Cambrian Early Rift-Fill Sediments in the Southern Oklahoma Aulacogen: A "Granite Wash" Analog in the Subsurface of the Arbuckle Mountains Area*

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Abstract

Surface exposures of volcanic rocks from the early rift stage of the Southern Oklahoma Aulacogen are limited to rhyolite outcrops in the Arbuckle Mountains and Wichita Mountains of south-central and southwestern Oklahoma. Early rift-fill sediments interbedded with volcanic units are integral to failed-arm/aulacogen rifting models. Although these sequences have been imaged on deep-seismic experiments in southwestern Oklahoma, there are no known outcrops of early rift-fill sedimentary rocks in the region. The Washita Valley Fault in the western Arbuckle Mountains thrusts rift-related volcanic rocks of the aulacogen over younger oil-bearing sediments. Drilling along a 25-mile section of the overthrust has resulted in numerous penetrations of the igneous section up to a maximum drilled thickness of 16,000 feet, encountering two or more intervals of early rift-fill sedimentary rocks contained within the volcanic sequence. These intervals are interpreted to be a complex of fluvially generated fan deltas emerging from the craton into the rapidly subsiding aulacogen. The maximum drilled thickness of a complete sequence is 1,417 feet. Lithologies present include sandstone, arkose, limestone, dolomite, dolomitic conglomerate, volcaniclastics, and water-lain chloritized tuffs. Interbedded extrusive and intrusive rhyolites, as well as overlying rhyolites and basalts, constrain the intervals as syn-volcanic. The complex depositional sequence indicates multiple source areas within the volcanic terrain and the granitic craton. Lithologies indicate facies representative of volcaniclastic and eolian deposition, as well as thick fluvial and marine arkosic deposits.

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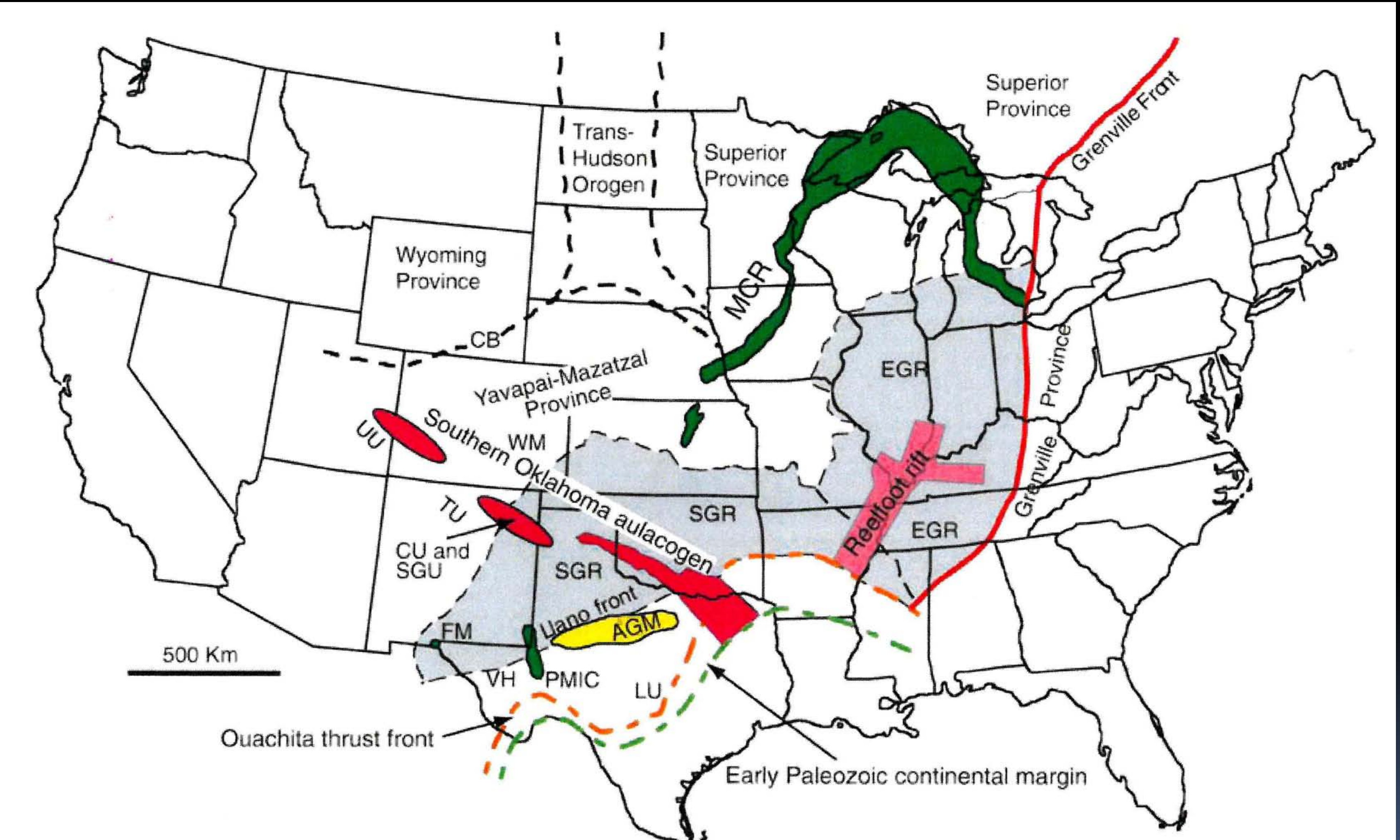
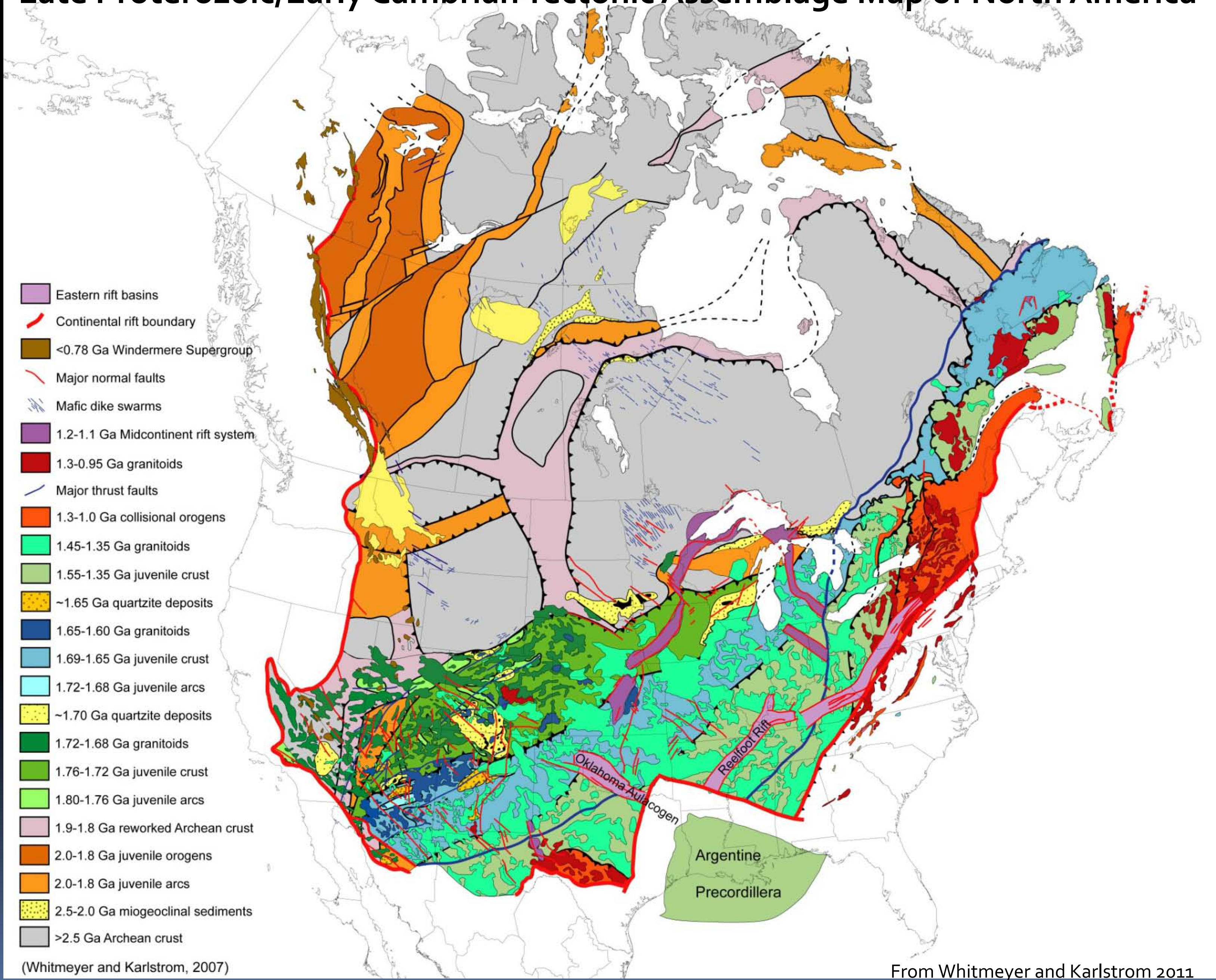
Bob Puckett, Oklahoma City

Southern Oklahoma Aulacogen



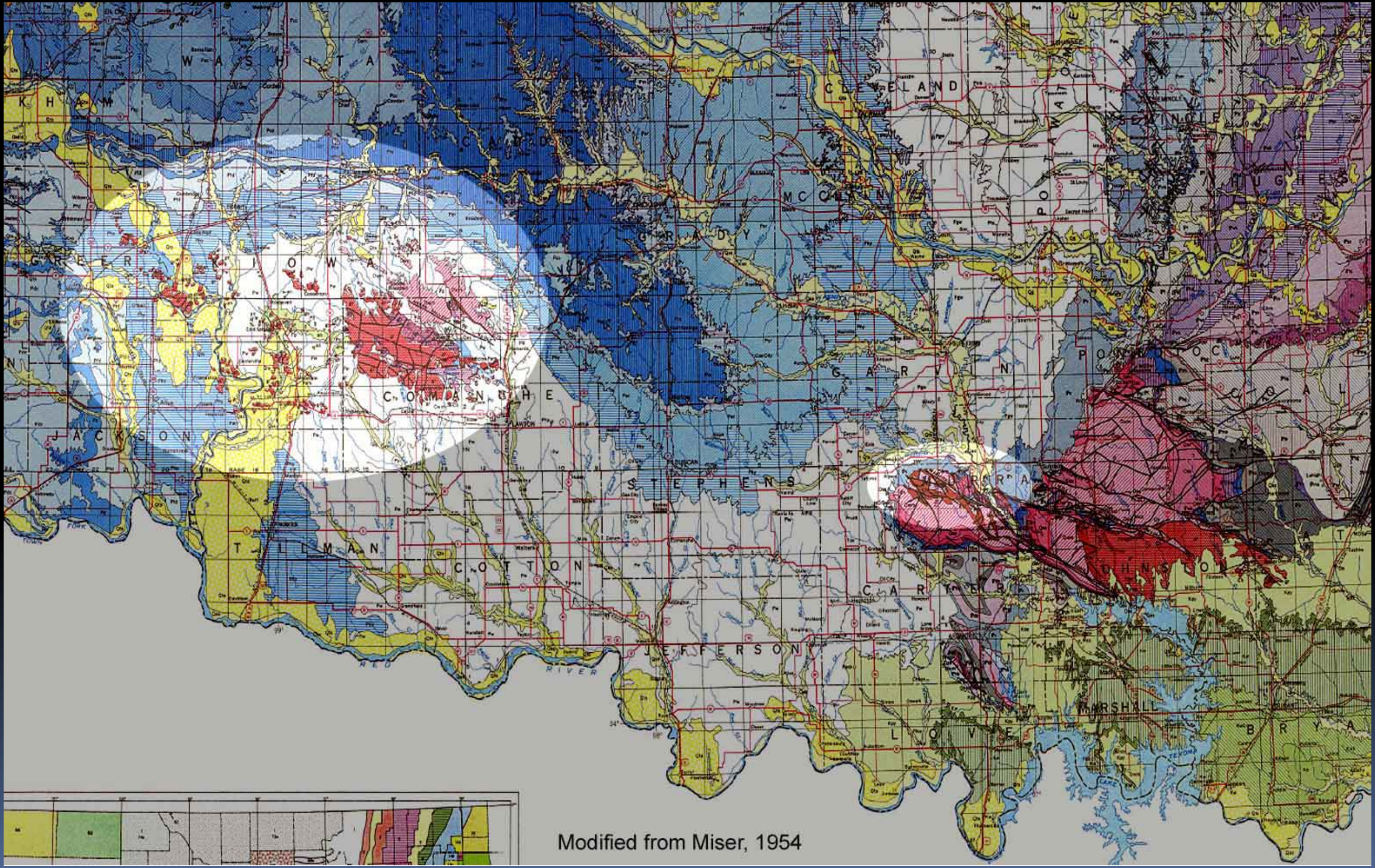
From Keller and Stephenson, 2007

Late Proterozoic/Early Cambrian Tectonic Assemblage Map of North America

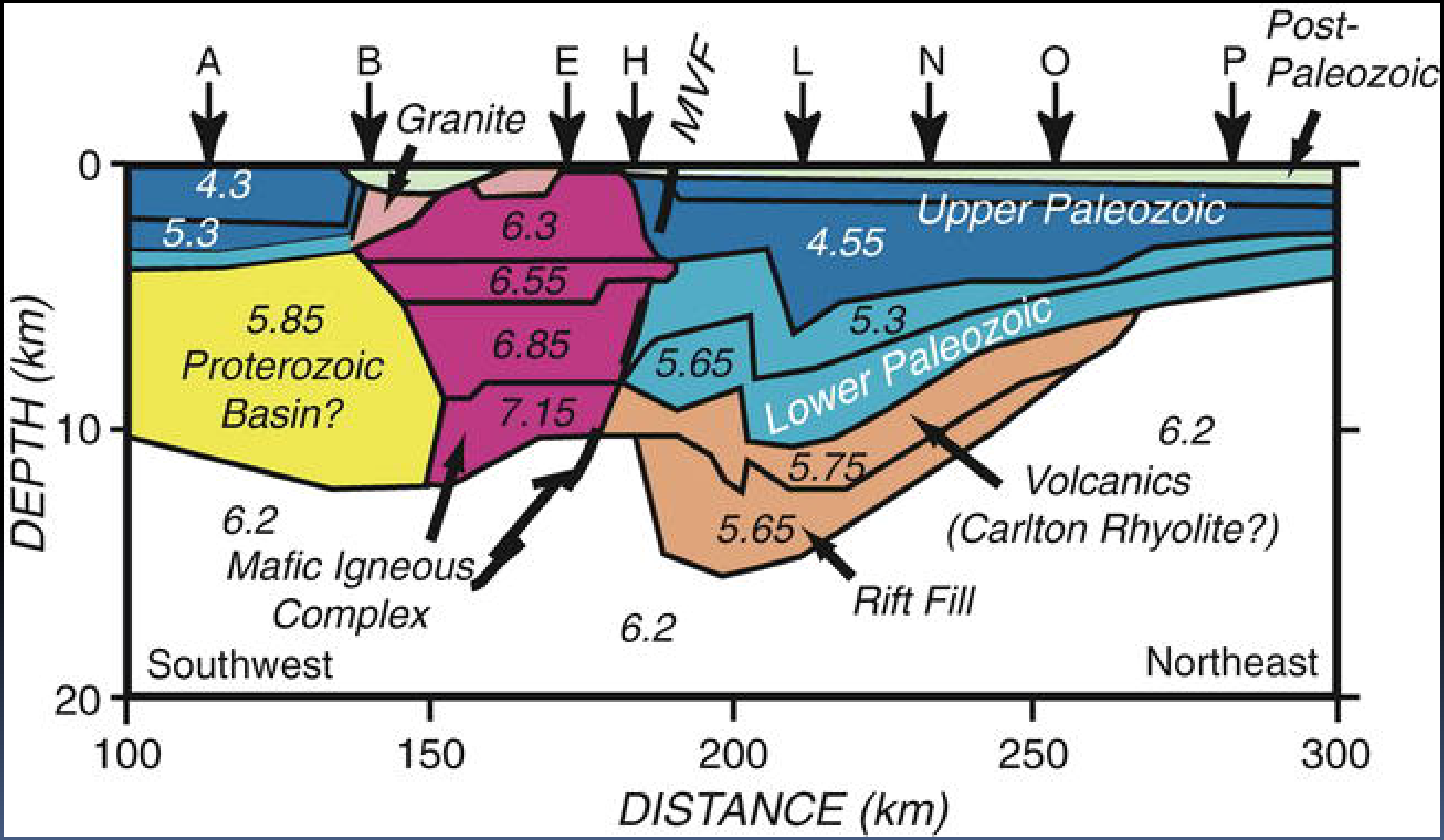


From Whitmeyer and Karlstrom 2011

Cambrian Igneous Rock Outcrops – Southern Oklahoma

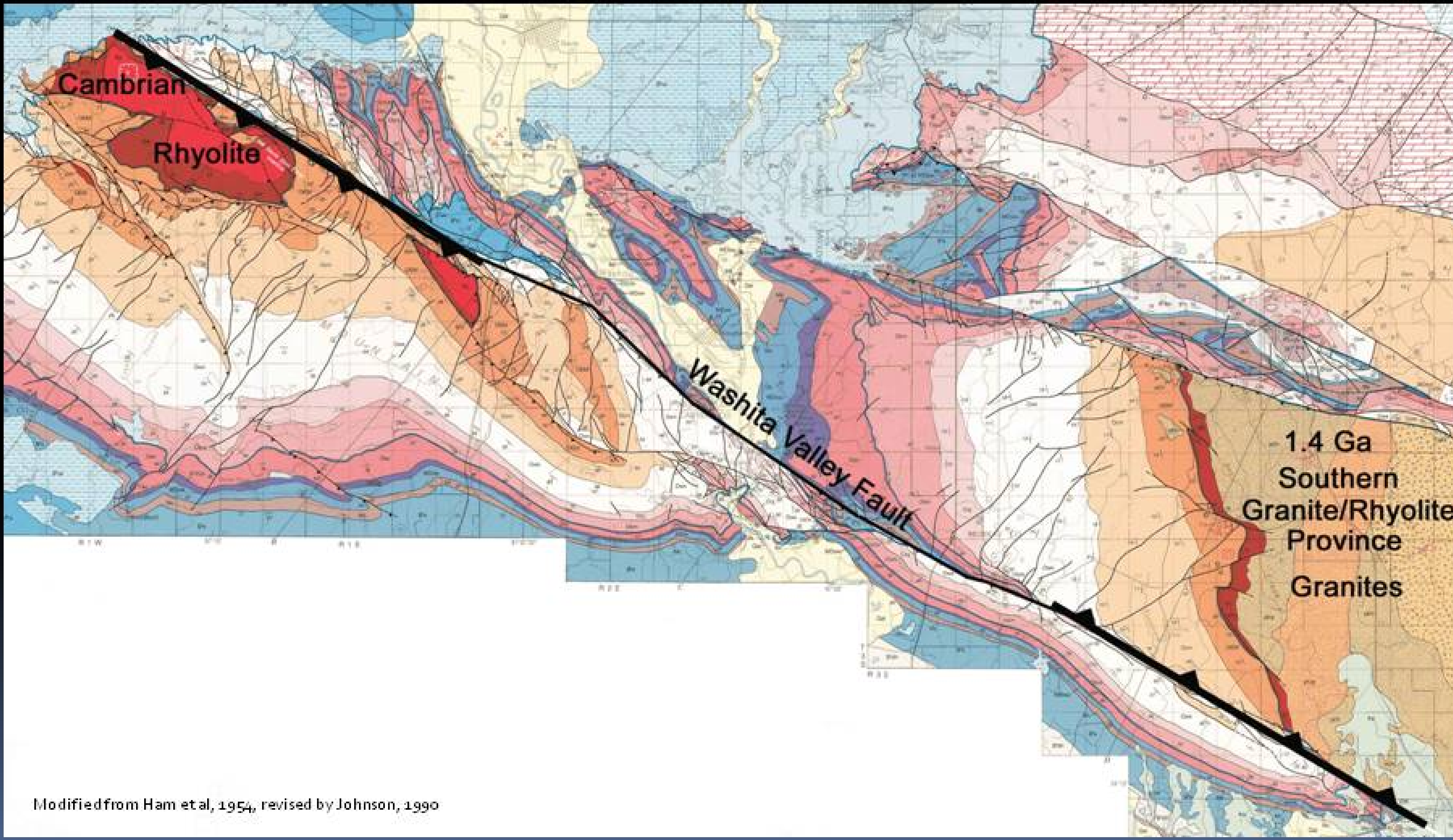


Seismic velocity model derived from the University of Texas, Dallas, and University of Texas, El Paso, seismic experiment.

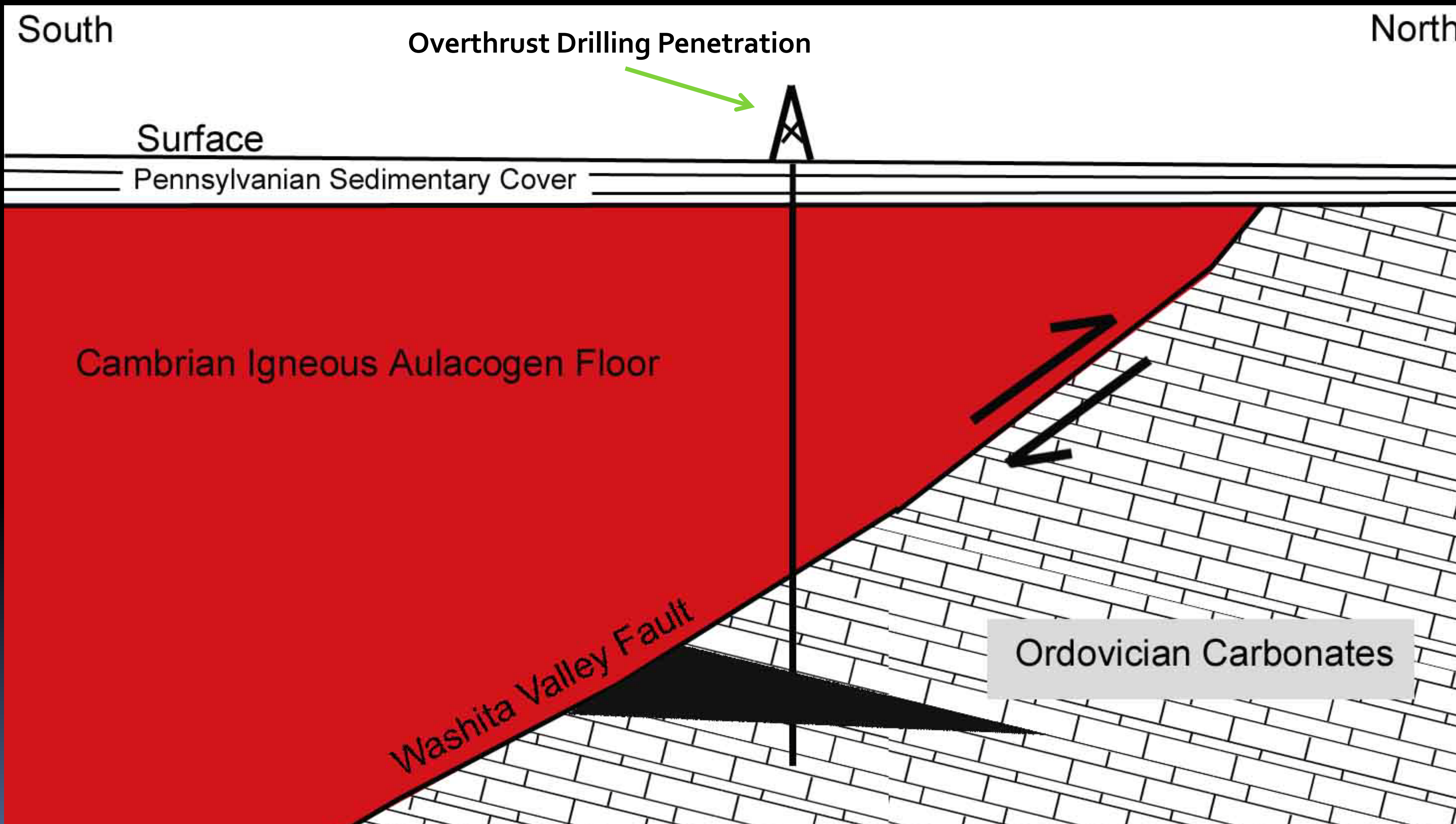


From Keller and Stephenson 2007

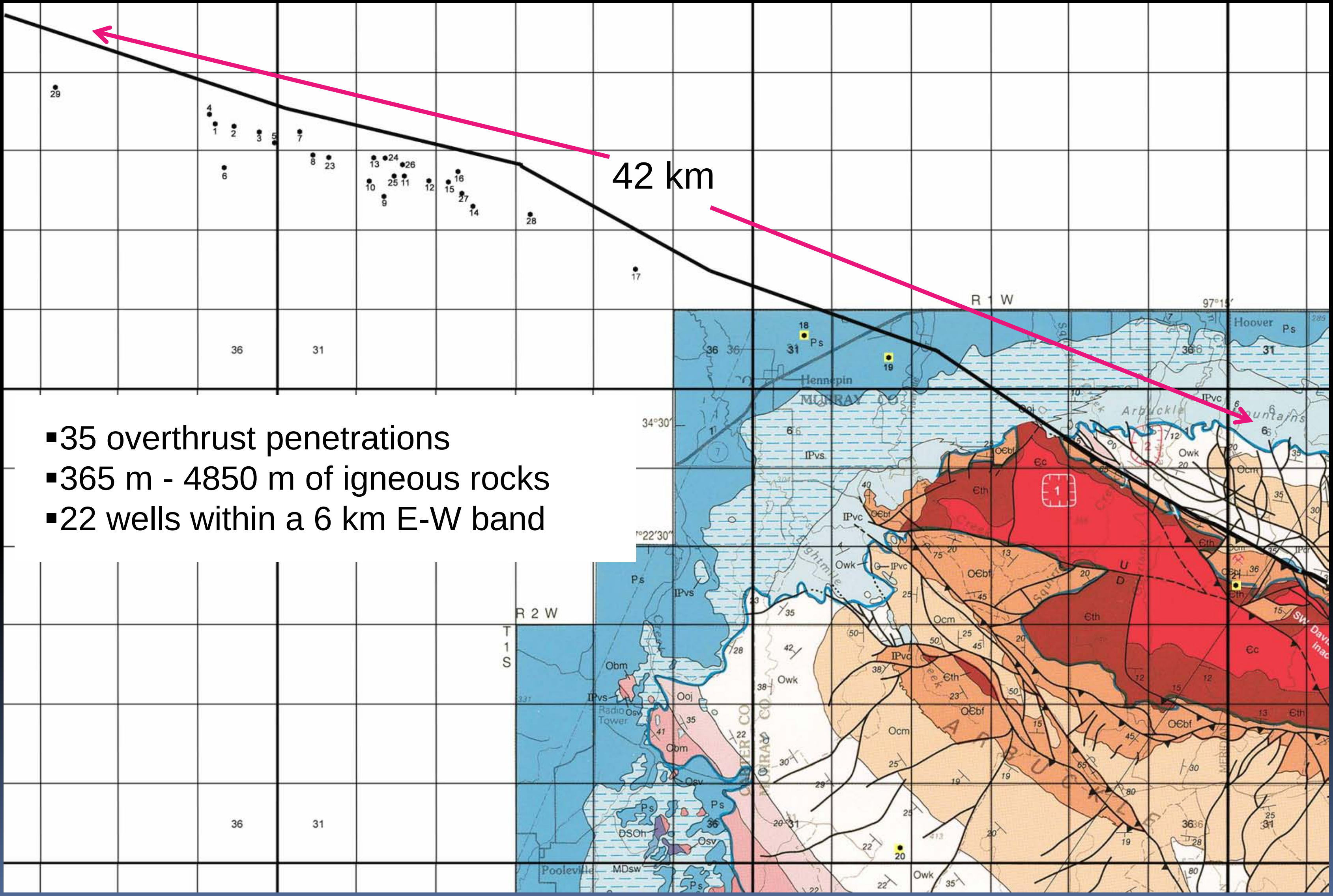
Washita Valley Fault



Western Arbuckle Mountains Schematic Cross Section



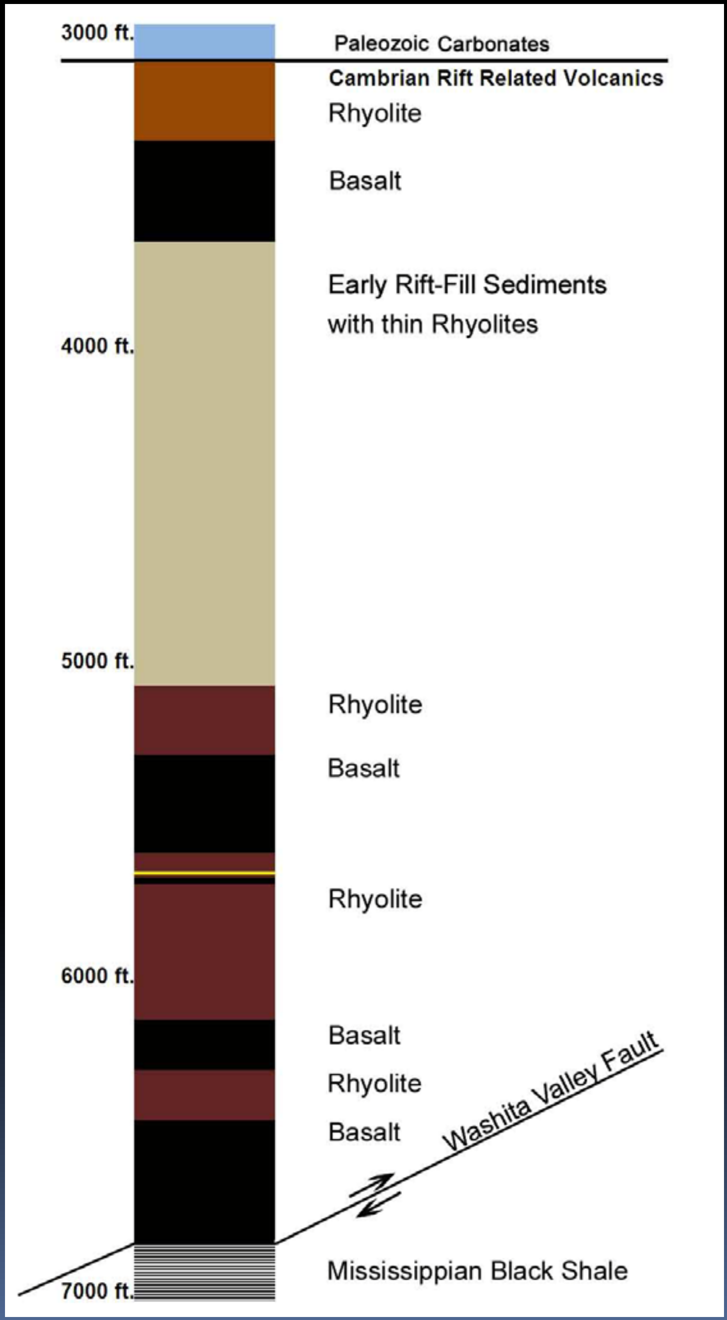
Overthrust Penetrations – Western Arbuckles



- 35 overthrust penetrations
- 365 m - 4850 m of igneous rocks
- 22 wells within a 6 km E-W band

Stratigraphic Section

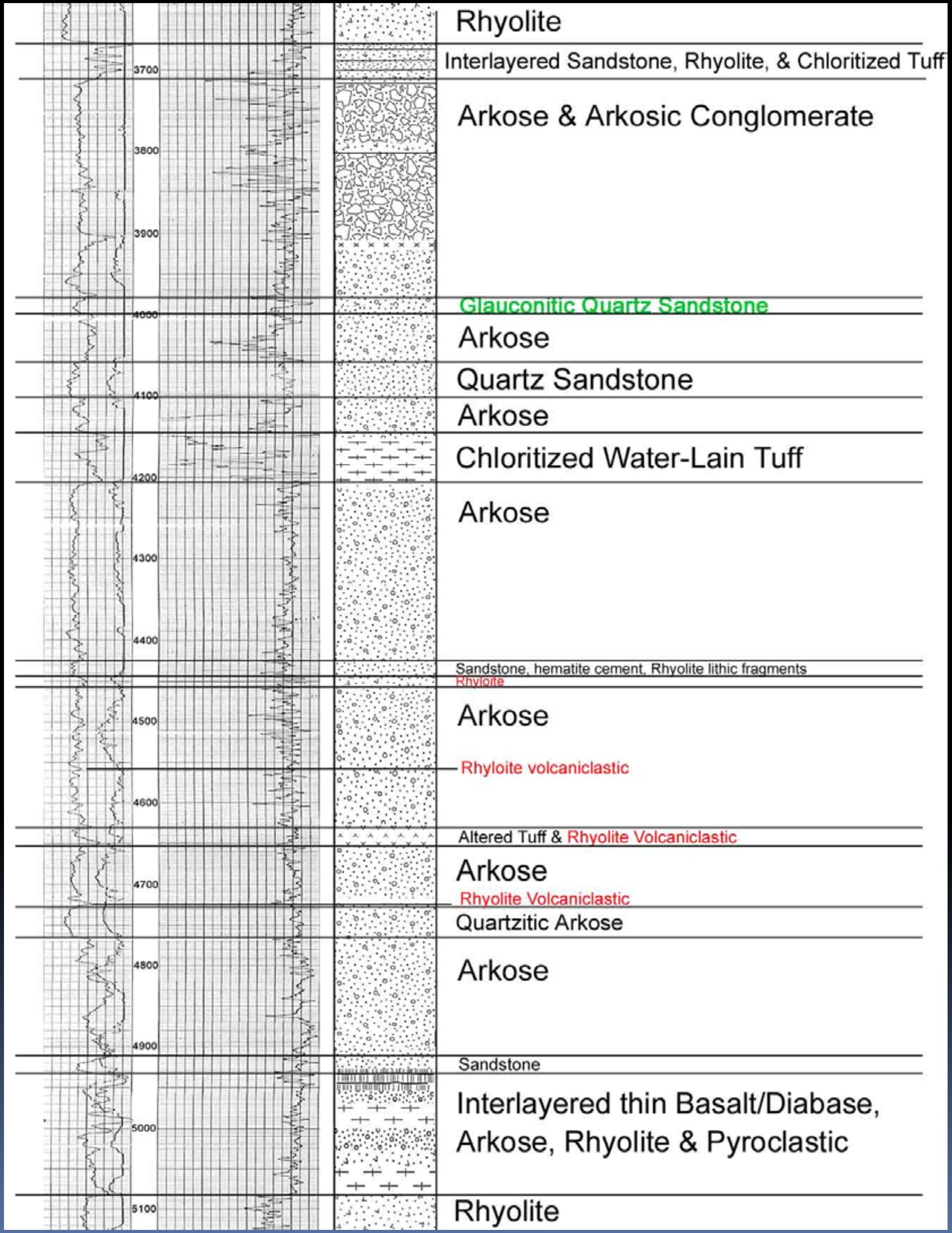
Pan American Oil Company
Jarman #1
Sec 19-T1N-R2W



Clastic Interval

Jarman #1

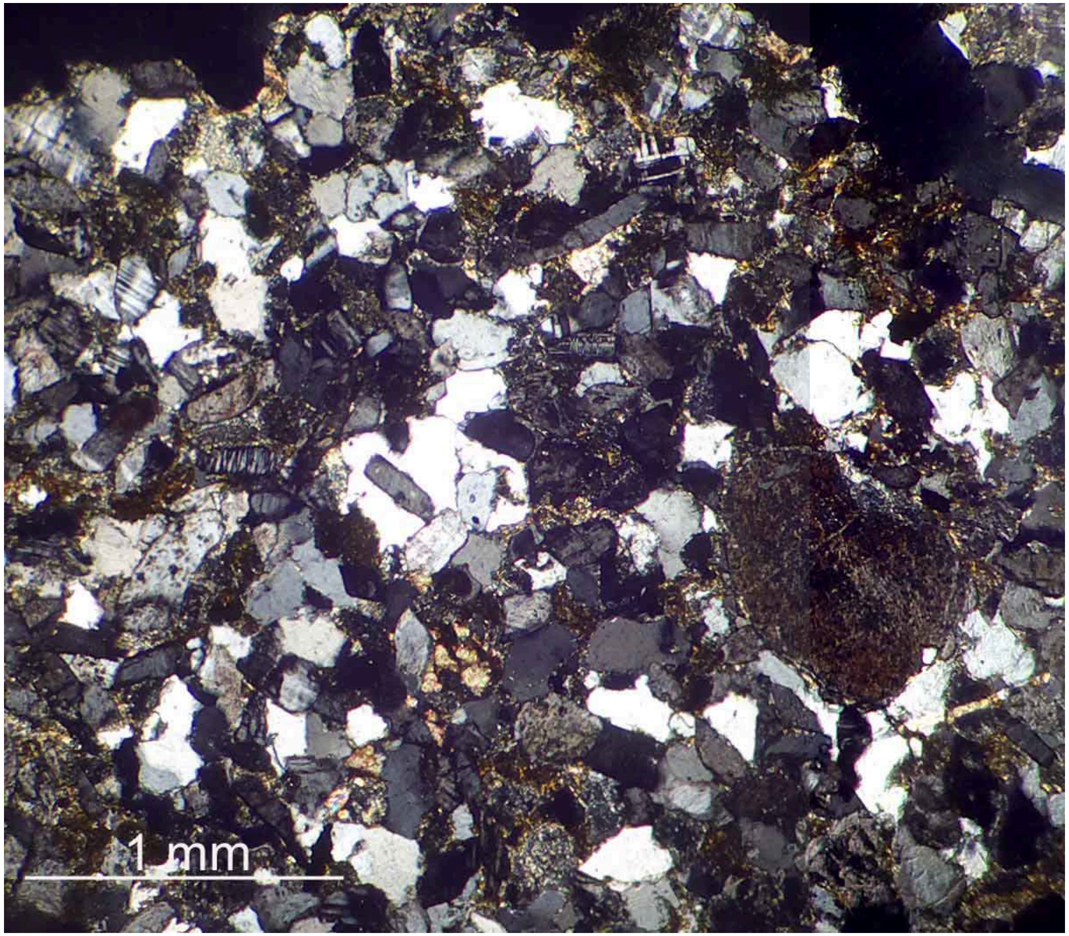
Sec 19-T1N-R2W



Typical Texture

Poorly sorted fine grained angular to sub-angular quartz and varying amounts of feldspar mixed with coarse grained quartz, feldspar, and granitic fragments in a matrix composed of feldspar derived clay and alteration products with carbonate cement.

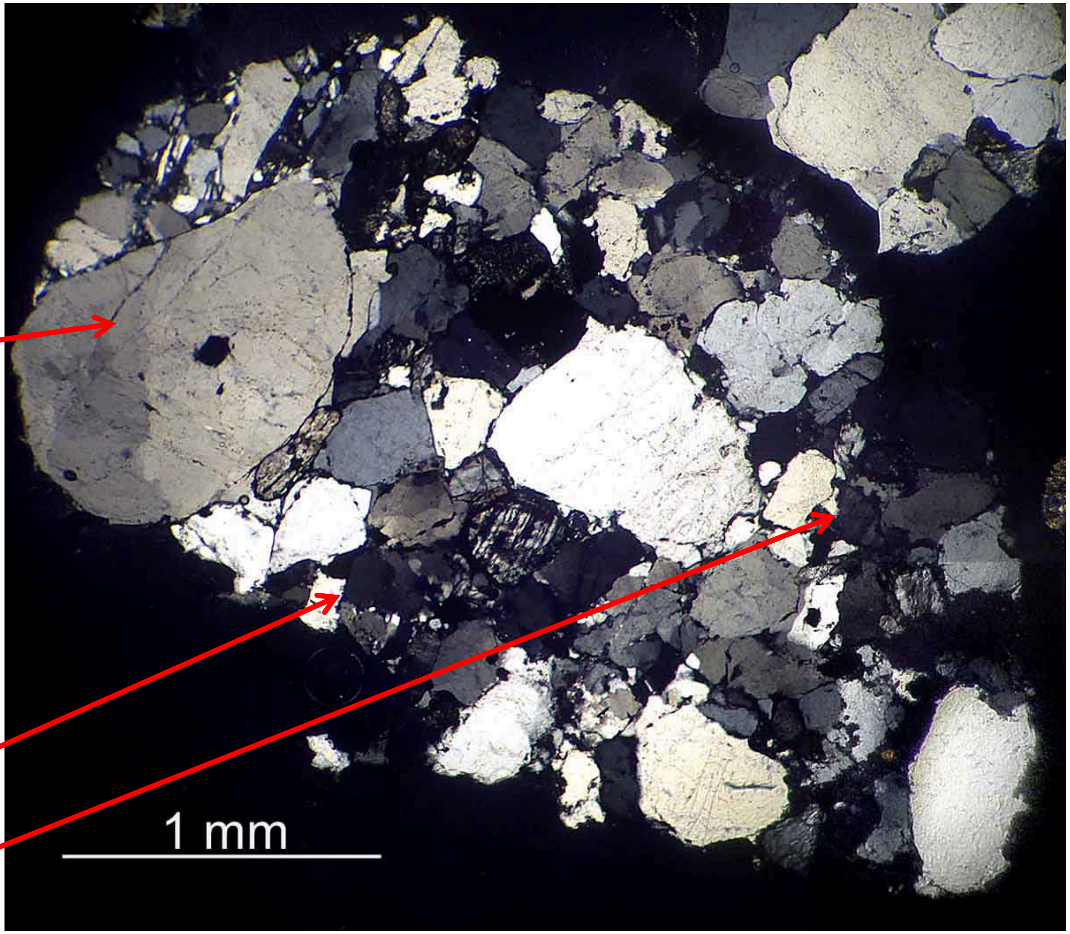
Most feldspars are partially replaced by carbonate and commonly have rims of alteration products



The source area included structurally juxtaposed shallow and deep crustal granites.

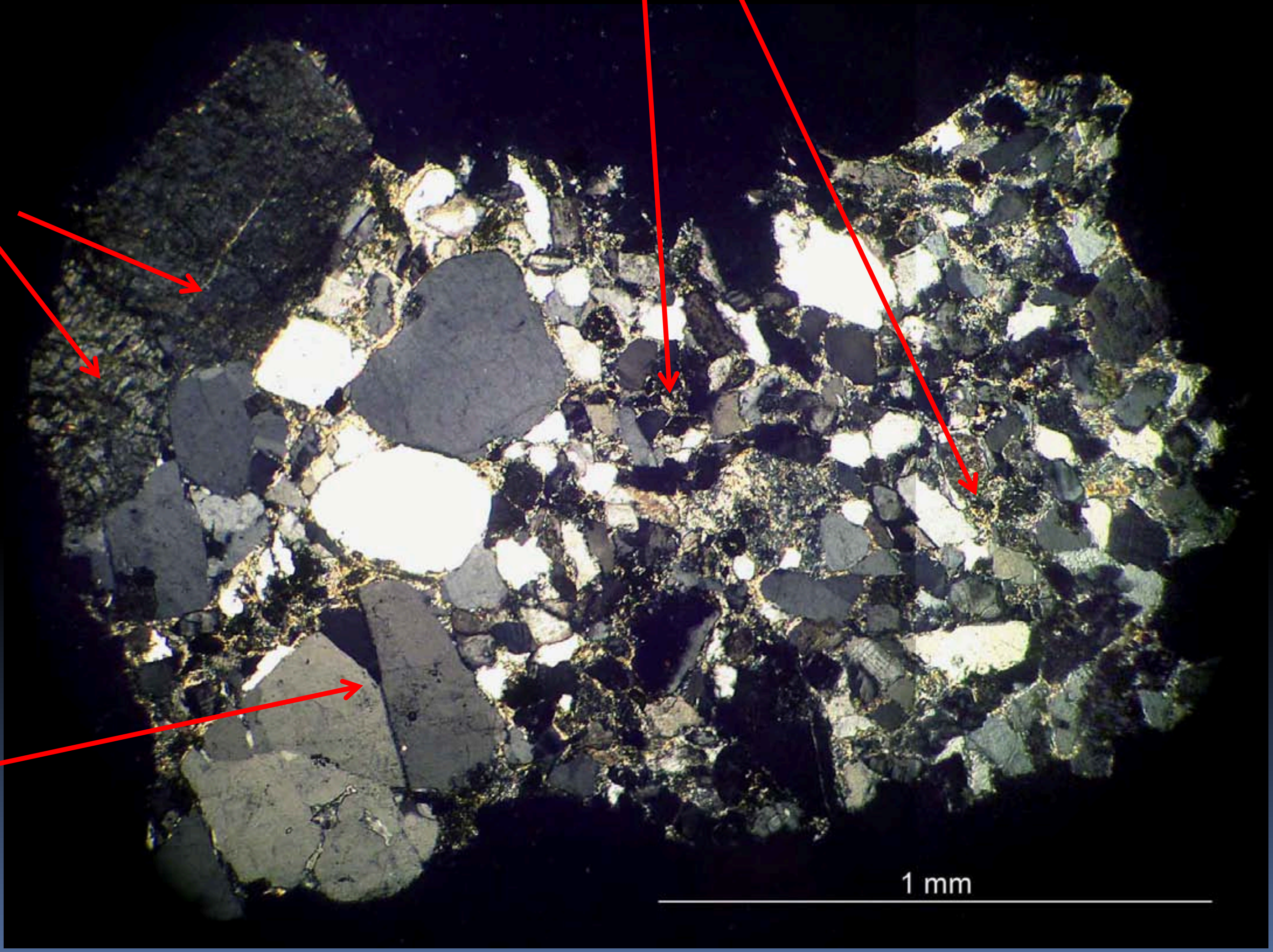
Large, sub-rounded quartz grain derived from coarse-grained granite crystallizing at deeper crustal levels

Smaller sub-angular quartz and feldspar grains derived from medium-fine grained granite emplaced at shallow levels



Fine grained matrix quartz and feldspar in carbonate cement.

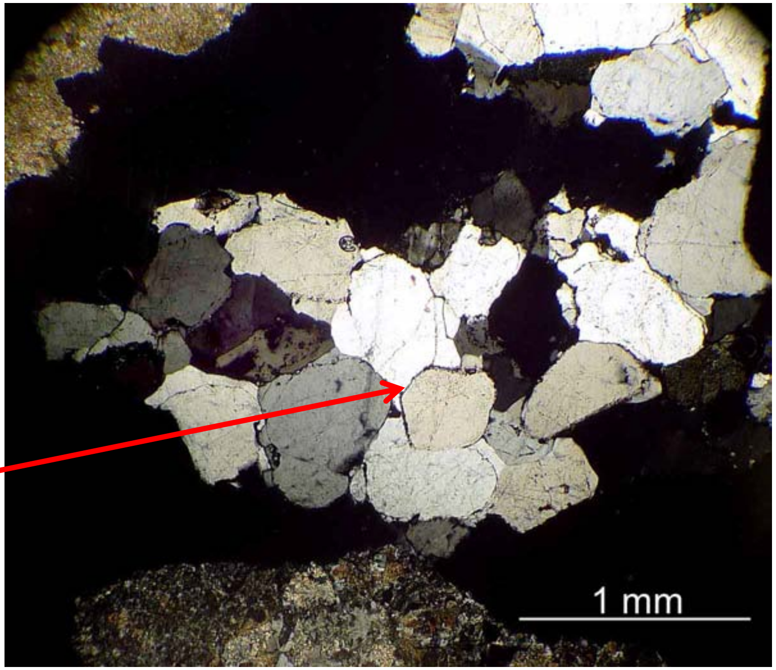
Altered feldspars in granitic fragment



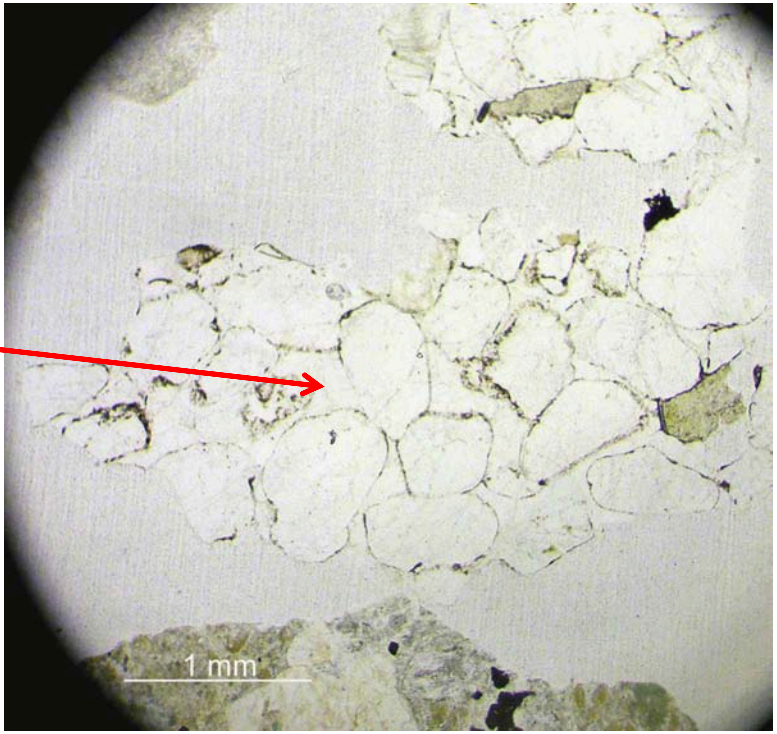
Large polycrystalline Quartz cluster

Complex Diagentic History

At first glance, under crossed polars, the rock has a plutonic igneous texture based on grain boundary geometry.

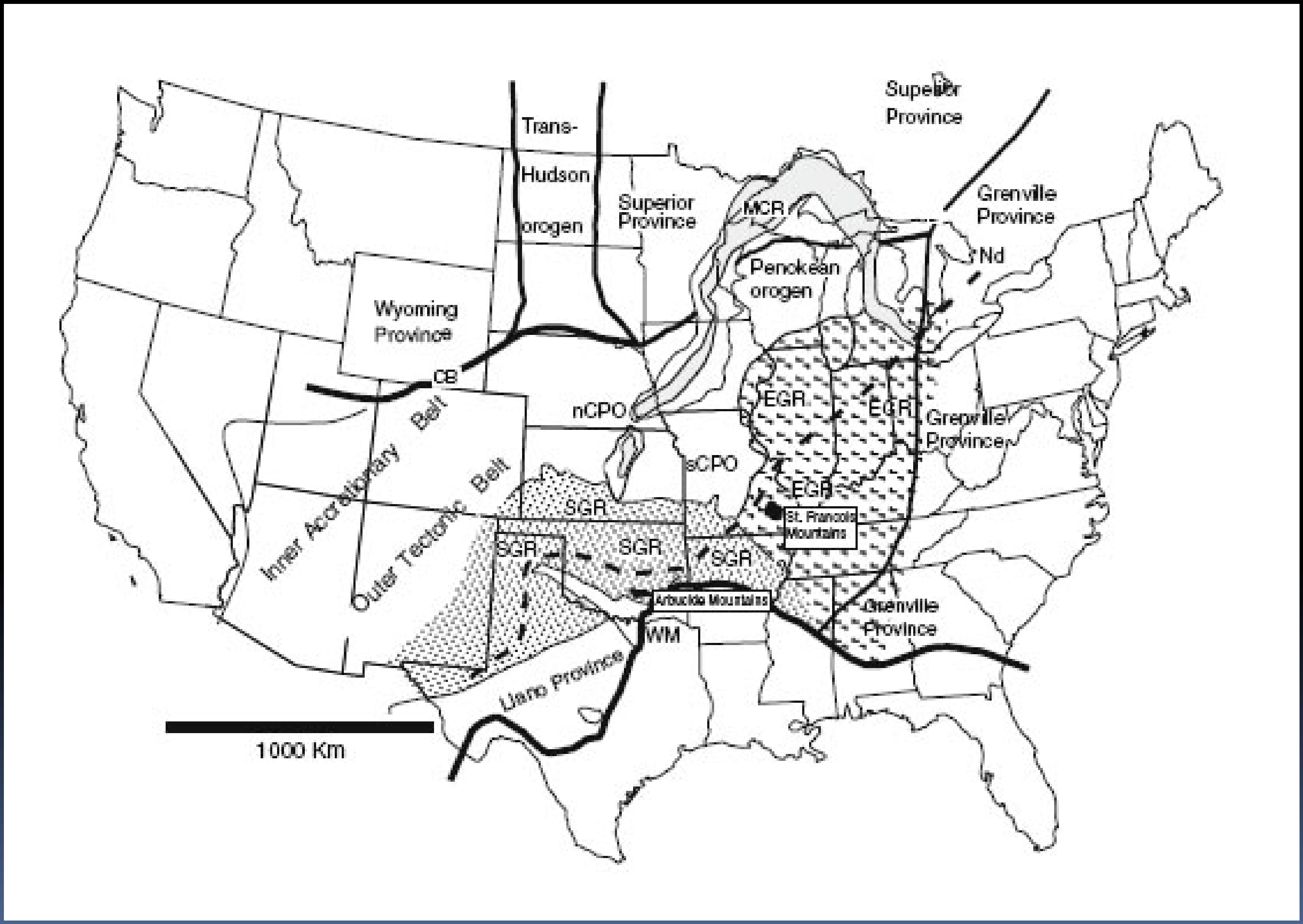


Viewing under plane polarized Light reveals original grain boundaries outlined by early precipitation of diagenetic clays followed by silica cementation.



Sediment source rock - Exposed Basement Surface of the Southern Granite Rhyolite Provence

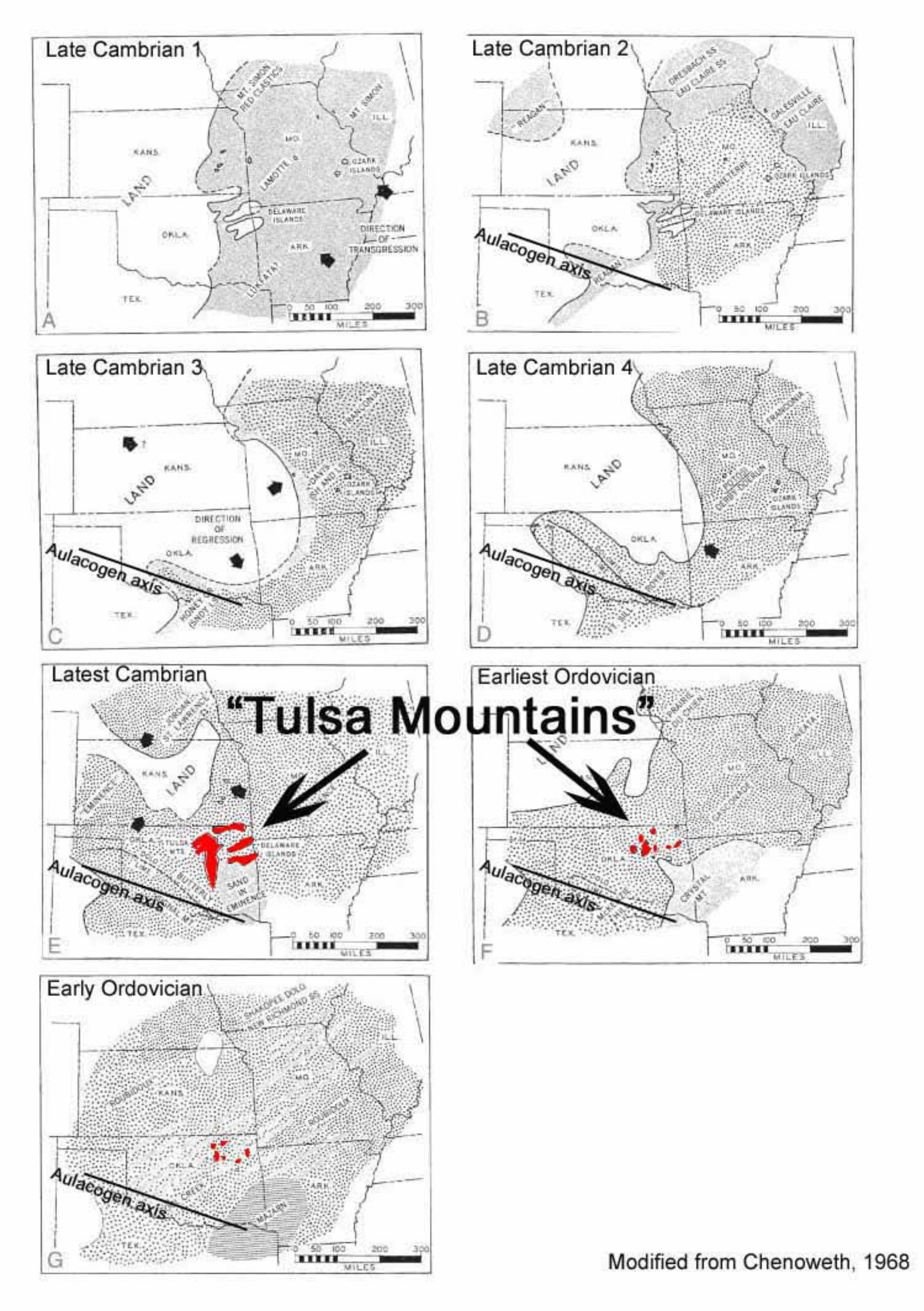
1.3 to 1.4 Ga Granites and Rhyolites



Topographic Relief on the Exposed Southern Granite-Rhyolite Provence Surface

In Cambrian time, flooding of the Laurentian craton proceeded southern continental margin.

The “Tulsa Mountains”, survived as emergent topography until the early Ordovician.



Similar fan deposits can be seen in the basalt walls of the Rio Grande Gorge near Taos where alluvial fans originating in Proterozoic granites flowed into the rift and were encapsulated by later eruptions.

Summary

-Thick, poorly sorted, texturally immature sediment

-Not present in adjacent wells along strike with the aulacogen axis

-Petrology consistent with derivation from rocks bounding the aulacogen and present in the scarp of the bounding faults

-Volcaniclastics present in minor amounts separating thick depositional units of basement rock derived clastics

-Similar deposits documented in modern continental rift