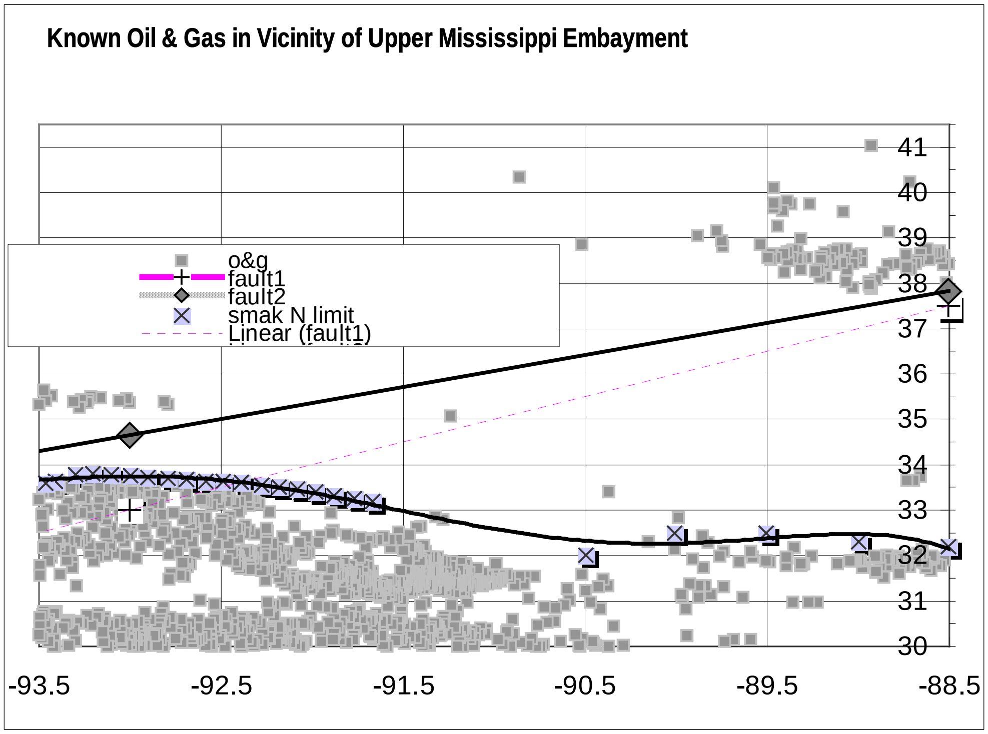
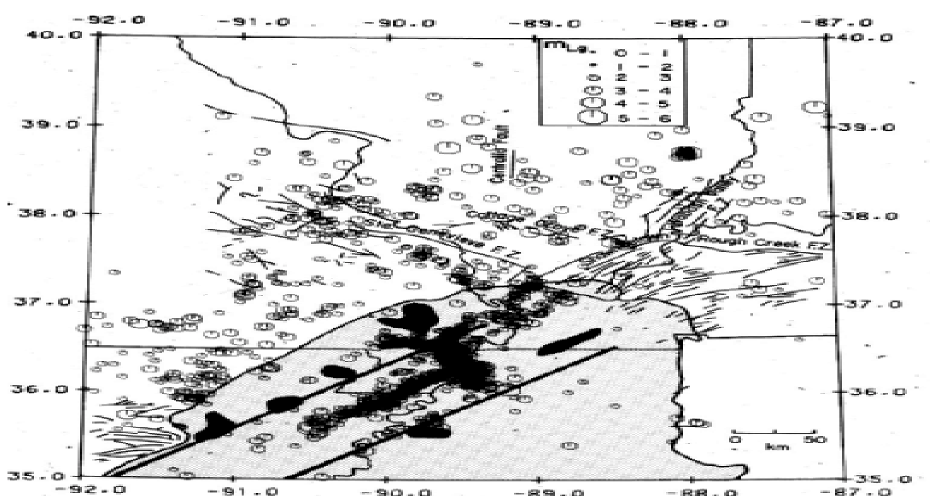
**Abstract:**




The late Cretaceous of the Mississippi embayment (ME) has produced large quantities of oil and gas to the south of north-east Arkansas (NEA). This first chart shows both late Cretaceous and other known oil and gas deposits in areas sourrounding NEA. With so much production around NEA, 'what makes it so difficult to find productive zones within NEA'? This area of Arkansas has been tested by some 500 dry exploration holes since early in the 20th century. Approximately 10 to 20 of test wells drilled since 1960 used modern well logs, all without reports of commercial production from the ME area of Northeast Arkansas and Northwest Mississippi.



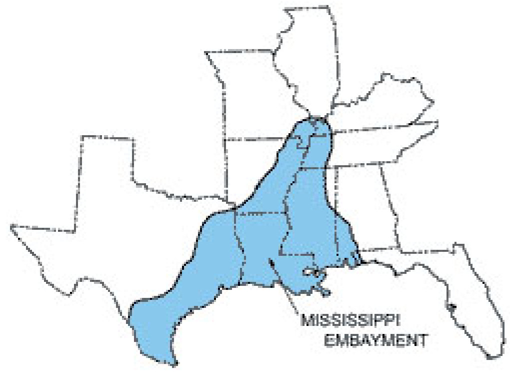

Absence of underlying Jurassic and lower Cretaceous rocks in the upper ME may contribute to a lack HC accumulation in the area. This is easily seen by over-plotting the trend line of the Smackover formation (Upper Jurassic) and known production. This, chart 1, shows most (but not all) production falls below this line.

It is proposed that the lack of Lower Cretaceous and Jurassic formations does not condemn the area from having H/C accumulations. Presence of igneous plugs, deep faults, (chart 2 above) and hydrocarbon shows within the area all offer hope that commercial hydrocarbon accumulations will be found in this area. But, given the number of prior test drillings and steep underlying slope of buried sediments indicates accumulation structures are likely to be both sparse and small.

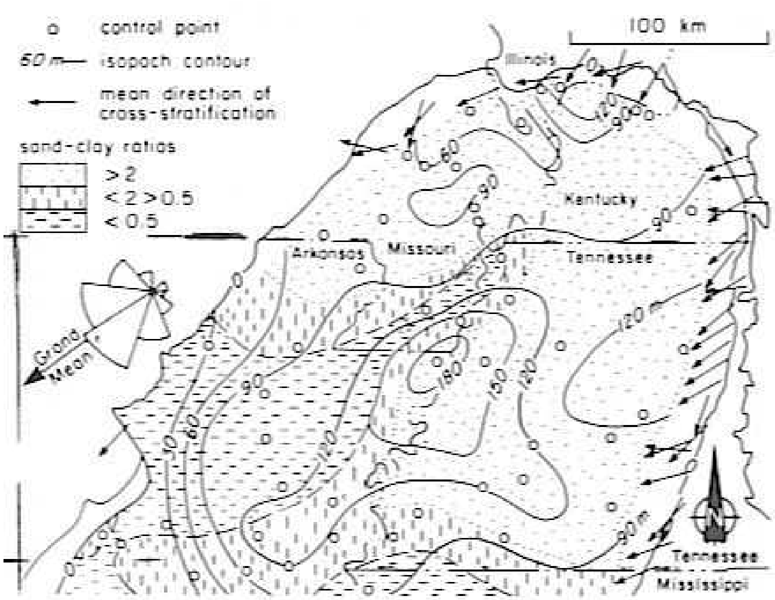
Details of this concept are provided in the following text.

**Introduction**

The ME, figure 3, is a large sedimentary basin deepening out into the gulf of Mexico, formed by deposits primarily transported by the Mississippi river and other tributaries draining the middle parts of continental USA. The Precambrian basement is in some instances more that 20,000 feet deep on the continent[38]. Adjacent to the NE corner of Arkansas' ME, BP-Amoco drilled a deep test dry-hole near Senath in the "boot-heal" of southeast Missouri, northeast Arkansas, between the 90m and 120m Nacatoch isopach contour[20], Figure 4. It found the Jefferson city dolomite at 1960 feet, with basement reached at 10,089 feet, after 24 drill bits, and total drilling time of 79 days. Other wells within the northeast Arkansas ME area have exceeded 10,000 feet, yet without commercial production.[28]




This discussion centers on, Cretaceous thru Pennsylvanian formations. The Navarro group forms the younger Gulfian Cretaceous. Navarro group production obtained thus far has been from large structural anomalies within the embayment, such as the Monroe Uplift of NE Louisiana, the Jackson uplift of SW central Mississippi, the El-Dorado fault zone of south central Arkansas and the Caddo Parrish area of the Sabine uplift in NW Louisiana and SE Texas. These latter three areas held massive oil deposits from same upper cretaceous rocks present in Northeast Arkansas ME.



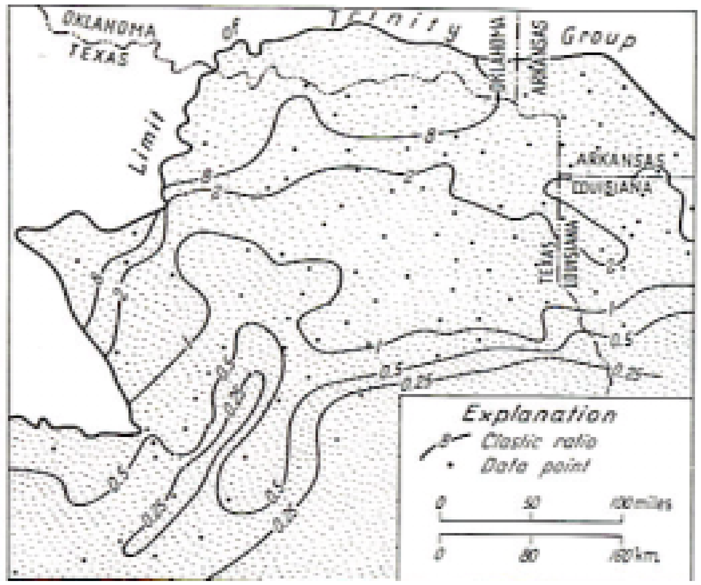

Caplin[2] notes: "in the Mississippi Embayment (ME) of northeast Arkansas… sediments of Upper Cretaceous age overlie Paleozoic rocks … uncomfortably … no Permian, Jurassic, or Lower Cretaceous (Commanchean) have been found . . the lower cretaceous is mostly absent in NE Arkansas … with the possible exception of Desha basin area... where the Eagle Mills, Cotton Valley and younger pre-upper cretaceous sediments may be represented in the deeper portions."

He further states: 'a basal detridal unit can be seen overlying the entire ME… since this basal sandstone is of variable age.. younger up dip .. only a limited sector can be contributed to the Tokio-Eutaw formation … the 600 foot thickness contour line on the cretaceous isopachous map is the tentative northwest limits of the Tokio-Eutaw phase of the basal unit.

**Caddo Parrish Chalk Rock Oil of Western Louisiana[10]**

Over 200 million oil barrels have been produced from the productive sediments of upper Cretaceous-Gulf series in the fields of Caddo Parrish, in the NW corner of Louisiana bordering Texas and Arkansas. The upper cretaceous sediments are:

- Nacatoch Sand (Navarro group)
- Saratoga Chalk (Taylor series)
- Annova chalk,
- deeper in the Austin group, are:
- Tokio sand and
- Tuscaloosa or Woodbine Sand.




The oil gravity is 20-25API in Nacatoch sands, Annova Chalk 30-42API and 30-36API from the Woodbine.

There are no spacing requirements and some area's produce at a density of 1 well per acre at rates of 3-20 bbls/well, although most wells produce at 1-2 bbls/well in the 21 st. century. A typical Annova well depth is 1500 to 2000 feet deep.

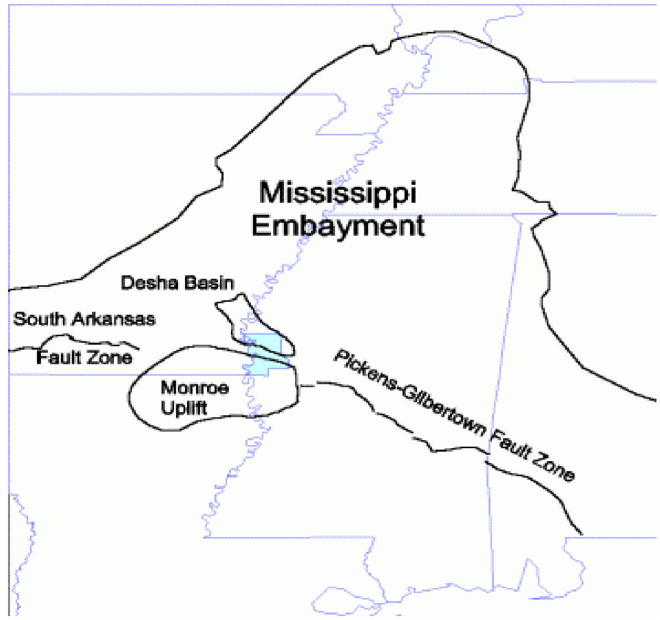
The Annova chalk of this area has typical porosity of 25-30% and 0 to 1.5md of permeability. Connate water, Swc, varies from 0.3-0.6 but clean oil can be produced from Swc up to 0.75.

Water salinity is typically 27,000ppm, Rw = 0.18, water viscosity in place 0.70cp, oil gravity at T=95F, is 34,API with viscosity of 5cp with a volume factor of 1.05. Typical well log[12, 15] parameters are:

- F=12.5,
- Rsn=8 om/m, at Rmud of 1.2, Rmf 0.80 at T=95F
- Rt=11,
- R.lat~9 $R_{LN}$ = 6.5
- Sw= 0.30 and oil mobility 1450 BBL/AcFt

**SW Arkansas**

In the area of El Dorado Arkansas, the south Arkansas fault zone and local structural highs produced large accumulations of oil in the upper Cretaceous-Gulfian series [3]. Total production from the shallow series exceeded 500 million barrels of oil. Transversing downwards the upper cretaceous sediments; Gulfian (Cenomanian) series in the fields of Union county Arkansas are: Arkadelphia marl, Nacatoch sand of the Navarro group, the Saratoga Chalk of the Taylor series, Marlbrook and the Annova chalk, the Ozan (Primm, Meakin, Graves or Buckrange sands) the Blossom sand of the Brownstown followed by the Tokio sand atop the lower cretaceous Kiamichi shale.




The depth of productive Nacatoch sands ranges from 1180 feet to 2250 feet, with oil gravity between 12 and 29 API, being predominately disposed to range from 14-22 API. The lower cretaceous is mostly absent in NE Arkansas. In the upper Cretaceous, production has been predominately from the Nacatoch, Tokio, and Meakin sands.

Lithological descriptions are easily referenced[3] for this area and are not repeated here. The connate water and porosity of the sands are high, with typical Bulk Volume Water being in the range of 0.10 to 0.14. Local sand porosity is typically 30%. Water TDS ranges from 5400ppm to 80,000 ppm in productive zones.
Nacatoch water TDS levels regressed to this equation: TDS=[(ft depth)$^{2.59}$]/10,000, rr=0.7

Transversing from bottom up the Lower Cretaceous formations (Trinity Group) of SW Arkansas are: Neocomian and lower Aptian is Travis Peak/Hosston; Aptian and lower Albian are Glen Rose group of Sligo, Pine Island, Rodessa, Ferry Lake anhydride., Moringsport, below the Paluxy; within the Middle Albian is the Gatesville group of Goodland lime atop the Walnut, all below the Kiamichi shale; the upper Albian being absent.

Below are tables summarizing known parameters for Cretaceous and the Nacatoch sand of south and SW Arkansas. The shallower production comes from up dip areas closer to the “fall line”.

OTHER CRETACEOUS FORMATION PRODUCTION PARAMETERS

| Field | Formation | N | W | D' frmn | TDS | P | Swc | md | cp | T,F | API oil |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Hampton | Meakin | 33.45 | -92.52 | 2500 | 93600 | | | | | | 12-18 |
| Bradley | Buckrange | 33.08 | -93.58 | 2788 | nd | | | | | | 26.3 |
| Lawson | Meakin | 33.19 | -92.47 | 2584 | nd | | | | | | 16 |
| Lenz | Paluxy | 33.4 | -93.8 | 2584 | nd | | | | | | 30 |
| McDonald | L.GlenRose | s25T15s | R18w | 2864 | nd | | | | | | 26-34 |
| N.Stephens | Buckrange | 33.4756 | -93.135 | 1995 | nd | | | | | | 26 |
| Spirit Lake | Paluxy | 33.3569 | -93.658 | 3010+ | nd | | | | | | nd |
| Rainbow City | Tokio & lower | 33.2531 | -92.528 | 2780+ | 60-100k | | | | | | 24 |
| Troy | Tokio | 33.54 | -93.17 | 2170 | 38.2k | 32 | .4 | 1.9k | 75 | | 22 |
| Garland City | Paluxy | 33.3994 | -93.783 | 3570 | 88.4k | 27 | .34 | 1.1k | 12 | | 34 |

NACATOCH SAND PRODUCTION PARAMETERS

| Area/Field | N | W | D' Nacatoch | TDS | TDS clc | P | Swc | md | cp | T,F | API oil |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Smak lo | 33.38 | -92.69 | 1925 | 41000 | 32113 | 0.30 | 0.3 | 1500 | 68 | 110 | 18 |
| Smak hi | 33.38 | -92.69 | 2175 | 59000 | 44057 | 0.25 | | 2250 | | | 23 |
| E.Eldorado | 33.24 | -92.58 | 2135 | 68000 | 41989 | | | | | | 20.5 |
| S.Eldorado | 33.17 | -92.68 | 2203 | 55000 | 45542 | | 0.4 | | 7.7 | | 33 |
| Irma | 33.55 | -93.22 | 1150 | 5400 | 8457 | 0.35 | .35-.45 | 2000 | 1200 | 85 | 14 |
| Stephen | 33.40 | -93.11 | 1350-1530 | nd | 16830 | 0.30 | | | | | 13 |
| Woodly | 33.17 | -92.58 | 2175 | 68400 | 44057 | | | | | | 21 |
| Lisbon | 33.31 | -92.82 | 2100 | 60000 | 40230 | | | | 7.6 | | 34 |
| Urbna | 33.17 | -92.43 | 2270 | nd | 49216 | | | | 7.7 | | 33 |
| Hillsboro | 33.16 | -92.51 | 2200 | 79000 | 45381 | 0.18 | 0.4 | | 30.3 | | 24 |
| Bragg. Camden | 33.52 | -92.90 | 1355 | nd | 12934 | | | | | | |
| Troy | 33.54 | -93.17 | 1250 | 21000 | 10495 | 0.30 | 0.4 | 18-800 | 1250 | | 14 |
| Falcon | 33.45 | -93.41 | 1180 | nd | 9040 | | | | | | 14 |
| Gum creek | 33.40 | -92.95 | 1590 | nd | 19571 | 0.28 | 0.24 | 491 | | | 21 |
| Hibank | 33.12 | -92.55 | 2075 | nd | 39001 | | | | | | |

**East Texas Field** [6, 7, 11]

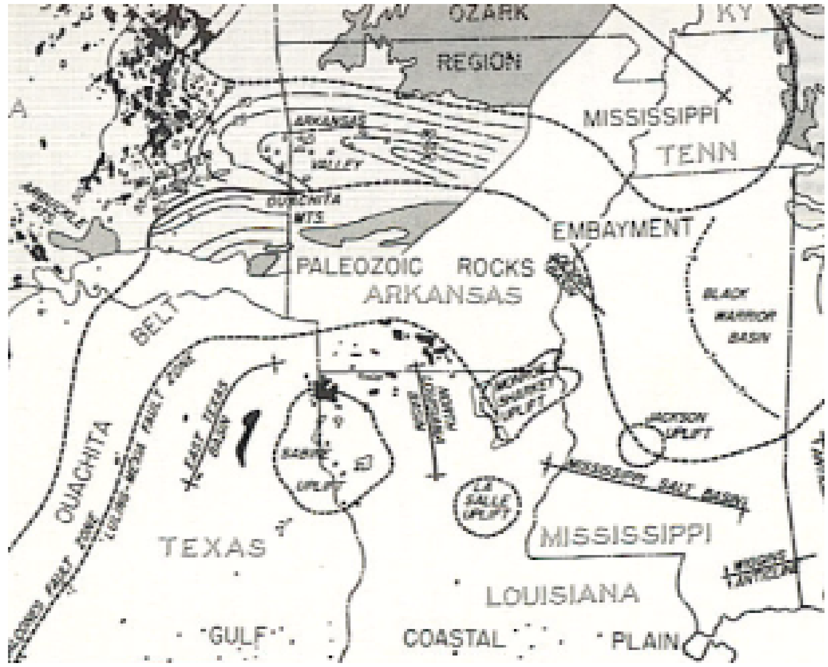
In 1929 Dad Joiner discovered the mammoth east Texas field. The Woodbine sand (-3250 ft). has since given over 3 billion barrels oil. Longview is at the NE edge of a sand lense type (not anticline) field. Errosional sands from Sabine uplift formed a 35 mile long sand bar along an ancient burried coast line. Encroaching seas burried the sandy shoreline under muds and when the area emerged, muds turned shales with the sandbar, at its eastern edge, a poorly consolidated sandstone[24].. Transversing the Gulf series of the upper cretaceous downward from the Eocene Midway, the formations are: Navarro group; Arkadelphia shale and marl, Nacatoch sand, and Neylandville; followed by the Taylor group of Pecan Gap dense chalk (not locally productive), Marlbrook, Buckrange, Blossom, and Tokio atop the Austin chalk group (Gober & Ector ) followed by the Eagleford shale/ sandy shale group (locally productive), sitting atop the Woodbine sand group. The Woodbine is the base of Gulfian series of upper cretaceous, the lower cretaceous being present along with Jurassic sediments. Approximately 16,000 feet of Tertiary, Cretaceous, and Jurassic sediments are present within the East Texas basin confines. Faults both north and south of the basin tend to run east to west.

**Jackson Mississippi Structure and Upper Cretaceous Chalks**

Gas was discovered in 1930 from a structural high known as the Jackson uplift, located on the east flank of the ME in the Gulf coastal plain[17]. The structural high is the result of uplift by an underlying igneous plug. The cap rock is Clayton lime of the Midway overlying the Selma chalk, sitting atop the Eutaw formation. Gas flowed from the Selma chalk formation at absolute depth of –2060 to –2200 feet. Gas production from 7500 acre of structure exceeded 65 billion cubic feet. The typical gas flow per well was in the range of 25 to 50 mmcfd.

Additionally, a heavy oil was found in Selma chalk. Three wells produced over 15,000 bbls oil in 2 years and much salt water. Initial oil well production varied from 50 to 200 bbl/dy from a total depth of about 2500 feet. The surface elevation varies from 270 to 340 feet.

Concerning the Selma formation: Caplin wrote, “along the embayment trough adjacent to northwest Mississippi, the Nacatoch grades into the Ripley of Mississippi which in turn constitutes the upper portion of the Selma in the northern part of that state” … near the embayment trough the Ozan of Arkansas is generally related to the Selma facies and is not readily separated as a lithological entity… depositional environments near the embayment trough were generally more closely related to those of Tennessee and Mississippi than to the conditions governing sedimentation in southwest Arkansas & north Louisiana, consequently the Taylor & Navarro age sediments identified in the shallower portions of the embayment grade basin-ward into the Selma & Ripley formations of those other states.




Production from Jackson structure Selma Chalk of late cretaceous age is similar to Niobrara chalk of eastern Colorado and western Kansas. Where gas production was established from the Smoky Hill Chalk member of the upper cretaceous Niobrara. North Sea production is also from late cretaceous age chalk. Scholle, notes that, "gulf coast chalks such as the Austin, Selma, and Annova were deposited in shallower water (than those of the North Sea), as evidenced by bioherms and erosional water channels. Such on-shore chalk deposits are significantly thinner than offshore chalks. For example: Isopachous maps of Upper Cretaceous and Danian chalk of the North Sea have thickness of up to 1200m and 700m for the Maestrichtian chalk section alone. But onshore sections of upper cretaceous chalks of Europe and USA typically range much thinner, Niobrara, 0-300m, Austin, 85-185m". It is possible that thinner sections are off-set by increased porosity in less deeply buried sediments, as seen in excellent well productivity of the Jackson structure.

The Selma has also produced gas in Jasper County Mississippi from both Sharon and Heidelberg fields. Some wells of the Heidelberg field reported oil stains in the Selma, p67 DeVries.

**Tokio-Eutaw Age Oil & Gas Pools of Jasper County Mississippi**

Jasper County [4] has been an important petroleum province in Mississippi producing over 100 million barrels of oil and 50 billion cubic foot of gas, from primarily upper cretaceous rocks. A significant proportion of this production has been from the upper cretaceous Eutaw formation. Production from this area is typically along the Pickens-Gilbertown fault zone, on fault bounded structures.

For the Heidelberg Field, Masonite#1 of Jasper Co. Miss., S36-1N-12E, the log parameters were as follows: lateral R18'8" was 7om/m, R16" =4.6, and R64"=3.5 with SP of –25mv, logged 1954 with Schlumberger ES tool. [22]

Caplin considered the north and western limits of Tokio-Eutaw age basal cretaceous unit of the ME in NEA to lie along the 600 foot cretaceous isopach contour line. He considered the NEA basal unit to be of variable age as either Nacatoch, Saratoga, Tokio-Eutaw, Ozan, Tuscaloosa-

Woodbine, Meakin, Buckrange, Blossom, or Graves, depending on overlying sediments.

Eutaw Age Production Statistics of Jasper County Mississippi

| | N | W | ft-d | ft-d | t-ft | por% | md | Swc | T, F | API | GOR |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Eutaw E.Hieldbg | 31.900 | -88.997 | 4509 | 5061 | 39 | 27.9 | 767 | 33 | 151 | 19-26 | 120 |
| Up Tuscaloosa | 31.881 | -88.99 | 4844 | 5020 | 55 | 28.8 | 1500 | 30 | 151 | 23.4 | 77 |
| Eutaw-Masonite | 31.881 | -89.02 | 4874 | 4884 | | 29.5 | 700 | 50 | 120 | 24 | |
| Eutaw | 31.879 | -89.01 | 4956 | 5147 | 21 | 29.6 | 1500 | 50 | 122 | | |
| Eutaw-West | 31.883 | -89.03 | 4772 | 5318 | 31 | 28.8 | 630 | 37 | 150 | 19-33 | 207 |
| Massive. Tuscaloosa | 1n12e | | 6256 | 6266 | 20 | 29 | | | 150 | 34.2 | 100 |
| Christmas gas | 31.813 | -89.32 | 6590 | 6732 | 15 | 28.8 | 3000 | 14 | 177 | 66.4 | 37000 |
| Stanley gas | 31.804 | -89.31 | 6444 | 6538 | 14 | 25.5 | 700 | 44 | 177 | 61 | 40700 |
| Eutaw gas | 10n11w | | 5490 | 5605 | 33 | 28 | 465 | 72 | 162 | 52 | 176000 |

**Monroe Uplift Area Production of NE Louisiana**

Another major structural feature located in the ME of Arkansas, Louisiana, and Mississippi is the Monroe Uplift. Production from the Monroe Uplift area has been a major production province of Louisiana. Normal production depths ranges from 1800 to 3200 feet for Monroe gas rock. The Gas-Rock is a faces of the Arkadelphia & Nacatoch formations.

The Monroe uplift was described by Caplin as: situated on a northwest-southeast trending line of weakness which coincides with the projected trend of the Ouachitaw mountains under coastal plain sediments .. taking form in upper cretaceous time and persisted as an up warp into the tertiary period…. a platform reef type limestone deposit of Navarro age covering the Monroe uplift in basin areas… in areas of maximum development the Monroe Gas Rock facies may be found to replace in entirety both the Nacatoch & Arkadelphia formations. Off structural highs the gas rock lime become more sandy.

Doyle[31] states: oil and gas production from chalks is found from south Texas to Alabama". The Austin, Annova, Selma, Saratoga, and "*Monroe*" formations all produce from chalky facies[32]. A typical Monroe Gas Rock well is the Epps #1, (N32.644 W91.441), flowing 1/2mmscfd of gas at a depth of 2345 feet. Caplin[2] list other examples of reef type, fossiliferous, sandy, crystalline limestone found locally within Nacatoch-Ripley sections as: Crittenden Co. AR (Sanderson1, S15T6N-7E), Nelson 2A, Poinsett Co. AR, Bateman1 Shelby Co. TN.

**Western Black Warrior Basin (BWB) in Mississippi**

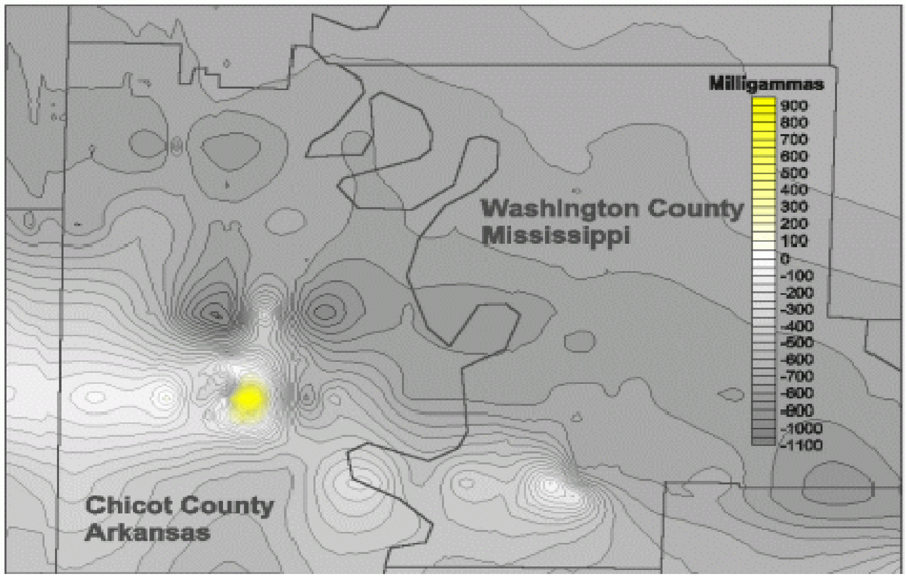
In an extension of the BWB, gas was discovered in Monroe County[25] adjacent to northwest Alabama. In 1926, the Carter#1 struck Paleozoic gas at a depth of 2402, flowing 5mmcfd for some years. The well was drilled about 7 miles SE of Amory MS (N33.99W88.49) [18]The gas analysis of Carter #2 gas is as follows: $CO_2$ 0.78%, Oxygen 0.47%, C1, 96.1%,

| Monroe Well | el, ft | Paleozoic top' | Comment |
|---|---|---|---|
| Cowart 1 | 342 | 149.3+ | Oil & Gas Show 3800ft rig burnt down |
| Hall 1 | 488 | nd | 2400ft oil show |
| Carter 1 | 512 | -208.4 | 2400ft gas 1/3mmscfd |
| Carter 2 | 489 | -40.5 | 2580ft 1/2mmscfd gas |
| Carter 3 | 490 | -44 | 2404ft 4 mmscfd |
| Harris 1 | 455 | -23 | 2400ft 5mmscfd gas |
| Bourland 1 | 274 | -126 | 745 & 1085ft oil show, 2900gas |
| C Rye 1 | 234 | -356 | 2870ft 1/2foot oil sat core |
| FL Rye 1 | 232 | -372.6 | 2700ft gas |
| CC Day1 | 198 | -522 | 4000ft gas show |

C2, 1.1%, N 1.4%, He, 0.16%. This gas is typical of Arkansas Ozark Paleozoic gases from the opposite side of the ME. Arkansas Atoka gases are “distinguished by an unusually high C1 (95-98%) content, low % of higher hydrocarbons and nitrogen with a relatively high % of oxygen”[2].

Contrast the Paleozoic gas types to typical associated gases in which Helium and Oxygen are never present. [13] For example the deep (255F) Smackover “Plum Nearly” gas from SE Mississippi has only 74.7% C1, no oxygen nor helium, and a full compliment of heavy gases, through Heptanes. [14]

**Desha Basin**



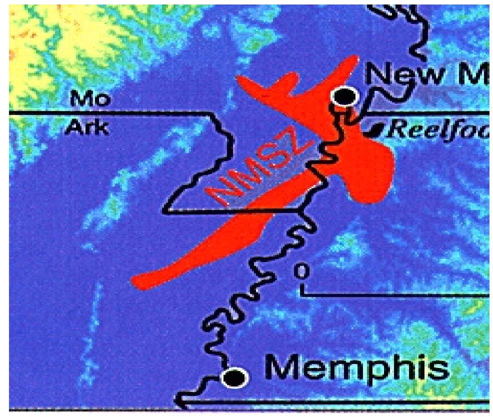

Igneous plugs are common around the ME of Arkansas. Examples of intrusive effects include: Murphysboro, AR Diamond pipe (only active diamond mine in USA), Hot Springs AR mineral baths with radon water, Granite mountain quarry in Little Rock, around which 2 large silver plugs were found, the NMSZ of northeast Arkansas, the abandoned zinc mining district of Sheridan. The Desha Basin is shown as an example of a large collapsed igneous plug found in the ME of Arkansas. The yellow dot represents the eye of the pit and darker colors, more elevated areas.

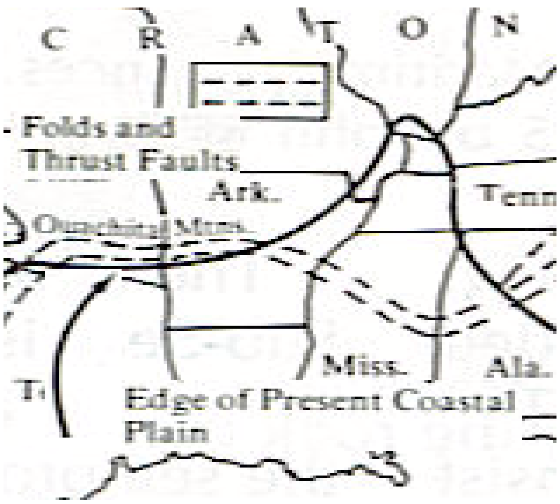
In drillings around the Desha Basin oil shows were reported by Caplin along with samples of igneous rock. Some examples are:

| County | S | T | R | Well Name | Comment |
|---|---|---|---|---|---|
| Grant Co. | 34 | 4s | 13w | Youngblood 1 | Igneous Plug –2254 feet |
| Pulaski | 21 | 2s | 11w | Wilson 1 | Igneous Rock 1544 |
| Ashley | 25 | 17s | 6w | Crossett Lumber 1 | IP 3283 |
| Ashley | 8 | 18s | 4w | Williams 1 | I.R. 3287 |
| Ashley | 29 | 17s | 4w | Betty 1 | I.R. 3001 |
| Ashley | 23 | 16s | 5w | Cone 1 | IP 4755 |
| Ashley | 33 | 16s | 4w | Gay 1 | I.R. 3166 |
| Ashley | 11 | 18s | 4w | Keifer 1 | I.R.-2901 |
| Ashley | 28 | 17s | 4w | Fee 1 | Oil gas shows I.R.-2295 |
| Ashley | 34 | 17s | 4w | Cooperage 1 | Oil gas shows I.R.-2350 |
| Chicot | 17 | 18s | 1w | Dowdle 1 | I.R. 3245 |
| Chicot | 9 | 15s | 2w | Thudium 1 | I.R.4090 o&g shows-3957 |
| Cleveland | 25 | 11s | 9w | Reap 1 | IR 4204 |
| Drew | 13 | 15s | 4w | Jerome 1 | I.R. 3454, 3540 |
| Desha | 34 | 8s | 3w | V. Cross 1 | I.R.4875, typ. 3 others S34 |
| Cross | 4 | 6n | 5e | Park-G 1 | I.R.3720 |

An example of production from sediments near an igneous plug is the Dollar Lake Field of Leflore County, Miss., (N33.394W90.368). Pay dirt was hit at 6536 feet and 6650 feet in the Lower Cretaceous of GW Brogden1. It flowed 169 and 120 bbl/dy of 49API oil from the Hosston formation of the lower cretaceous[24]. The listed tops for the well were: Selma 3510, Eutaw 4148, Hosston 5890, Cotton Valley 6890 and Igneous 8630 feet.

Another area within the Arkansas ME of known igneous intrusions lies along the New Madrid Seismic Zone, NMSZ. The right figure outlines the NMSZ, to the east of Crowley's Ridge. The NMSZ is an active earthquake zone, second possibly only to the activity of California. Seismic activity from the NMSZ in early 1800's was likely the largest witnessed in continental USA, altering even the course of the mighty Mississippi river. It is also accepted that Crowley's Ridge is an up faulted area[23].




Another feature of interest are thrust faults thought to be associated with deeply buried Ouachitaw mountians[20]. To the east of the fall line of Arkansas these mountains are covered by relatively flat tertiary sediments.

**Lack of Water Salinity**

One consideration in basin analysis concerns water salinity, specifically, the lack there-of in NEA, The below table of salinity for Nacatoch sand in NEA, shows water TDS to be 3000 ppm or under above north latitude 35.7°. This is not a consideration for some petroliferous deposits found close to the surface, such as, Athbaska Oil Sands[25], Berea Tar Pits, nor the Venezuela heavy crude[27]. Neither has a lack of water salinity been a consideration for upper Cretaceous, Wasia deposits of the Arabian Gulf. [26] Examples are the Gulfian series of the Mishrif, Rumaila, Ahmadi, and Wara reservoirs of the Dammam Field where gas deposits are found, the 12API oil of Khursaniyah field in the Wara, the 27 API oil of Safaniya, Ahmadi, and Wara reservoirs. All these deposits are found in brackish waters of the Wasia Formation in Arabian Gulf. The Wasia Cretaceous formations of Arabia are Turonian & Cenomanian age upper Cretaceous series, corresponding to the Gulfian series of NE Arkansas. Water salinity for the Arabian Wasia formations are in the 7,000 ppm range, or brackish waters.

| East ° => | -92.0 | -91.5 | -91.0 | -90.5 |
|---|---|---|---|---|
| 10k TDS | 34.5 | 34.6 | 35.0 | 34.7 |
| 3k TDS | 35.0 | 35.4 | 35.7 | 35.2 |
| TDS | isothere | North ° | | |

Given below is a plot of Nacatoch resistivity in the ME of NEA. The lack of water salinity is indicated by the increasing resistivity in the NW areas.

**HC Shows**

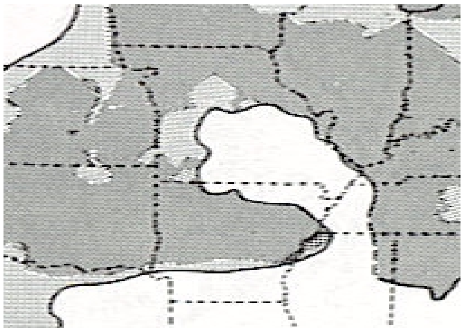
Documentation of oil shows in the ME of NEA are available, but scarce. Arkansas reports edited out shows which could not be independently verified. Some confirmed shows are [1 & 2]:

- Monroe County, AR, vicinity of Cotton Plant: wells reported to flowed salt water with a small amount of gas[1,2]p13, p39, driller log indicate faulting between Nathan 1 and Miller1 with a 50 ft difference between tops
- White Co., AR[2]: Deeprock1 Sample gas flow: 3512-74 feet from St. Peter S/S p29
- White County AR[26]: various reports from water well drillers of shallow gas shows, both flammable & non flammable and one producing gas well near the city of Paingburn.
- White Co[1] Curl.1, S10-9N5W Penn1318' Ordv. 4100' 4330' dolo w/ waxy shale p152
- White Co[1]. Sheridan1 S31-T6N-7W top Paleozoic at 335' Atoka 1675-1700 tight fine grained s/s w/oil stain, p153-4, .
- St. Louis Mo[2]., Kimmswick Ordovician LIME oil production p62
- In "NE Ark &SE Missouri the Nacatoch is fresh water bearing but some wells show dead oil staining & asphaltic material[1]…"
- Arkansas Co.[1]AR, Rosencrantz1 S2-3S-6W, Schlumberger: Nacatoch top, 3024, core 3054-71 contained few beads of oil oozing from an 8 inch piece of sandy laminated shale… sand streaks at top of core with slight oil odor on fresh break. Pg17.
- H. Johnson #1 in Craighead[1] Co. AR, S10-13N-1E Nacatoch top 770 core from 790-816 very porous sandstone w/ dead asphalt stain p37.
- Hinkle #1 S17-13N-6W Independence Co. AR, Batesville S/S at 19ft. gas pocket at 77ft and again at 285ft, hole boiled up like kettle-heavy boiling, Drillers note, Well verified by USGS[1], p63, Chattanooga shale at ~590-700ft md.
- Prairie Co. AR, Novak1, S36R2N6W, 2896' DST SW w/small gas, upper Paleozoic[1] p121
- Lee[1] Co. AR, Comer1 S17T3N2E, 3235'brown-sandly lime w/asphalt, 3580 top Penn. Atoka-Lower detridal asphalt stain p83
- St.Fran. Co[1].AR, Tombaugh1 Nac. 2164-2455, core 2209' 6" sand dead asph. stain p141
- Cross Co[1].AR, Poinsett Lumber Co. #1, Wilcox 1017-1715ft, at 1410ft a trace of asphalt like stain which did not fluoresce, p57.
- Tallahatchie Co. Miss[18], S32T26N3E, Bardwell1, Approx. 34.05$^{o}$NW89.98$^{o}$, 300ft=elev., lower Midway1880' gas show, lower Arkadelphia, gas show in sandy shale at 2124ft, hard sandy shale 2180' w/gas oil show bailed dry w/o o&g show, 2238-2261 oil gas shows, recovered 2 meter of paraffin core, 2264 black wax oil residue, 2355 hard Selma chalk

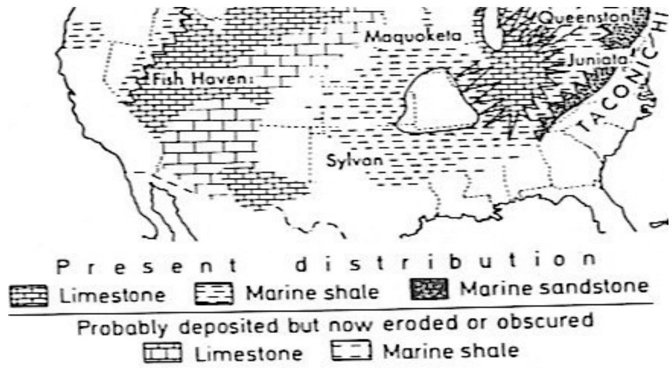
**Source Beds with-in the ME of NEA**

One series of source beds not present directly within the ME of NEA are the Jurassic and lower Cretaceous. However, HC migration up dip from the southern areas is one possibility of HC accumulation within the ME of NEA. The deeper Paleozoic beds are another source for the ME of NEA. Production from Paleozoic zones may not be as prolific as areas where lower Cretaceous and Jurassic beds are present, but is never the less feasible. For example, production from the Illinois basin is primarily from Paleozoic beds of Pennsylvania and older age[8]. Ordovician age production is common in Michigan basin, West Texas[9], Golden Belt trend of Oklahoma[33], parts of Kansas[36], and the Baltic Sea area of NE Europe[26].

Fayetteville shale thickness is thought to be up to 400ft, it gives H/C odor on fresh break, distills petroleum H/C's. Presently, one company is leasing 15mm$ of land for a Fayetteville shale gas play. It is equal to the Caney shale of Arbuckle's with 500ft maximum thickness in the ME of NEA.

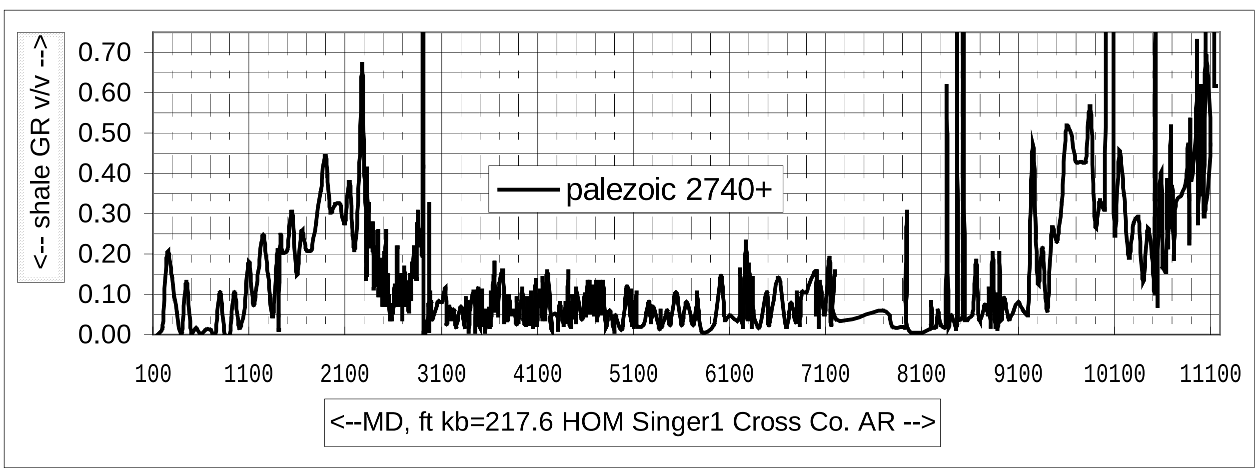


The Chattanooga Shale (left[19]) is considered Mississippian to Devonian age. It is present over much of the ME of NEA. The maximum thickness is predominately under 30ft. Freshly broken samples, in outcrops near Batesville, yield a petroleum odor and are rich enough to burn and also distills hydrocarbons, upon heating.



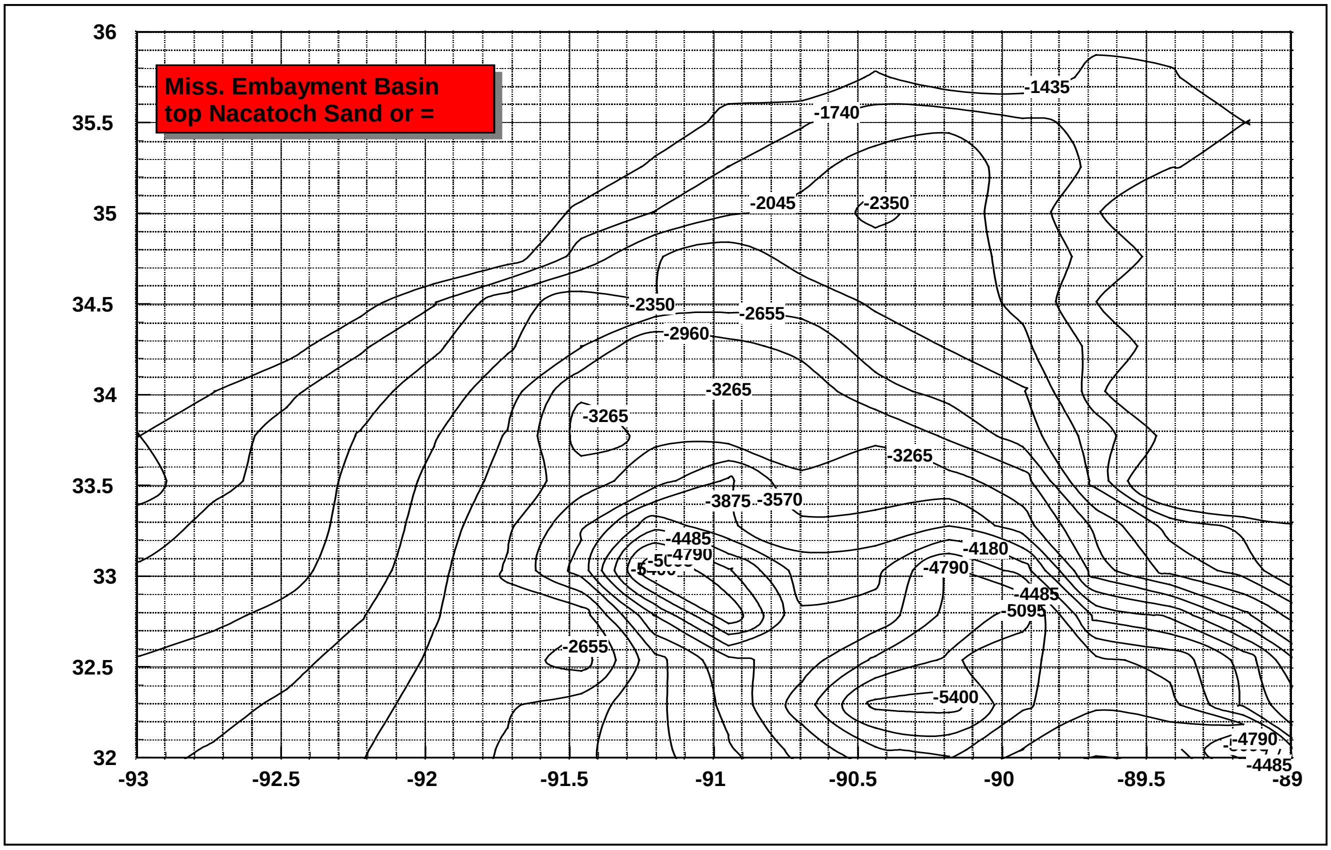

The Cason Shale is of upper Ordovician age. It is age equivalent of the Sylvan[19] shale in Arbuckle basin and Maquoketa in Illinois, map. The thickness in ME of NEA is thought predominately under 20ft.

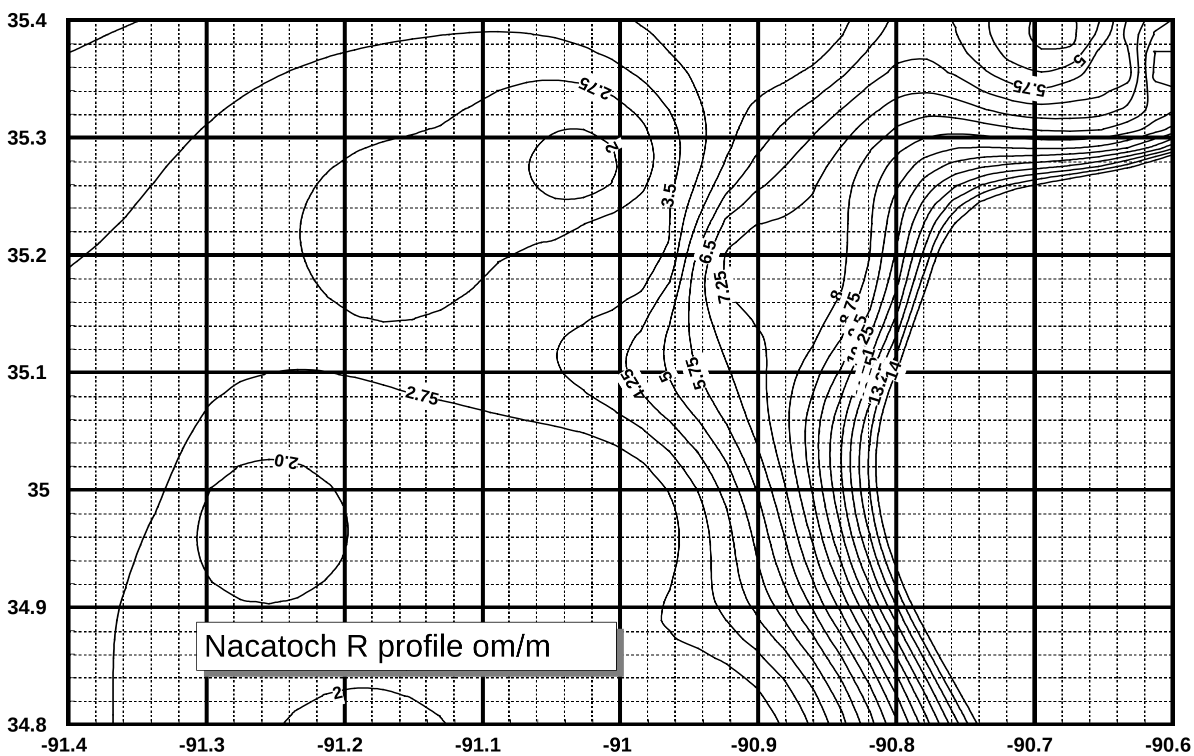
"The Alsobrook series of formations in Mississippi[22] which includes the Mississippi-Age sands, Cripple Deer and Hargett are strongly asphaltic and are quarried for road Asphalt near Cherokee Alabama (n34.76w87.97) the Allsboro sand is also asphaltic, the Southward pond limestone "A" is quarried for road asphalt at Margerum and Colrock Alabama… bitumen bearing limestone and sand suitable for Asphaltic road pavement exists in small areas of Tishomingo Co. Miss." (n34.85w88.32), p73., 61.




Above is a graph of shale volume for the Singer 1 prospect of Cross county, Arkansas. Several deep shales can be seen, as well as some more shallow shale sections.

Below is a depth contour plot of Nacatoch-McNary-Selma-Monroe Gas Rock depth within the ME in and around the vicinity of northeast Arkansas. This upper cretaceous group was chosen because it is the oldest continuous over a large area.


Miss. Embayment Basin
top Nacatoch Sand or =
-1435
-1740
-2045
-2350
-2350
-2655
-2960
-3265
-3265
-3265
-3875
-3570
-4485
-4790
-4180
-4790
-4485
-5095
-2655
-5400
-4790
-4485
36
35.5
35
34.5
34
33.5
33
32.5
32
-93
-92.5
-92
-91.5
-91
-90.5
-90
-89.5
-89


Nacatoch R profile om/m
2.75
2.75
3.5
6.5
7.25
4.25
5
5.75
5.75
2.0
2
35.4
35.3
35.2
35.1
35
34.9
34.8
-91.4
-91.3
-91.2
-91.1
-91
-90.9
-90.8
-90.7
-90.6

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Appendix 1 **SP Method Analysis Basis**

Sw = √(FRw/Rt) and Sxo = √(FRmf/Rxo) => Sx/Sw = √[(Rmf/Rw)(Rt/Rx)]

Taking logs of both sides gives: 2[log(Sx/Sw)] = log(Rmf/Rw) + log(Rt/Rx)

Multiply both sides by K: 2K[log(Sx/Sw)] = Klog(Rmf/Rw) + Klog(Rt/Rx) rearrange:

-Klog(Rmf/Rw) = -K[log(Rx/Rt) + 2log(Sx/Sw)]

The term, -Klog(Rmf/Rw) is the Static Self Potential, SSP, allowing for K in the usual definition of SP. A typical value of K is 75. A more detailed value of K in terms of formation temperature is ($^oR_f$)./7.63

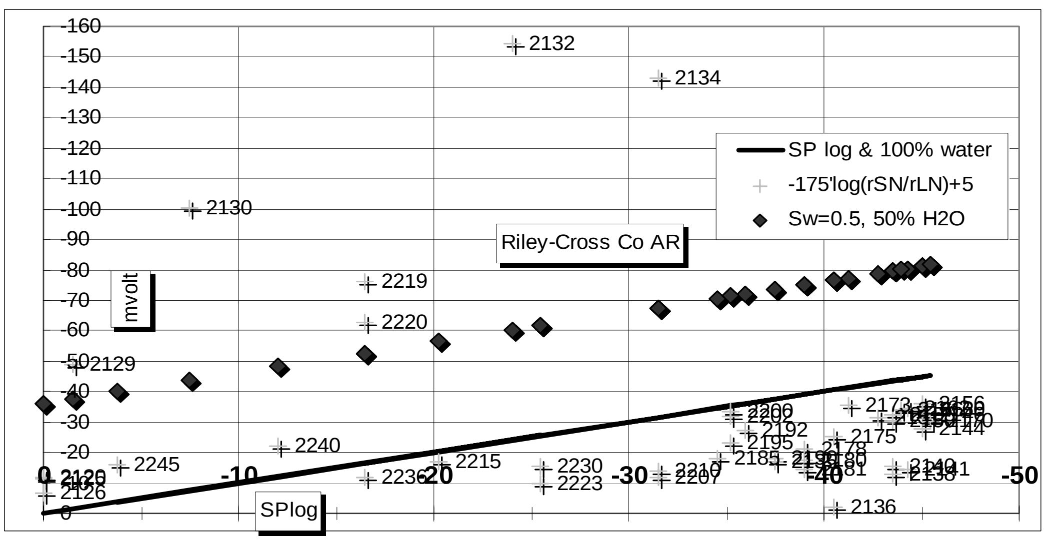
SSP = Klog(Rt/Rx) - 2Klog(Sx/Sw) = -Klog(Rx/Rt) - 2Klog(Sx/Sw)

Subsitution of: Sx =Sw^0.2, gives Sx/Sw = 1/Sw^0.8

SSP = -K[log(Rx/Rt) - 1.6log(Sw)]

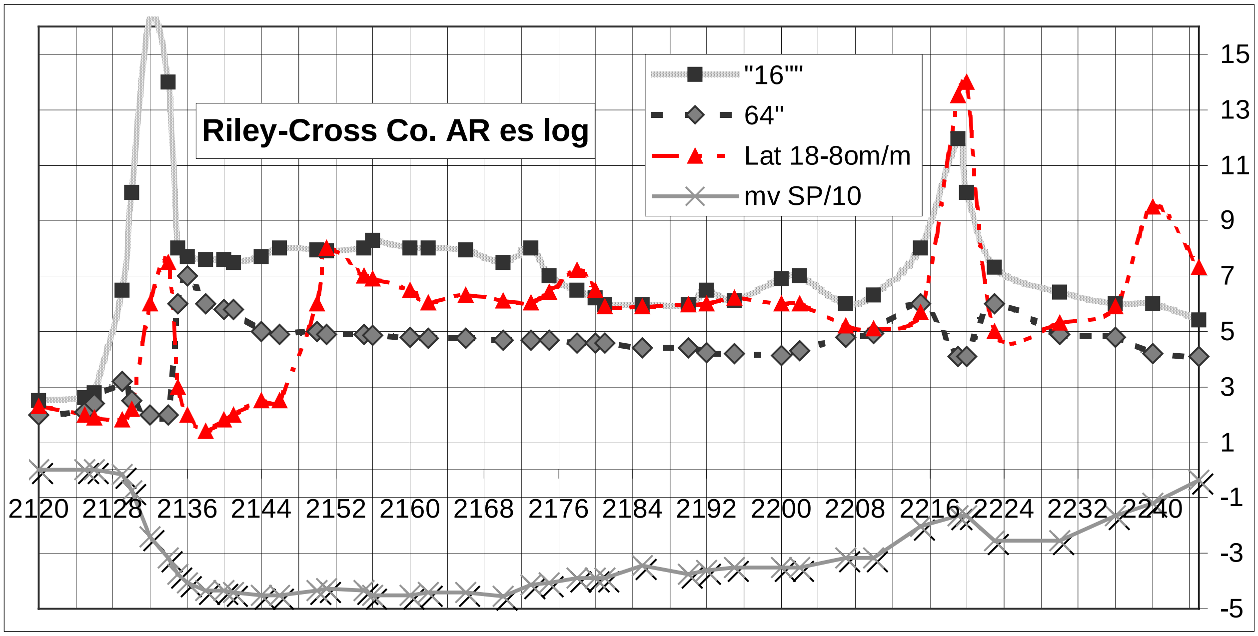
When Sw is unity, a plot of SP vs. -Klog(Rx/Rt) will form a straight line, called the water line, provided measured SP reflects the static SP

For any given $SSP_o$, at Sw=1, it is possible to calculate the saturated $SSP^w$ at various water levels as




$SSP^w = SSP_o + 1.6Klog(Sw)$

The method is illustrated by the above plot for the Riley-Surrat-1 of Cross Co. Arkansas. The trend of –Klog(Rx/Rt) +C is plotted by determination of C's value to make the water line cross at 0,0. In the above plotted case, C and K were empirically determined, using Rsn as Rxo and long normal as Rt.

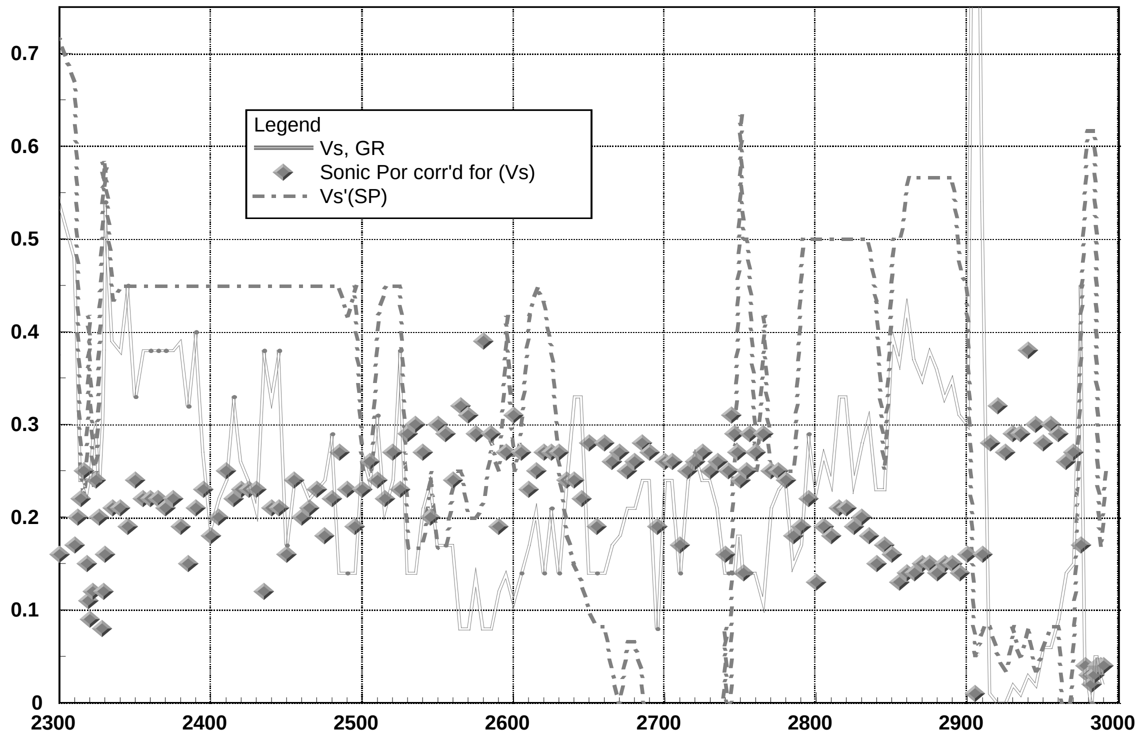



Hydrocarbon accumulation is indicated below each limestone cap in two zones a)2129 to 2134 and b) 2219-2220. The oil to water contact, OWC, in zone A is indicated between 2136 and 2142, as seen in decreasing resitivity of 64 and 16" normal. The decreasing short normal between 2224 and 2230, with constant SP, also indicates an OWC zone, the high lateral value at 2222 also indicates a thin HC zone.

The only reported core analysis of NEA was from the Engler1 of Petroleum Products Co., St Francis county AR, (N34.96 W91.12), no oil or gas show in any core. Particulars are: elev datum logging tool = 209ft, top Wilcox : 1160ft, top Midway 1670, top Arkadelphia 2180ft, Nacatoch 2236ft, Rm =3.1 at 77F, TD=2725, AO LN=24ft., AM SN=16in. From the Core analysis reported results are:

| Depth | k, md | Por % | lithology | Rsn | R-LN | R-Lat | SP, mv |
|---|---|---|---|---|---|---|---|
| 1665ft | 222 | | dark grey sand | =3.3 | 3.3 | 1.95, | -30 |
| 2250ft | | 25% | dark grey limy sand | 3 | 2.0 | 2.5 | -55, |
| 2252ft | 24 | | dark grey limy sand | 3 | 2.0 | 2.5, | -55 |
| 2256ft | 219 | | shaly sand, | 2.06 | 2.06, | 1.4 | ASP=-20, |
| 2268ft | 47 | | dark grey limy sand | 2.3 | 2.3 | 2.5 | ASP=-20 |
| 2294ft | 504 | 34% | grey sand | 2.3 | 2.3, | 2 | ASP-30 |
| 2255 –2273 | | | | 4.0 | 1.7 | 2 | SSP -55 |

Two limestone caps were found, one at top of Nacatoch at 2240ft and second at 2280 ft, Rsn 1st cap of t=10ft was 5om/m and 2nd cap SN = 7.8, with t=5ft, Nacatoch sand persisted from 2245 to 2420ft. average R lat was 2.5, range 1.5 to 3.5 below 2390 to 2507 was Nacatoch shale of about 2om/m resistivity. Detridal SS was only 10ft thick atop Atoka at 2700ft and below Marlbrook-Saratoga




The above chart for HOM Singer 1 well is presented to help explain low permeability of the highly porous Nacatoch sands. In this well, east of Crowleys Ridge, the Nacatoch is only from 2315 to 2333 feet and Paleozic Top sits at 3030 ft. Sonic Porosity is reduced by the shale factor using [porosity*(1-Vsh)]. Shale volume is calculated from the gamma ray tool. As a check, shale volume is also calculated from the SP curve. The chart shows mostly good porosity, but shale content mostly above 25%. Notable exceptions are just below 2900 feet and just above 2600 and 2700 feet. The presence of small shale particles tends to reduce permeability.

Engler 1 St Fran Co. driller log

| | d, ft | discription | | d, ft | discription |
|---|---|---|---|---|---|
| Claiborne | 135 | ? Claiborne Top | | 1120 | gravelly snd |
| | 260 | cement drilling plug | | 1143 | vfg ss w/shly mtrx |
| | 270 | gry flaky clay lignite trace | Wilcox | 1155 | formation top |
| | 300 | grey grity fissle shale | | 1160 | med ss trc por |
| | 330 | sandy cly | | 1170 | med ss trc por dead stain |
| | 350 | fissle ligntic shle | | 1300 | layered slty ss & shle |
| | 360 | poorly fissle shale | | 1385 | faint stain tght lamnr ss |
| | 370 | fg p/srt shly tght snd | | 1405 | as 1385 w/thk lign at base |
| | 395 | poorly fssle shle | | 1435 | slty ss |
| | 440 | loose sand trace chert | | 1445 | thk lignt |
| | 460 | sandy clay | | 1530 | anglr ss trce por |
| | 495 | loose sand trace lignte | | 1540 | slty ss |
| | 510 | gritty brn cly..poss dead stn | | 1590 | sndy shle w/ trc lign |
| | 555 | shly ss | Midway | 1645 | PORTERS CREEK fmnTop |
| | 565 | fissle ligntic shale | | 1655 | sndy shle |
| | 590 | siderite ss w/shly matrx | | 1670 | slty ss |
| | 610 | plastic cly few sndy spots | | 1700 | gritty shle |
| | 650 | silty cly trce lignte | Midway | 2100 | fissle shle CLAYTON top |
| | 680 | poorly fissle shale | Arkadelphia | 2180 | calcrcs shle |
| | 700 | shaly ss | | 2212 | calcrcs shle |
| | 705 | plastic clay | | 2236 | shale |
| | 740 | shly ss | Nacatoch | 2240 | frmn top |
| | 750 | poorly fissle shale | | 2400 | ss w/layers dnse l/s |
| | 800 | vfg ss w/shly mtrx | Saratoga | 2510 | calc shale |
| | 810 | poorly fissle shle | | 2600 | calc shale |
| | 925 | fg ss shly matrx | marlbrook | 2690 | calc shale |
| | 930 | plastic shle | | 2698 | calc snd pryte |
| | 1070 | fine2crse ss in shly mtrx | basal s/s | 2690 | ss w/qrtz basel ss |
| Claiborne | 1088 | CANE RIVER Frmn top | atoka | 2705 | atoka |
| | 1100 | sndy shle w/gravel Top SW | | 2725 | TD |
| | 1110 | plastic shale | | | |

209Ft El datum Rmud 3.1/ 77F 127F bht

Start june 1947, complete Aug24 1947.

Below is a chart of drilling time in feet/hr for the No.1 LW Robinson drilled 1948, in Lee Co. AR. The average drill time was 19 feet/hour. The median variance range was max time of 45f/h and minimum of 13f/h.
The called tops follow as: Unspecified aluval at less than 250ft., Jackson 250 ft, Clairborne 740ft. Cain River member of Clairborne 1220ft, Wilcox 1430, Midway top Porter Creek member 2205, top Clayton member and base Porter creek Arkadelphia top 2725, Nacatoch top 2785, Saratoga Top 3075, Annova Marlbrook top 3175, Ozan top 3448 Atoka top 3545ft measured from elevation of 203ft. The well start was May10 and completed June 14 in Pennsylvanian Atoka at TD of 3643.