OKLAHOMA GEOLOGICAL SURVEY

MAP GM-46
Structural / Tectonic Map of Oklahoma
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STRUCTURAL / TECTONIC MAP OF OKLAHOMA

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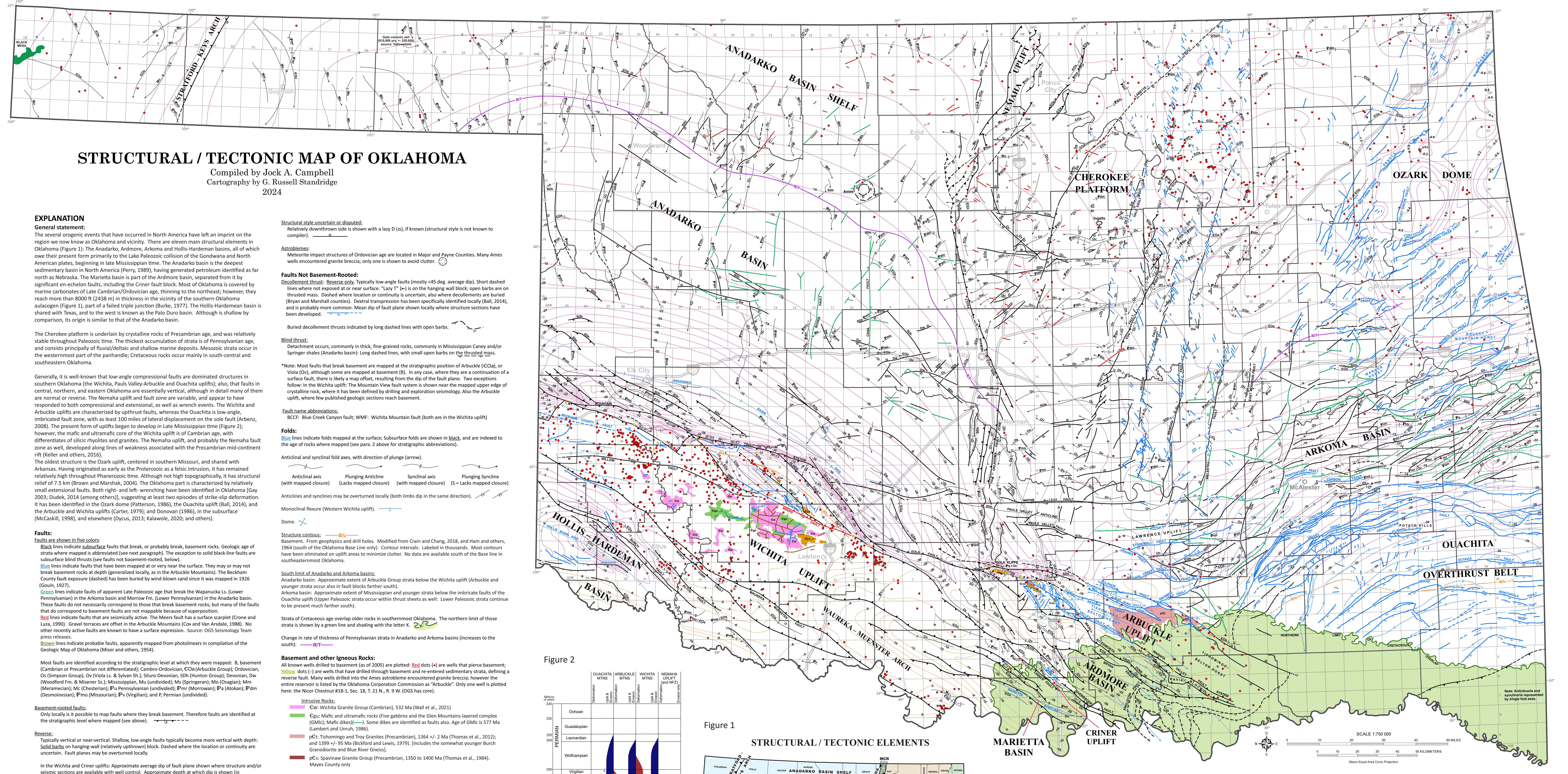

EXPLANATION

General statement:

The several orogenic events that have occurred in North America have left an imprint on the region we now know as Oklahoma and vicinity. There are eleven main structural elements in Oklahoma (Figure 1): The Anadarko, Ardmore, Arkoma and Hollis-Hardeman basins, all of which owe their present form primarily to the Lake Paleozoic collision of the Gondwana and North American plates, beginning in late Mississippian time. The Anadarko basin is the deepest sedimentary basin in North America (Perry, 1989), having generated petroleum identified as far north as Nebraska. The Marietta basin is part of the Ardmore basin, separated from it by significant en-echelon faults, including the Criner fault block. Most of Oklahoma is covered by marine carbonates of Late Cambrian/Ordovician age, thinning to the northeast; however, they reach more than 8000 ft (2438 m) in thickness in the vicinity of the southern Oklahoma aulacogen (Figure 1), part of a failed triple junction (Burke, 1977). The Hollis-Hardemean basin is shared with Texas, and to the west is known as the Palo Duro basin. Although is shallow by comparison, its origin is similar to that of the Anadarko basin.

The Cherokee platform is underlain by crystalline rocks of Precambrian age, and was relatively stable throughout Paleozoic time. The thickest accumulation of strata is of Pennsylvanian age, and consists principally of fluvial/deltaic and shallow marine deposits. Mesozoic strata occur in the westernmost part of the panhandle; Cretaceous rocks occur mainly in south-central and southeastern Oklahoma.

Generally, it is well-known that low-angle compressional faults are dominated structures in southern Oklahoma (the Wichita, Pauls Valley-Arbuckle and Ouachita uplifts); also, that faults in central, northern, and eastern Oklahoma are essentially vertical, although in detail many of them are normal or reverse. The Nemaha uplift and fault zone are variable, and appear to have responded to both compressional and extensional, as well as wrench events. The Wichita and Arbuckle uplifts are characterized by upthrust faults, whereas the Ouachita is low-angle, imbricated fault zone, with as least 100 miles of lateral displacement on the sole fault (Arbenz, 2008). The present form of uplifts began to develop in Late Mississippian time (Figure 2); however, the mafic and ultramafic core of the Wichita uplift is of Cambrian age, with differentiates of silicic rhyolites and granites. The Nemaha uplift, and probably the Nemaha fault zone as well, developed along lines of weakness associated with the Precambrian mid-continent rift (Keller and others, 2016).
The oldest structure is the Ozark uplift, centered in southern Missouri, and shared with Arkansas. Having originated as early as the Proterozoic as a felsic intrusion, it has remained relatively high throughout Phanerozoic time. Although not high topographically, it has structural relief of 7.5 km (Brown and Marshak, 2004). The Oklahoma part is characterized by relatively small extensional faults. Both right- and left- wrenching have been identified in Oklahoma [Gay 2003; Dudek, 2014 (among others)], suggesting at least two episodes of strike-slip deformation. It has been identified in the Ozark dome (Patterson, 1986), the Ouachita uplift (Ball, 2014), and the Arbuckle and Wichita uplifts (Carter, 1979); and Donovan (1986), in the subsurface (McCaskill, 1998), and elsewhere (Dycus, 2013; Kalawole, 2020; and others).

Faults:

Faults are shown in five colors:

Black lines indicate subsurface faults that break, or probably break, basement rocks. Geologic age of strata where mapped is abbreviated (see next paragraph). The exception to solid black-line faults are subsurface blind thrusts (see faults not basement-rooted, below).

Blue lines indicate faults that have been mapped at or very near the surface. They may or may not break basement rocks at depth (generalized locally, as in the Arbuckle Mountains). The Beckham County fault exposure (dashed) has been buried by wind-blown sand since it was mapped in 1926 (Gouin, 1927).

Green lines indicate faults of apparent Late Paleozoic age that break the Wapanucka Ls. (Lower Pennsylvanian) in the Arkoma basin and Morrow Fm. (Lower Pennsylvanian) in the Anadarko basin. These faults do not necessarily correspond to those that break basement rocks; but many of the faults that do correspond to basement faults are not mappable because of superposition.

Red lines indicate faults that are seismically active. The Meers fault has a surface scarplet (Crone and Luza, 1990). Gravel terraces are offset in the Arbuckle Mountains (Cox and Van Arsdale, 1988). No other recently active faults are known to have a surface expression. Source: OGS Seismology Team press releases.

Brown lines indicate probable faults, apparently mapped from photolinears in compilation of the Geologic Map of Oklahoma (Miser and others, 1954).

Most faults are identified according to the stratigraphic level at which they were mapped: B, basement (Cambrian or Precambrian not differentiated); Cambro-Ordovician, ꞒOa (Arbuckle Group); Ordovician, Os (Simpson Group), Ov (Viola Ls. & Sylvan Sh.); Siluro-Devonian, SDh (Hunton Group); Devonian, Dw (Woodford Fm. & Misener Ss.); Mississippian, Mu (undivided); Ms (Springeran); Mo (Osagian); Mm (Meramecian); Mc (Chesterian); ℙu Pennsylvanian (undivided); ℙmr (Morrowan); ℙa (Atokan); ℙdm (Desmoinesian); ℙmo (Missourian); ℙv (Virgilian); and P, Permian (undivided).

Basement-rooted faults:
Only locally is it possible to map faults where they break basement. Therefore faults are identified at the stratigraphic level where mapped (see above).

Reverse:
Typically vertical or near-vertical. Shallow, low-angle faults typically become more vertical with depth: Solid barbs on hanging-wall (relatively upthrown) block. Dashed where the location or continuity are uncertain. Fault planes may be overturned locally.

In the Wichita and Criner uplifts: Approximate average dip of fault plane shown where structure and/or seismic sections are available with well control. Approximate depth at which dip is shown (in thousands of feet). **S** indicates fault dip obtained from geologic sections with reflection seismology. Primary sources of data: Cooper (1995), and McConnell (1987). **M** indicates MS thesis study.

16.1 / 40°   M / 65°   S / 70°

Normal:
Normal faults are shown with hachures on foot-wall (relatively downthrown block). V indicates an essentially vertical fault. Approximate dip of fault plane is shown locally, as measured in strata above basement. Dashed where the continuity or location are uncertain.

Approximate strike and dip of several faults in western Major and adjacent Woods counties from a study by Bizzell (2017). 80°

Strike-slip (may be normal or reverse also):
Right-lateral or left-lateral, as shown by arrows (left-lateral shown). Actual faults are mostly oblique slip, as opposed to purely dip-slip or strike-slip displacement (demonstrating transpression). Minimum lateral displacement shown in miles locally. Broken arrows for indicated as opposed to demonstrated displacement. Dashed where location or continuity is uncertain.

Strike-slip probable (some evidence, but detail undocumented).

Structural style uncertain or disputed:
Relatively downthrown side is shown with a lazy D (ᗝ), if known (structural style is not known to compiler).

Astroblemes:
Meteorite impact structures of Ordovician age are located in Major and Payne Counties. Many Ames wells encountered granite breccia; only one is shown to avoid clutter.

Faults Not Basement-Rooted:

Decollement thrust: Reverse only. Typically low-angle faults (mostly <45 deg. average dip). Short dashed lines where not exposed at or near surface. "Lazy T" (⊢) is on the hanging wall block; open barbs are on thrusted mass. Dashed where location or continuity is uncertain, also where decollements are buried (Bryan and Marshall counties). Dextral transpression has been specifically identified locally (Ball, 2014), and is probably more common. Mean dip of fault plane shown locally where structure sections have been developed.

Buried decollement thrusts indicated by long dashed lines with open barbs.

Blind thrust:
Detachment occurs, commonly in thick, fine-grained rocks, commonly in Mississippian Caney and/or Springer shales (Anadarko basin): Long dashed lines, with small open barbs on the thrusted mass.

*Note: Most faults that break basement are mapped at the stratigraphic position of Arbuckle (ꞒOa), or Viola (Ov), although some are mapped at basement (B). In any case, where they are a continuation of a surface fault, there is likely a map offset, resulting from the dip of the fault plane. Two exceptions follow: In the Wichita uplift: The Mountain View fault system is shown near the mapped upper edge of crystalline rock, where it has been defined by drilling and exploration seismology. Also the Arbuckle uplift, where few published geologic sections reach basement.

Fault name abbreviations:
BCCF: Blue Creek Canyon fault; WMF: Wichita Mountain fault (both are in the Wichita uplift)

Folds:

Blue lines indicate folds mapped at the surface; Subsurface folds are shown in black, and are indexed to the age of rocks where mapped (see para. 2 above for stratigraphic abbreviations).

Anticlinal and synclinal fold axes, with direction of plunge (arrow).

Anticlinal axis (with mapped closure)	Plunging Anticline (Lacks mapped closure)	Synclinal axis (with mapped closure)	Plunging Syncline (S = Lacks mapped closure)

Anticlines and synclines may be overturned locally (both limbs dip in the same direction).

Monoclinal flexure (Western Wichita uplift).

Dome.

Structure contous: B/L
Basement. From geophysics and drill holes. Modified from Crain and Chang, 2018, and Ham and others, 1964 (south of the Oklahoma Base Line only). Contour intervals: Labeled in thousands. Most contours have been eliminated on uplift areas to minimize clutter. No data are available south of the Base line in southeasternmost Oklahoma.

South limit of Anadarko and Arkoma basins:
Anadarko basin: Approximate extent of Arbuckle Group strata below the Wichita uplift (Arbuckle and younger strata occur also in fault blocks farther south).
Arkoma basin: Approximate extent of Mississippian and younger strata below the imbricate faults of the Ouachita uplift (Upper Paleozoic strata occur within thrust sheets as well: Lower Paleozoic strata continue to be present much farther south).

Strata of Cretaceous age overlap older rocks in southernmost Oklahoma. The northern limit of those strata is shown by a green line and shading with the letter K.

Change in rate of thickness of Pennsylvanian strata in Anadarko and Arkoma basins (increases to the south): R/T

Basement and other Igneous Rocks:

All known wells drilled to basement (as of 2005) are plotted: Red dots (●) are wells that pierce basement; Yellow dots (●) are wells that have drilled through basement and re-entered sedimentary strata, defining a reverse fault. Many wells drilled into the Ames astrobleme encountered granite breccia; however the entire reservoir is listed by the Oklahoma Corporation Commission as "Arbuckle". Only one well is plotted here: the Nicor Chestnut #18-1, Sec. 18, T. 21 N., R. 9 W. (OGS has core).

Intrusive Rocks:
- ꞒW: Wichita Granite Group (Cambrian), 532 Ma (Wall et al., 2021)
- Ꞓgu: Mafic and ultramafic rocks (Five gabbros and the Glen Mountains layered complex (GMlc); Mafic dikes)(—). Some dikes are identified as faults also. Age of GMlc is 577 Ma (Lambert and Unruh, 1986).
- pꞒt: Tishomingo and Troy Granites (Precambrian), 1364 +/- 2 Ma (Thomas et al., 2012); and 1399 +/- 95 Ma (Bickford and Lewis, 1979). [Includes the somewhat younger Burch Granodiorite and Blue River Gneiss].
- pꞒs: Spavinaw Granite Group (Precambrian, 1350 to 1400 Ma (Thomas et al., 1984). Mayes County only

Extrusive Rocks:
- Tb: Black Mesa Basalt (Pliocene)
- Ꞓca: Carlton Rhyolite Group, Wichita uplift, Cambrian, 532 Ma (Wall et al., 2021).
- Ꞓco: Colbert Porphyry, Arbuckle uplift, Cambrian, 539 +/- 5 Ma (Ershberger et al., 2014).

Note: Virtually all structures shown are from the published literature, and from unpublished theses and dissertations. Structures smaller than about two sections are generally not mapped. Much surface structure is incomplete or not mapped in areas of complex subsurface structure. There are several interpretations of all or parts of the Ouachita Mountains. That of Arbenz (2008) was selected because his early (Arbenz, 1956) and continuing study of the region. References are available separately as a supplement.

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Caveat: The position of fault traces my be imprecise due to the dip of the fault plane, change in scale from original mapping, and differences in map bases.

Figure 2

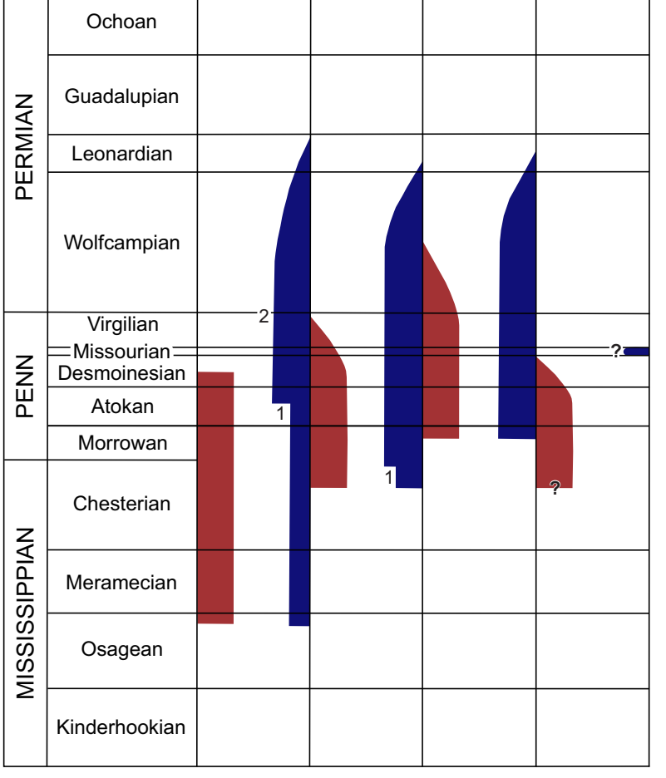
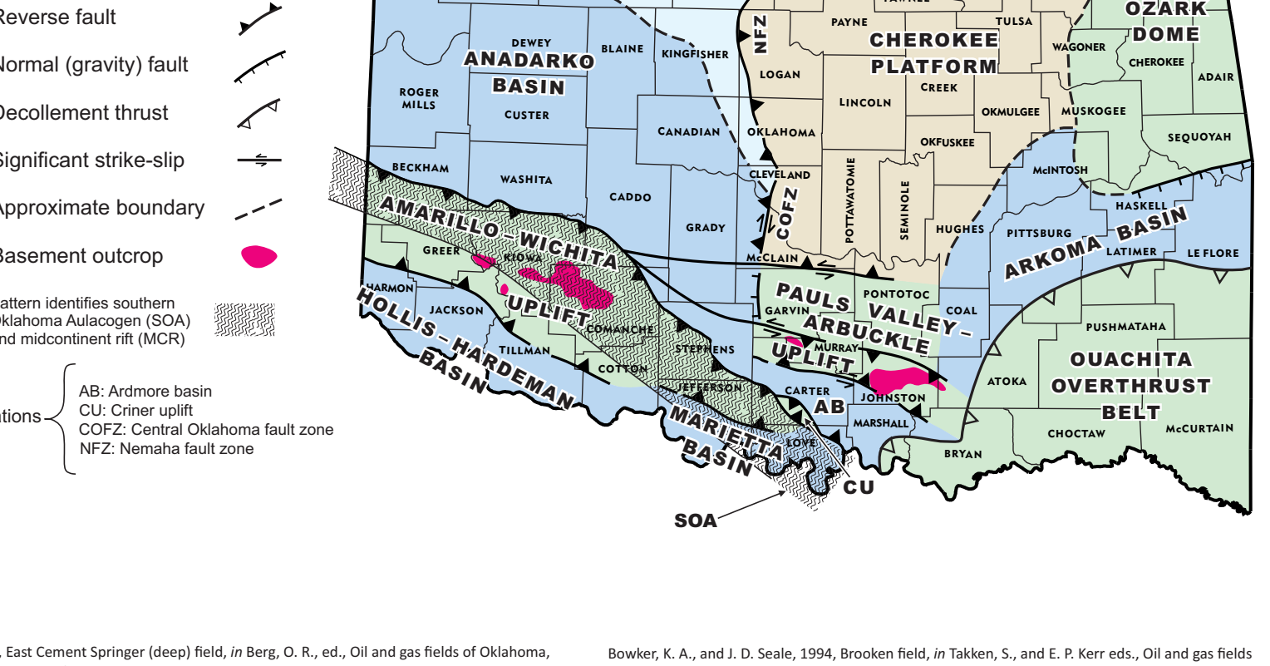


Chart showing ages of deformation and uplift of major structural elements in Oklahoma (Late Paleozoic only). Red: Deformation; Blue: Erosion. Steps labeled 1 represent ages of subaerial exposure in Ouachita and Arbuckle Mountains. Step labeled 2 represents possible uplift of Broken Bow and Benton Uplifts in Ouachita Moutains. Amended from Suneson and Stanley, 2018.

Figure 1

STRUCTURAL / TECTONIC ELEMENTS



Note: The prefix **S** indicates a surface study.

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Note: The prefix S indicates a surface study