstones
North flank of Arbuckle Mountains near Exit 51 (I-35)

Stop 9: Martin-Marietta's Davis Quarry

Working Quarry. Aggregate

West Spring Creek (Ordovician) Limestone

Lower bench is about 460 feet below surface

Reservoir Engineers like this place

Much calcite and pyrite to be found here









Machine used to drill shot holes





Shot holes drilled for later blasting.



Impressive Quarry (and Formation)

In Memory of Marlan W. Downey



Marlan W. Downey introducing daughter Julie Garvin, President of Roxanna Oil, in Ardmore, OK, March, 2017

Bob Allen and Bob Neman wish to thank:

Our wives, Fran Graffham Allen and Jo Neman

Robert Smartt, Ardmore Photographer

Tracy Yarbrough, Quintin-Little Co., Ardmore

Mr. Bernardo Montell, Lead Instructor, Halliburton

Mr. Eddie Torres, Plant Mgr, Martin-Marietta Quarry

Mike Allison, President, Ardmore Geological Society

Clayton Edgar, Director, Goddard Youth Camp

Mr. & Mrs. Pruitt in Sulphur for their Oil Creek Property

And the hundreds of Halliburton Engineers who
have taken our trips over the last 25 years.

Bob Allen and Bob Neman thank you for your attendance

