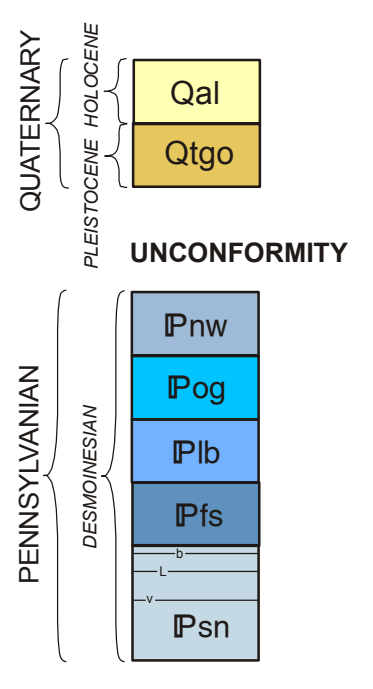
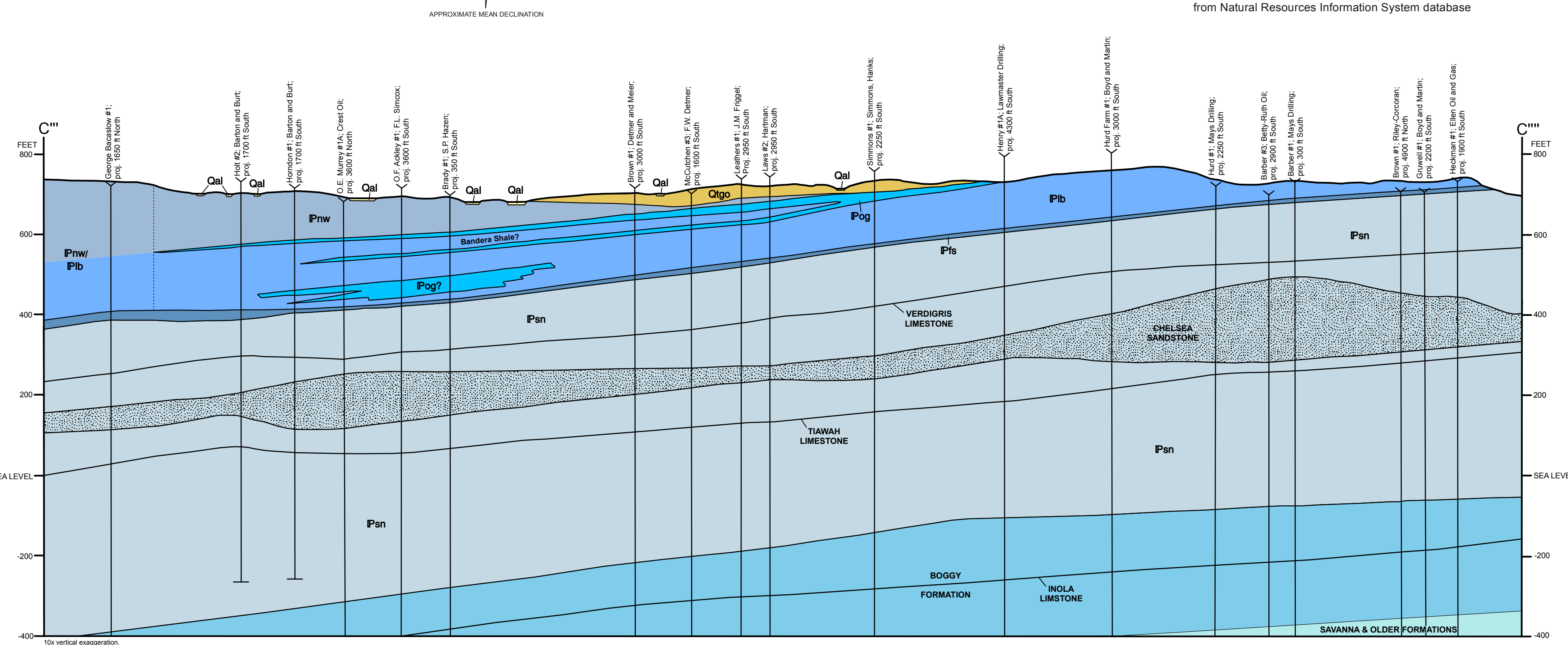
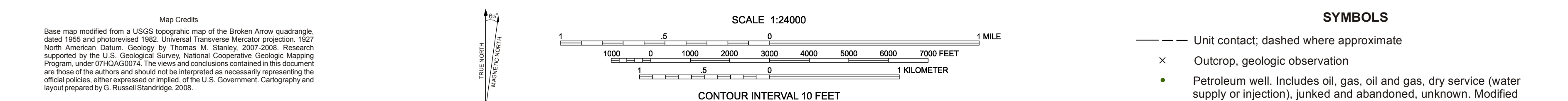


CORRELATION OF MAP UNITS



DESCRIPTION OF UNITS*

- Qal** ALLUVIUM (Holocene)—Clay, silt, sand, and gravel in channels and on flood plains of modern streams. Includes terrace deposits of similar composition located directly above and adjacent to modern channels and flood plains. Thickness: 0 to about 30 ft.
- Qtgo** REMNANTS OF OLDER TERRACE DEPOSITS (Pleistocene)—Clay, silt, sand, and gravel adjacent to the flood plain of the Arkansas River. Sand commonly is medium- to rarely coarse-grained and very light colored; when present, gravel locally consists of concentrations of local and distally derived, subrounded pebble and cobble-sized clasts of limestone and dolomite composition. The upper third to half of the deposit exhibits signs of aeolian reworking and modification that suggests a prevailing northeast wind direction throughout the Holocene. Thickness: 0 to as much as 100 ft.
- Pnw** NOWATA FORMATION (Pennsylvanian, Desmoinesian)—Rarely crops out in map area. Areas inferred to be Nowata consist of a light brown (5YR5/6) to light gray (N7) silty, clay loam silt, which probably formed from weathering of a silty clay shale. Basal contact drawn along the inferred, westernmost extent of outcrops of Oologah Formation. Only the basal 200 ft exposed in quad.
- Pog** OOLOGAH FORMATION (Pennsylvanian, Desmoinesian)—Formation predominantly a medium gray (N5), medium dark gray (N4), medium bluish gray (5B5/1), to locally yellowish gray (5Y7/2) limestones of the Sageyah, Pawnee and Altamont Members, with an intervening silty clay shale, that may represent the Bandera Shale, in the middle of the outcrop belt. The basal limestone interval characterised 5-8 ft of dark gray (N3), unfossiliferous, thin-bedded, pyritic, carbonate mudstone of the Sageyah Member, which grades upward into alternating thin- to medium bedded, wavy, skeletal and whole-fossil mudstones and wackestones characteristic of the Pawnee Member. Generally, thinner bedded limestones of the Pawnee Member tend to have a wackestone texture and yellowish-gray hue, while thicker bedded limestones have a lime mudstone texture and bluish-gray hue; bedding varies between 1-16" thick. Thin fractures filled with sparite are common throughout this lower interval. Fossils dominated by numerous species of brachiopod, phylloid algal, and crinoid debris; fenestrate and ramose bryozoans present in thicker beds, while bivalve-filled burrows also common in some sections that have a large complement of argillaceous limestone. The upper Altamont Limestone interval is more regularly thin-bedded compared to Pawnee interval and consists of slightly argillaceous, fossiliferous mudstones; bedding planar to slightly wavy, ranging from 2-5" thick; fossils content similar to the Pawnee interval, except less of a phylloid algal content.
About 20-35 ft above base of formation encounter a 30 ft thick interval of pale yellowish orange (10YR6/2) weathering, weakly calcareous, silty clay shale that probably represents the Bandera Shale. Oologah limestone immediately above shale interval contain irregularly-shaped chert pods, most of which have been weathered out along with fossil components, suggesting paleo-karst erosion may have occurred.
Unit thins considerably to the south and west, and most likely pinching out just north of the Arkansas River beneath the terrace cover. Thickness varies from 110 ft in the northern part of the quad, to as little as 30 ft in the southern-most outcrop extension.
- Pib** LABETTE FORMATION (Pennsylvanian, Desmoinesian)—Light olive gray (5Y5/2) to dusky yellow (5Y6/4), occasionally medium light gray (N6), laminated, very silty to micaceous, concretionary clay shale; concretions dusky red (5R4/2) to moderate red (5R5/4), composed of hematite and/or siderite(?), and usually occur sporadically throughout formation as 1-3" diameter discoid-shaped clasts. Clay shale predominantly non-calcareous, although some narrow horizons are weakly calcareous (particularly those associated with abundant concretions). Locally, various minor very sandy or sandstone horizons occur.
Within the upper 50 ft of the formation a sequence of interbedded sandstones and shales (Peru sandstones) occur. The Peru sandstones consist of between 2 to 4 intervals of dusky yellow (5Y6/4), moderately indurated, thin- to medium-, trough-cross-bedded, fine-grained, non-calcareous sandstones; sandstone intervals vary between 5 to 15 ft thick, where the thicker intervals have been variably termed the Upper and Lower Peru Sandstones by previous investigators. Each separated by 7 to 10 ft thick intervals of well-laminated, flaser-bedded, calcareous, interbedded mud shale and siltstone.
Locally, and where the Peru sandstones are absent, a highly fossiliferous clay shale may occur instead the usual non-fossiliferous concretionary shales within the uppermost 30 ft of the formation. These fossiliferous clay shales are typically pale yellowish brown (10YR6/2), yellowish gray (5Y7/2), to rarely moderate yellow (5Y7/6), slightly silty, calcareous and well-laminated. Fossils are dominated by Desmoinesia, Linoproductus, Jurensia and Megachonetes, and with minor elements consisting of small ramose bryozoans, crinoid debris and small spirifer brachiopods.
Within the main outcrop area the Labette Formation is a uniform 110 ft thick, but in begins to thin to the south in subsurface well logs.
- PIs** FORT SCOTT FORMATION (Pennsylvanian, Desmoinesian)—The formation consists of only two members, in descending order: 1) the Little Osage Shale; and 2) the Blackjack Creek Limestone. Thickness of the formation is about 5 to 8 ft thick.
Little Osage Shale: Similar to the Exello Shale of the Senora Formation, a medium dark gray (N4) to dark gray (N3), well-laminated to fissile, phosphatic, silty clay shale, usually a very pale orange (10YR8/2), dark yellowish orange (10YR6/2), pale brown (5YR5/2), light brown (5YR5/6), grayish yellow (5Y8/4), and yellowish gray (5Y7/2); clay is predominant cement, calcite rare.
Clayshales immediately above coal seams tends to be harder, silt-free, slightly phosphatic, with slightly thicker laminated bedding, and are weakly calcareous; color usually a medium dark gray (N4).
The interlaminated sandstones and siltstones are friable to poorly indurated, usually a very pale orange (10YR8/2), pale orange (10YR8/2), or dark yellowish orange (10YR6/2) sandstone more common than siltstone, typically fine- to very fine-grained; predominant cement is clay, with a possible weak silica. Total thickness of the Senora Formation exposed in quad about 200 ft.
A number of prominent stratigraphic horizons occur in the Senora Formation, these are in descending order:
Exello Shale: A medium dark gray (N4) to dark gray (N3), well-laminated to fissile, phosphatic clay shale; however, upper 2-5' a light brownish gray (5YR6/1) to pale brown (5YR5/2), laminated, slightly silty, calcareous clay shale; phosphatic nodules throughout lower part of member, occurring as 0.25-0.5", ovoid-shaped clasts. Thickness about 5 ft, but may be as thin as 2 ft locally.
Blackjack Creek Limestone: Light gray (N7), medium light gray (N6), light brownish gray (5YR6/1), to moderate orange pink (5YR6/4), thin, planar to wavy bedded, skeletal to whole-fossil wackestone. Bedding varies from 2" to 5" thick; wavy bedding contacts due (in part) to stromatolitic bedding; limestone in upper 1-3 ft of member exhibiting wavy laminated bedding and more fragmentary bioclasts compared to lower parts of member. Fossils dominated by spirifer and productid brachiopods, and crinoid debris; and fusulinid shells in some intervals. Unit thins considerably to the south, with thickness from 3 to 5 ft in the northern outcrop area of quad, but averaging closer to 1 ft in the southern-most extension of the map area.
- Psn** SENORA FORMATION (Pennsylvanian, Desmoinesian)—Mainly a silty to sandy clay shale, locally interlaminated with a 0.16-1" thick very fine-grained sandstone and siltstone beds, clay shale bedding laminated, becoming blocky where deeply weathered; color variable, ranging from the most frequent to infrequent: medium light gray (N6), brownish gray (5YR4/1), grayish orange (10YR7/4), very pale orange (10YR8/2), dark yellowish orange (10YR6/2), pale brown (5YR5/2), light brown (5YR5/6), grayish yellow (5Y8/4), and yellowish gray (5Y7/2); clay is predominant cement, calcite rare.
Clayshales immediately above coal seams tends to be harder, silt-free, slightly phosphatic, with slightly thicker laminated bedding, and are weakly calcareous; color usually a medium dark gray (N4).
The interlaminated sandstones and siltstones are friable to poorly indurated, usually a very pale orange (10YR8/2), pale orange (10YR8/2), or dark yellowish orange (10YR6/2) sandstone more common than siltstone, typically fine- to very fine-grained; predominant cement is clay, with a possible weak silica. Total thickness of the Senora Formation exposed in quad about 200 ft.
A number of prominent stratigraphic horizons occur in the Senora Formation, these are in descending order:
Exello Shale: A medium dark gray (N4) to dark gray (N3), well-laminated to fissile, phosphatic clay shale; however, upper 2-5' a light brownish gray (5YR6/1) to pale brown (5YR5/2), laminated, slightly silty, calcareous clay shale; phosphatic nodules throughout lower part of member, occurring as 0.25-0.5", ovoid-shaped clasts. Thickness from 3-6 ft, averaging 4 ft.
Breezy Hill Limestone (b): Grayish orange (10YR7/4), yellowish gray (5Y7/2), pale olive (10Y6/2), to medium light gray (N6), locally dark gray (N3); predominantly an alternating thin- to medium-, wavy bedded, whole-fossil wackestone. Bedding varies from 3-16" thick, with thinner bedding characterized by skeletal textures, and medium bedding a characteristically whole-fossil texture. Large Linoproductus, other small productids (Desmoinesia) and mesolobids are the most common fossils; chaetoid sponges and large crinoid stems also present. Skeletal material usually consists of sub-angular crinoid debris (ossicles and plates), and brachiopod shell fragments. Some exposures of the Breezy Hill contain an unusual facies consisting of a dense, dark gray colored, fossiliferous carbonate mudstone; fossils consist exclusively of well-preserved, monotypic assemblages of Mesolobus; facies commonly occurs near the contact with the Exello Shale. Overall, the Breezy Hill is thicker and more wavy bedded than the overlying Blackjack Creek Limestone. Thickness of the unit about 7 to 8 ft.
Kinnison Shale: Moderate yellowish brown (10YR5/4) to medium light gray (N6), fissile to well-laminated, fossiliferous silty clay shale. Silt and sand increasing toward top of member. Base occurs at the top of the Iron Post coal. Due to extreme thickness of the underlying Lagoda Sandstone this shale interval rarely exceeds 1 ft, and averages closer to 8 inches in thickness.
Iron Post coal: Where observed, coal is a single bed, black (N1) to grayish black (N2), having well-developed 2 directional cleats. Associated underclay not well-developed. Thickness about 6 to 8 inches.
Lagoda Sandstone (L): Grayish orange (10YR7/4), dark yellowish gray (10YR6/6), to very pale orange (10YR8/2), friable to moderately indurated, thin- to medium-bedded, sometimes wavy laminated, trough-cross-bedded, fine- to very fine-grained, slightly silty sandstone; shale partings may occur between cross-bed sets; sandstone mostly very clean, with rounded to well-rounded quartz grains, but it does become more argillaceous and micaceous toward top; calcite cement rare. Bedding varies from less than 1/16" thick to as much as 24" thick; thicker bedded material more common in the basal two-thirds of the member; ripple-bedded surfaces associated with internal tabular cross-lamination common in upper one-third of member. Molds of Linoproductus and Jurensia may occur locally. Thickness ranges from 10 ft, to as much as 20 ft thick in the more northern parts of outcrop area.
Verdigris Limestone (v): medium dark gray (N4) skeletal mudstone; but may weather to a medium light gray (N6), grayish red (5R4/2), or grayish orange (10YR7/4) color. Represented either by a single massive bed, or by a couple of 9-12" thick, wavy, skeletal mudstone beds; top 3-4" becoming a wavy laminated whole-fossil mudstone to wackestone, with large productid brachiopods and large crinoid stems. Chert pods, or silica replacement of limestone along bedding surfaces common. Thickness about 2 to 3 ft.
Crowbough coal: Poorly exposed in map area; where observed in old mine workings represented by a black (N1) to grayish black (N2), 0.5-2" thick coal bed overlying a comparably thick very light gray (N8) to light bluish gray (5B7/1) underclay. Locally, a pair of 9-12" thick, whole-fossil mudstones separated by a 6" thick clay shale interval, informally named the McNabb limestone by some geologists, occurs immediately below the underclay.



**GEOLOGIC MAP OF THE BROKEN ARROW 7.5' QUADRANGLE,
TULSA AND WAGONER COUNTIES, OKLAHOMA**

Thomas M. Stanley
2008

