OKLAHOMA GEOLOGICAL SURVEY
Charles J. Mankin, *Director*

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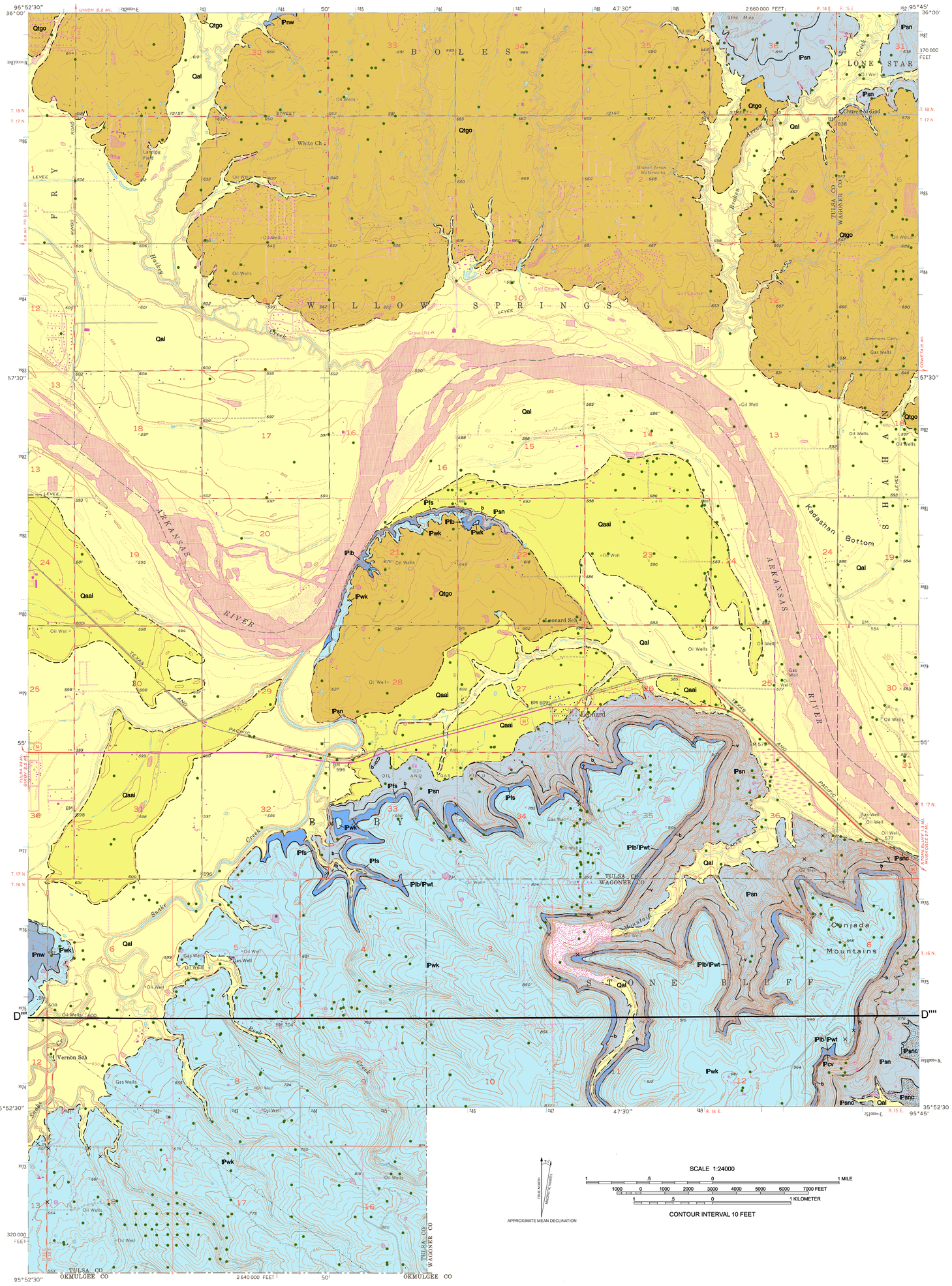
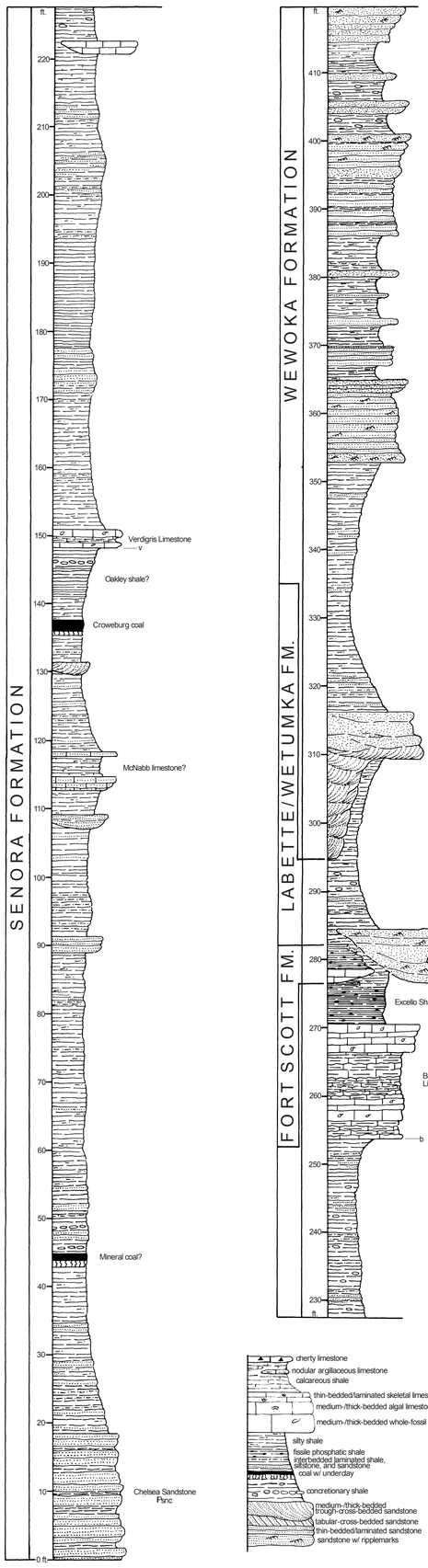
Oklahoma Geologic Quadrangle **OGQ-72**
**Geologic Map of the Leonard 7.5′ Quadrangle**

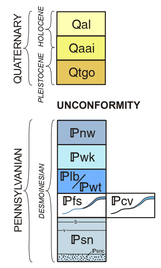



## STANDARD REFERENCE SECTION

Main stratotype section for the Leonard 7.5-minute quadrangle showing principal formations, members , and beds, their relative stratigraphic positions, general lithologic textures, and average thicknesses. Formal member and bed names are indicated by capitalization (i.e., Breezy Hill Limestone), while informal names are given in lowercase (i.e., Mineral coal). Unit names followed by a "?" indicate that the member or bed was not observed in the field area, but has been reported in adjacent areas or in the subsurface.




## 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.

**Qaai** ALLUVIUM OF ARKANSAS RIVER OF INTERMEDIATE AGE (Holocene and Pleistocene(?))—Clay, silt, sand, and minor gravel on adjacent to, and 10 to 20 ft above, modern flood plains of the Arkansas River. Area rarely subject to flooding. Thickness: unknown, most likely between 20 to 50 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 soil, which probably formed from weathering of a silty clayshale. Basal contact drawn along the inferred, western-most extent of outcrops of Wewoka Formation. Only the basal 20 to 30 ft exposed in quad.

**Pwk** WEWOKA FORMATION (Pennsylvanian, Desmoinesian)—Suite of interbedded sandstones and shales representing deltaic and pro-deltaic sedimentary influx off of prominent highlands that were forming in southern Oklahoma.

Approximately 3 to 5 major sandstone intervals occur, ranging between 3 to 18 ft thick; with numerous thinner, 1 to 3 ft thick, sandstone beds scattered throughout the exposed section. Sandstone intervals typically consist of grayish orange pink (5YR8/4), grayish orange (10YR7/4), and yellowish gray (5Y7/2), with light brown (5YR6/4) oxidation speckles; friable to moderately indurated; thin-, planar bedded, argillaceous, fine- to very fine-grained sand; sandstone intervals have tabular bedding geometries, with individual beds varying from 0.5-3.0 ft thick; soft sediment deformation such as load casts and flame structures common at the base of sandstone intervals; horizontal burrows common on bottom of bed surfaces throughout formation.

Each sandstone interval usually grading above and below into shale intervals that vary between 5 and 15 ft thick. Shales typically pale yellowish brown (10YR6/2), dark yellowish orange (10YR6/6), and light olive gray (5Y6/1) weathering, concretionary, slightly calcareous to noncalcareous, and texturally vary between silty claystones to mudstones. Calcite cement more common in shale horizons that occur adjacent to concretionary horizons. Concretions small, discoid-shaped, composed of fine-grained limestone and with calcite spar filling; a poorly preserved molluscan fauna locally preserved in some concretions.

Thickness of formation about 140 to 150 feet.

**Plb/Pwt** LABETTE / WETUMKA FORMATION (Pennsylvanian, Desmoinesian)—Both formations are lithostratigraphic equivalents that presumably interfinger south of the Arkansas River. The Labette is the main fine-grained terrigenous clastic unit that extends from the north while the Wetumka is texturally similar but extends from the south of the Arkansas River.

Units are poorly exposed in Leonard quad. Generally in areas where the Blackjack Creek Limestone of the Fort Scott Formation occur, the shale between the Fort Scott and Wewoka Formation should be labeled as the Labette Formation; however, in areas where the Blackjack creek pinches out, this intervening shale interval should be labeled the Wetumka Formation.

Where observed the interval consists of light olive gray (5Y5/2) to dusky yellow (5Y6/4), occasionally medium light gray (N6), laminated, very silty to sandy, micaceous, concretionary claystone; 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. Claystone predominantly non-calcareous, although some narrow horizons are weakly calcareous (particularly those associated with abundant concretions). Locally, various non-descript very sandy shale or very fine-grained sandstone horizons occur.

In the southern part of the quad the Labette/Wetumka Formation includes the Little Osage Shale of the Fort Scott Formation near its' base.

Total thickness is 30 to 40 feet.

**Pfs** 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. In the southern third of quad the Blackjack Creek Limestone is absent, most likely due to pinch-out; and although the Little Osage Member retains lithostratigraphic integrity and continues further to the south it is stratigraphically incorporated as a member in the Labette/Wetumka Formation. Thickness of the formation varies from 3 to 4 ft thick.

Little Osage Shale: Similar to the Excello Shale of the Senora Formation, a medium dark gray (N4) to dark gray (N3), well-laminated to fissile, phosphatic clayshale; upper 5-8" a light brownish gray (5YR6/1), blocky-bedded, silty, calcareous, fossiliferous clayshale. Phosphate nodules throughout lower part of member, occurring as 0.25-0.5", ovoid-shaped clasts. Thickness of member about 3 ft, but may be as thin as 2 ft thick locally.

Blackjack Creek Limestone: Light gray (N7), medium light gray (N6), light brownish gray (5YR6/1), to moderate orange pink (5YR8/4), thin, planar to wavy bedded, whole-fossil and algal carbonate mudstone. Bedding varies from 0.5" to 2" thick; wavy bedding contacts due (in part) to stromatolitic bedding. Fossils dominated by spirifer and productid brachiopods, and crinoid debris; fusulinids common in some intervals. Unit is absent in the south and southeast parts of the quad. Thickness of member from 0 to 1 ft.

**Pcv** CALVIN SANDSTONE (Pennsylvanian, Desmoinesian)—This formation is stratigraphically equivalent to the upper part of the Senora Formation and lower member of the Fort Scott Formation. In the Leonard quadrangle the Calvin Sandstone is exposed in the W1/2 Sec. 7, T.16N., R.14E.

The lithologic character of the Calvin Sandstone appears different than the sandstones common to the overlying Wewoka Formation, and consists of a light gray (N7) to very light gray (N8), moderately indurated, thin bedded, fine- to medium-grained, weakly siliceous, quartz-rich arenite; bedding is planar, varying from 3"-5" thick. Little iron-oxide staining is observed except along strongly weathered bedding and fracture surfaces.

The formation rests directly on top of the Excello Shale of the Senora Formation. Thickness of the formation varies from 0 to 8 ft.

**Psn** SENORA FORMATION (Pennsylvanian, Desmoinesian)—Mainly a silty to sandy clayshale, locally interlaminated with 0.16-1" thick very fine-grained sandstone and siltstone beds; clayshale 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. Only the uppermost 250 ft of the formation is exposed in quad.

A number of prominent stratigraphic horizons occur in the Senora Formation, these are in descending order:

Excello Shale: A medium dark gray (N4) to dark gray (N3), well-laminated to fissile, phosphatic clayshale; however, upper 2-5" a light brownish gray (5YR6/1) to pale brown (5YR5/2), laminated, slightly silty, calcareous, fossiliferous clayshale. Phosphate 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); upper and lower third of member predominantly an alternating thin- to medium-, wavy bedded, whole-fossil and skeletal wackestone. Bedding varies from 3-16" thick, with thinner bedding characterized by skeletal textures, and medium bedding a characteristically whole-fossil texture, with large linoproductids, other small productids (Desmoinesia) and mesolobids being the most common fossils observed; middle third of member a dark gray (N3) to medium dark gray (N4), wavy thin-bedded to wavy laminated, argillaceous carbonate mudstone containing few fossils; bedding in this middle horizon typically less than 1/2" thick. Some exposures of the Breezy Hill contain a well preserved, monotypic assemblage of Mesolobus; this facies commonly occurs near the contact with the Excello Shale, and at the base of the member. Thickness of the unit averages about 10 ft, but 15 ft thick sections are not uncommon.

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.

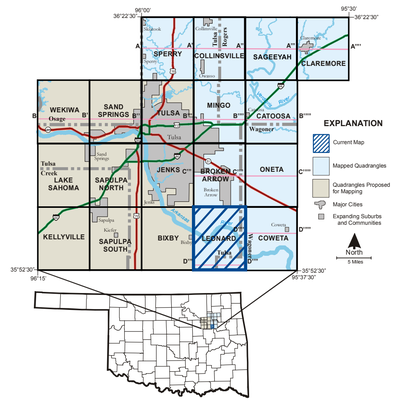
Croweburg coal: Poorly exposed in map area; where observed in old mine workings represented by a black (N1) to grayish black (N2), 0.5-2' thick coal bed overlying a comparably thick very light gray (N8) to light bluish gray (5B7/1) underclay. Locally, a pair of 9-12" thick, whole-fossil mudstones separated by a 6" thick clayshale interval, informally named the McNabb limestone by some geologists, occurs immediately below the underclay.

Chelsea Sandstone (Psnc): Poorly exposed in Leonard Quad. Consists of thin-bedded, argillaceous, fine-grained sandstone, that primarily forms a sandy loam soil in areas it underlies. Only uppermost 20 ft exposed in quad.

*Detailed descriptions only include mappable units observed in the field. Formal member and bed names are indicated by capitalization (i.e., Breezy Hill Limestone), while informal names are given in lowercase (i.e., Peru sandstone). Color of units based on fresh surfaces, unless stated otherwise.

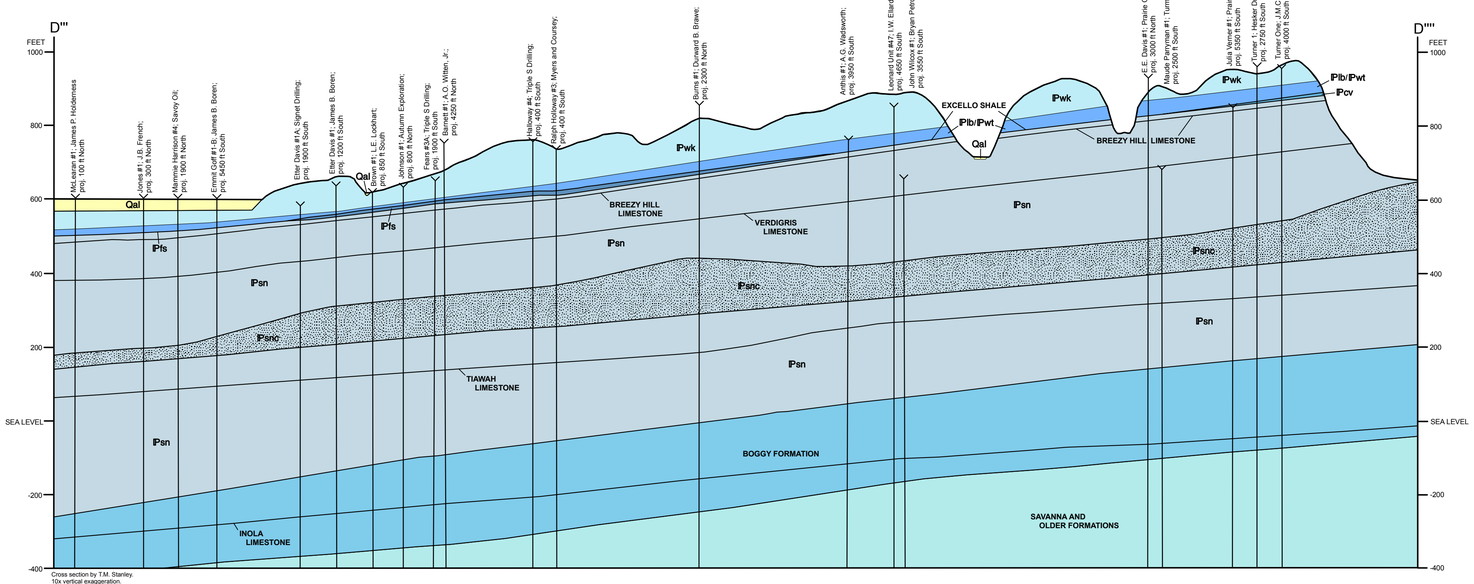
## SYMBOLS

- Unit contact; dashed where approximate
- Outcrop, geologic observation
- Petroleum well. Includes oil, gas, oil and gas, dry service (water supply or injection), junked and abandoned, unknown. Modified from Natural Resources Information System database




Map Credits

Base map modified from a USGS topographic map of the Leonard quadrangle, dated 1957 and photorevised 1967 and 1973. Universal Transverse Mercator projection, 1927 North American Datum. Geology by Thomas M. Stanley, 2007-2008. Research supported by the U.S. Geological Survey, National Cooperative Geologic Mapping Program, under 07HQAG0074. The views and conclusions contained in this document are those of the authors and should not be interpreted as necessarily representing the official policies, either expressed or implied, of the U.S. Government. Cartography and layout prepared by G. Russell Standridge, 2008.




Cross section by T.M. Stanley.
10x vertical exaggeration.

# GEOLOGIC MAP OF THE LEONARD 7.5′ QUADRANGLE, TULSA AND WAGONER COUNTIES, OKLAHOMA

**Thomas M. Stanley**

2008