West Gulf Coastal Plain

Overview

The West Gulf Coastal Plain, located in the southwestern quarter of the state, extends from the Oklahoma border on the west to the Bayou Bartholomew on the east (Fig. 1). It is approximately 100 miles wide (north to south) and 160 miles long (west to east). Elevations vary from 432 feet above sea level at DeQueen on the west to the floodplain of the Bayou Bartholomew on the east where the elevation is 184 feet. The landscape is especially hilly in the DeQueen area, near the Oklahoma border, and flat-lying near Monticello on the east. The region is crossed by four major river systems including the following: Red, Little Missouri, Ouachita, and Saline, all of which have well developed tributary networks. These drainage systems create a hilly, "rolling" landscape marked by numerous floodplains (Fig. 66).

At Caddo Valley, Scenic 7 leaves the Paleozoic-aged rock of the Ouachita Mountains and enters the younger sedimentary rocks and alluvial deposits of the West Gulf Coastal Plain. The sedimentary rocks and sediments exposed along Scenic 7 range in age from Early Cretaceous-age (145 million years ago) to Quaternary Period –Holocene Epoch-age sediments (recent to 11,700 years ago) (Fig. 67). The soft, fossil-bearing sedimentary rocks of the region are essentially flat-lying (dips less than one degree toward the south).

Rock Types Exposed Along Scenic 7 in the West Gulf Coast Plain

(Based on McFarland, 2004)

(Rock types are listed from youngest to oldest, map symbols follow formation names.)

Alluvium (Qal)

Age: Holocene Epoch (11,000 years ago to recent).

Description: modern stream-laid deposits, up to 25 feet thick, consisting of gravel of various sizes, usually overlain, by sand, silt, and a variety of clay types. None of these sediments are lithified. Usually, these "bottom-lands" contain significant amounts of organic matter (humus) making them excellent agricultural areas. Many of the gravel particles are novaculite and chert from the Ouachita Mountains and Cretaceous-age formations in the West Gulf Coastal Plain.

Environment of deposition: stream and river channels and flood plains.

Terrace deposits (Qt)

Age: Holocene Epoch (11,000 years ago to recent).

Description: The types of sediments just described as alluvium are also present in the terrace deposits. Most terraces are less than 50 feet thick and several ten's of feet above the modern flood plain.

Environment of deposition: A terrace is an old flood plain that was "left behind" as the river or stream responsible for the original deposit shifted course and eroded a new, deeper channel.

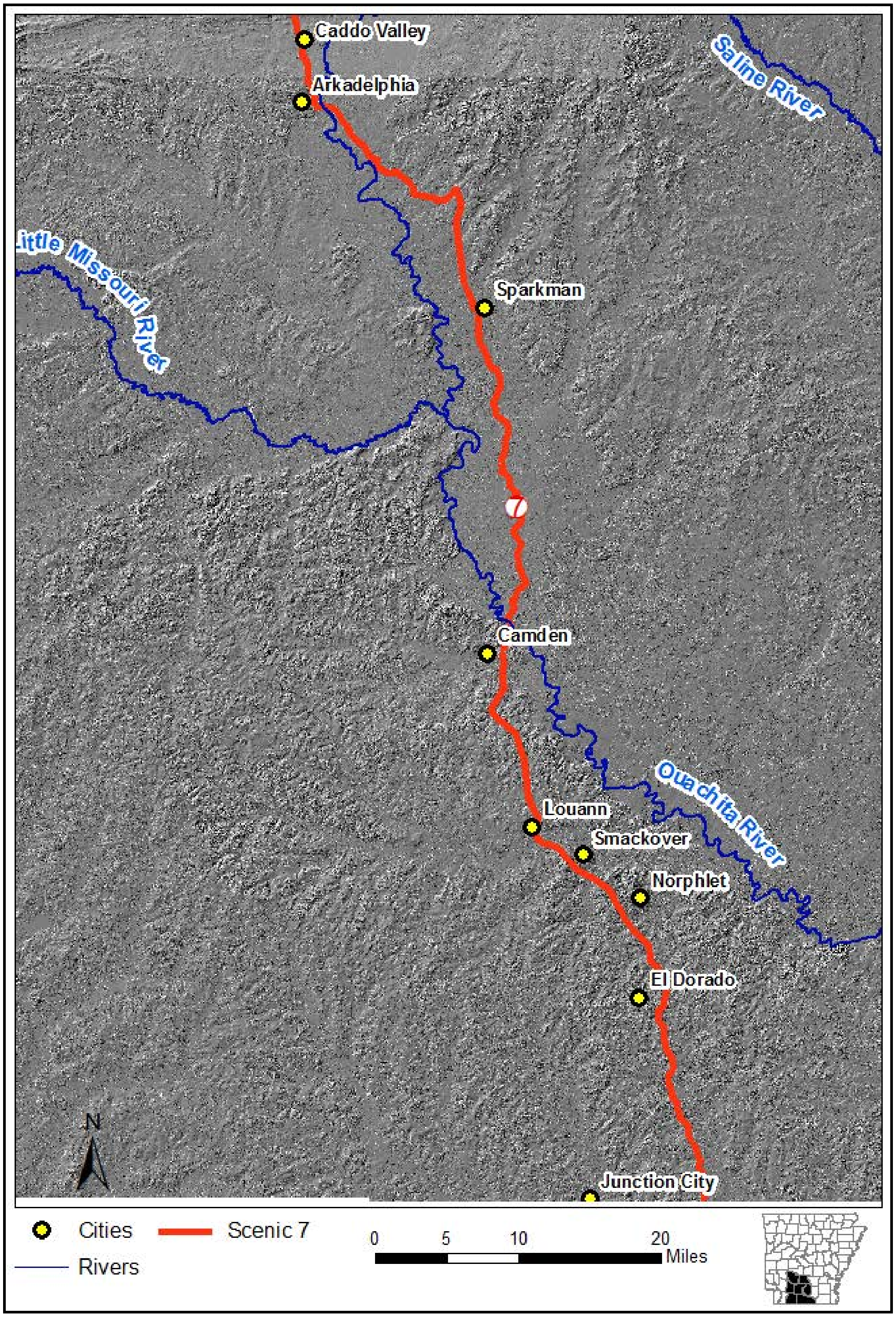

Figure 66. Shaded topographic relief map from Arkadelphia to El Dorado
(source, Arkansas Geological Survey)

Claiborne Group (Tc)
Age: Tertiary Period, Eocene Epoch (56 to 34 million years ago).
Description: medium to fine sands, silts, and silty clays. Some zones (levels) contain a significant amount of plant-derived, carbon-rich deposits. Lignite (soft brown coal) deposits are present in areas that were originally coastal swamps. Fossils in the Claiborne include: leaf impressions, woody material in the lignite beds, and reptile and fish bones and teeth. The Claiborne's lower contact is unconformable and the thickness ranges from a few feet to 1,500 feet.
Environment of deposition: coastal swamps and embayments, where low-lying, land-derived sediments were intermixed with marine sediments.

Wilcox Group (Tw)
Age: Tertiary Period, Eocene Epoch (56 to 34 million years ago)
Description: fine sands, silty sands, light gray or brown clays, and gravels with several thick beds of lignite; plant fossils and trace fossils are present in some lignite deposits and clays associated with the lignite. The Wilcox’s thickness ranges from very thin to over 1,000 feet, while the average thickness is reported to be 850 feet.
Environment of deposition: non-marine.

Nacatoch Sand Formation (Kn)
Age: Late Cretaceous Period (approximately 75 million years ago)
Description: unconsolidated sand, often yellow to gray in color that usually contains some of the following types of interbedded sedimentary materials: hard, fossil-bearing limestone; glauconite-bearing (an iron-bearing clay mineral, often called greensand) sandstone; clay-rich blue to black sand; light-gray clay; and calcite-bearing clay. The following types of fossils have been collected from the Nacatoch: corals, echinoderms, bryozoa, brachiopods, clams, cephalopods, gastropods, sea worm and crab parts, and shark teeth. The Nacatoch is separated from alluvium at its top and the underlying strata by unconformities. The Formation ranges from 150 to 400 feet in thickness.
Environment of deposition: shallow marine.

Brownstown Marl/Formation (Kb)
Age: Late Cretaceous (approximately 85 million years ago)
Description: clay-rich marl (a mixture of calcium carbonate and clay); some thin sandy limestone, sandy marl, and fine-grained sand. Colors are tan, brown, blue, green, red, yellow, gray and any combination depending on amount of weathering and iron content. Maximum thickness is about 250 feet, but thins east and west from the type locality in Howard County.
Environment of deposition: shallow marine.

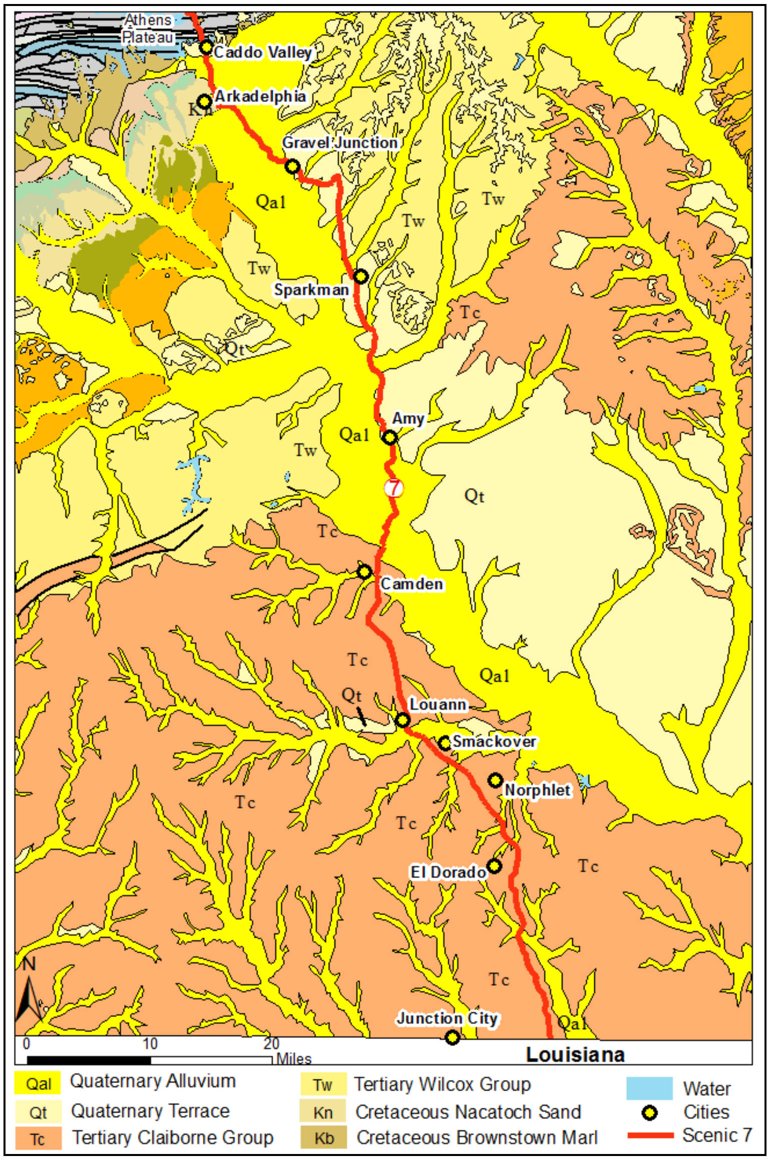

Figure 67. Geologic map of the West Gulf Coast Plain along Highway 7 from Arkadelphia to the Louisiana border
(from Geologic map of Arkansas, 1:500,000 scale)

West Gulf Coastal Plain Geologic History

(Based on Guccione, 1993)

During the Mesozoic Era (251 to 65 million years ago), the large continent formed by the collision of ancestral North America, South America, and Africa began to break apart due to sea-floor spreading (rifting). In the Jurassic Period (200 to 145 million years ago) rifting had progressed enough for the Gulf of Mexico to begin forming. The Gulf was relatively shallow and some areas became isolated enough to cause deposition of evaporate sediments: rock salt (halite) and calcium sulfates (gypsum and anhydrite). During the Cretaceous Period (145 to 65 million years ago) and the following Tertiary Period (65 to 2.6 million years ago), sea level continued to rise and sediments covered the southern edge of the Ouachitas forming the West Gulf Coastal Plain. The Ozark Plateaus and Ouachita Mountains remained above sea level and weathering and erosion of these exposed rocks produced sediments.

The fifth physiographic division of the state (Mississippi River Alluvial Plain) formed during the Tertiary Period. A billion-year-old graben structure in the basement igneous rock underlying the region (Reelfoot Rift, aka Mississippi River graben) was reactivated and extended northward from the ancestral Gulf of Mexico into North America creating what is known today as the Mississippi Embayment. The Embayment (Mississippi River Alluvial Plain) contains Tertiary and upper Cretaceous-aged sedimentary rocks, and alluvial sediments deposited by the Mississippi River.

Rock and Mineral Resources

Clark County

Sand and gravel are the most utilized mineral/rock resource in Clark County. However, the county has the following additional resources: crushed limestone, chalk, clay, and lignite (Fig. 68). Also, a mercury ore deposit was mined in the western part of the county south of the town of Amity. The mercury sulfide mineral (cinnabar) is present in fractures related to the thrust faults in the Jackfork Sandstone and Stanley Shale of the Athens Plateau. Mining of cinnabar began in Pike County in 1931, extended into western Clark County in 1939, and continued until 1946. Total production of refined mercury was over 950,000 pounds for the entire district over the 15 years of mining. The amount produced in Clark County was about 285,000 pounds. No commercial mining for mercury has occurred since 1946.

Dallas, Ouachita, and Union Counties

These counties have similar mineral/rock resources of clay, sand and gravel, and lignite (Fig. 69). Lignite is a soft brown-black coal that has about half of the heat production value of high-rank bituminous coal. Lignite has been blended with bituminous coal and used as a furnace fuel to generate electricity. However, it was recognized in the early 1900's that Arkansas lignite could be distilled to produce up to 38 gallons of crude oil per ton with an average yield of 25 gallons per ton (AGS Website, 2012). It is estimated by the Arkansas Geological Survey that the state contains about 4.3 billion tons of lignite in the Wilcox Group (Tertiary Period, Eocene Epoch) within 150 feet of the surface. This amount of lignite could produce approximately 2.6 billion barrels of liquid petroleum products. Such an amount is estimated to be about 14 percent of the crude oil reserves in the North Slope Field in Alaska.

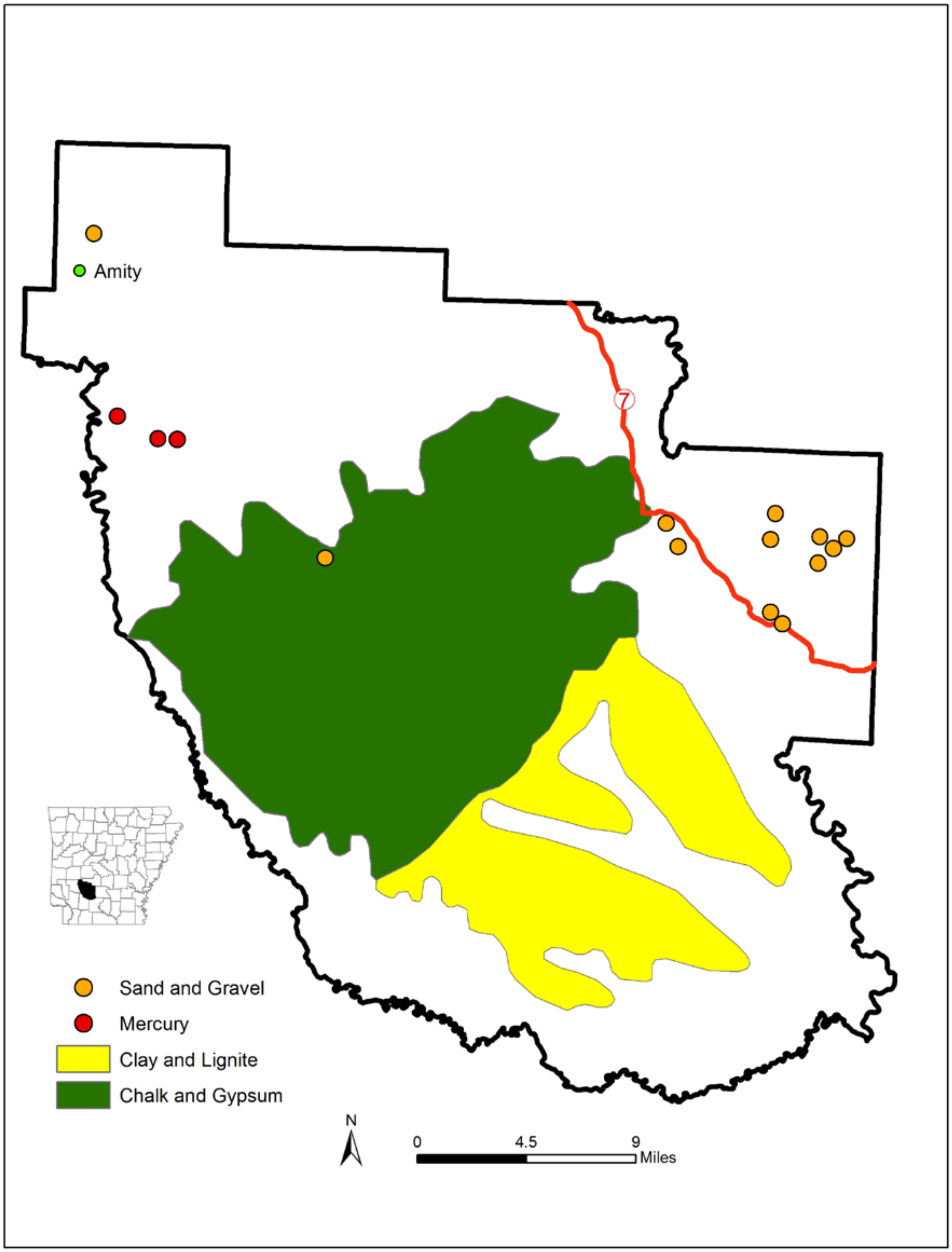

Figure 68. Rock and mineral resources of Clark County
(from Arkansas Mineral Resources, page size map**)**

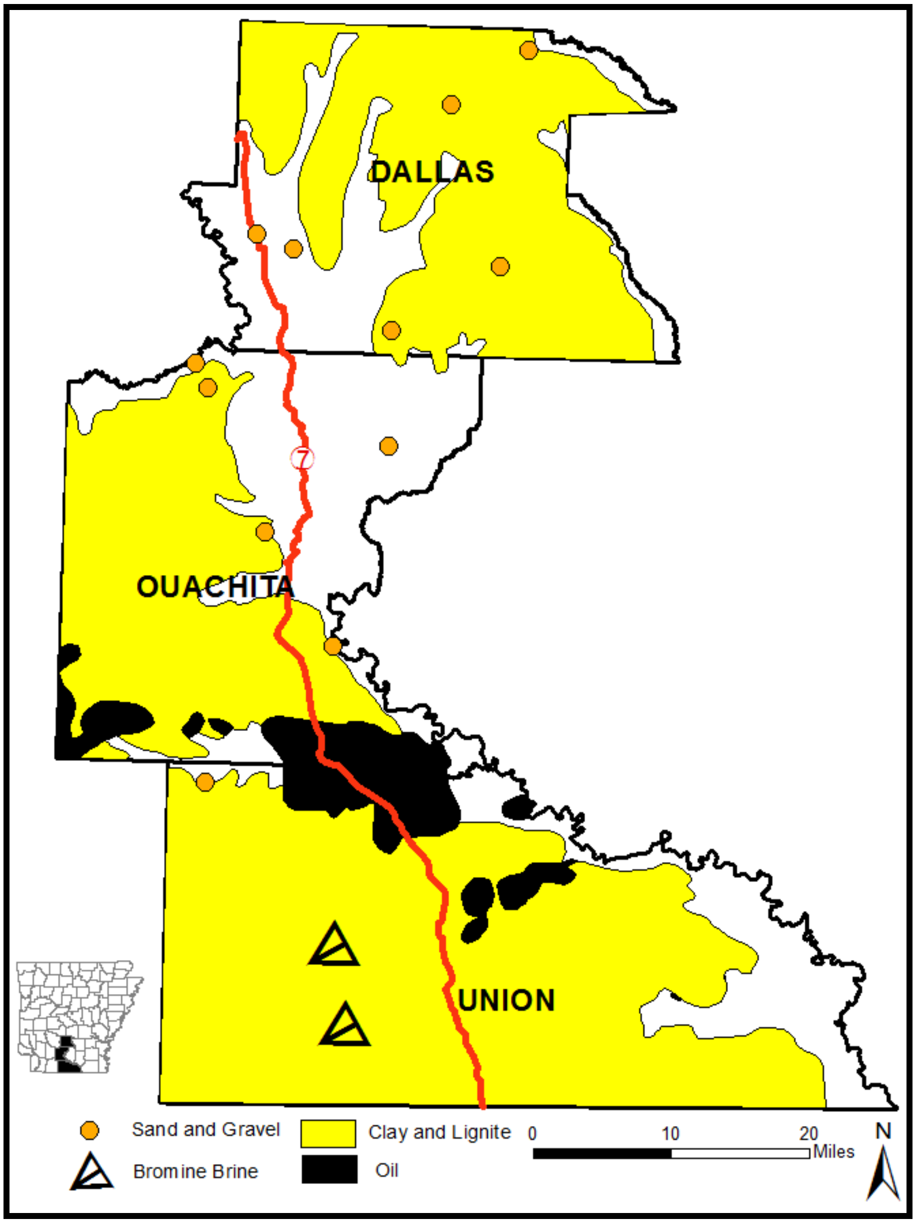

Figure 69. Rock and mineral resources of Dallas, Ouachita, and Union Counties
(from Arkansas Mineral Resources, page size map)

South Arkansas Oil

Ouachita and Union Counties

Scenic 7 passes through Arkansas' oil boom area of the 1920's. The towns of Smackover and El Dorado lie in the center of a ten county oil/gas-rich region. Eighty-five percent of the oil production has come from the following four counties: Union, Lafayette, Columbia, and Ouachita. If you have seen the movie “Boom Town” starring Clark Gable and Spencer Tracy you have seen Hollywood’s version of what that era was like. However, the real story is more interesting, amazing, and colorful than Hollywood’s.

After the discovery of oil in 1901 near Beaumont, Texas, interest in oil prospecting in surrounding states grew at a feverish pace. By 1910 there had been 47 wells drilled in Arkansas. Thirty-seven of these wells produced gas for which there was no market, but none produced oil. There were unsuccessful wells drilled in 1914 and 1916 near the Union-Columbia county line. Many of these early prospects were drilled where there were gas seeps at the surface. The Hunter No. 1 wildcat well was drilled in Ouachita County in 1920 with some oil being found, but not in commercial quantities.

The real oil boom in Arkansas began January 10, 1921 with the successful completion of a well a mile southwest of the town of El Dorado, a name that means “the Golden One”. The well, known as the Busey No.1, tapped into the Nacatoch sand at a depth of 2,233 feet. It began producing a mixture of gas, oil, and salt water with a roar that was heard over 2 miles away. The gusher spewed several hundred feet into the air and oil landed downwind as much as a mile away. Busey No. 1 produced as much as 10,000 barrels (a barrel equals 42 gallons) of oil per day. At 50 cents per barrel, the price in 1921, that works out to $5,000 per day, not bad. At today’s price, averaging about $100 per barrel, that amount of crude oil would be worth $1 million per day, now that is real money! However, the flow only lasted 45 days. But, that didn’t matter to speculators and wildcat oil prospectors.

About a year after the Busey No. 1 discovery, a geologic structure known as the Norphlet Dome was drilled about 8 miles north of El Dorado. The gas cap above the oil sand in the dome was penetrated and the gas pressure was so great the well blew out forming a surface crater 500 feet wide and 150 feet deep which swallowed the rig and all of the drilling equipment. The Smackover Field had been discovered with a bang!

Rapid expansion of the area took place and in three years it covered 40 square miles. By the end of 1922 there were over 900 wells in operation in Arkansas and production was 10,560,841 barrels for the year. In 1925 the Smackover Field was the largest oil producing area in the world! Some of its wells produced over 50,000 barrels per day! The peak of the oil boom in south Arkansas occurred in 1925 with 3,483 wells in production. That year the area produced 73 million barrels of oil. There was so much oil being produced it could not be hauled or piped away fast enough, so “crude” storage facilities were constructed. Pits were dug and earthen dams were piled up. Crude oil was stored in open lakes until it could be pumped into tankers and transported to refineries. Many personal fortunes were made and two well-known oil companies were founded, Murphy Oil Company and Lion Oil Company.

To see a graphic portrayal of the Arkansas Oil Boom, please visit the Arkansas Museum of Natural Resources in Smackover on Scenic 7 (Fig. 70). It is free and well worth your time.

Since 1970 annual oil production in Arkansas has declined from approximately 20 million barrels to 5.8 million barrels in 2011 placing the state 17th among the 31 oil-producing states. Using traditional drilling methods crude oil reserves are estimated to be 31 million barrels. However, horizontal drilling and advanced well completion methods could significantly increase crude oil production and reserves.

(A)

(B)

Figure 70. Modern pumper (A) and oil well (B) on display at the Arkansas Museum of Natural History

South Arkansas Brine Production

In the 1920's oil producers in Arkansas had a problem disposing of all of the salt water that accompanied oil production, especially the brines produced from the Smackover Formation (Late Jurassic age, 144 to 206 million years old). These brines contain approximately 70 times more bromine than is present in modern sea water. The bromine was considered to be "worthless" and difficult to manage. Today, it is recognized that bromine has significant value.

The commercial recovery of bromine began in 1957 from oil wells in Union County. Bromine is a reddish-brown liquid chemical element that gives off poisonous, corrosive fumes at room temperature. This dangerous chemical requires specialized equipment and well-trained personnel for its successful recovery and marketing.

Arkansas leads in production of bromine and supplies 40 percent of the world's need. Bromine is used in the manufacture of medicines, herbicides, pesticides, disinfectants, anti-knock motor fuel additive, and numerous other chemical applications. In 2011 the production was 289,818,680 barrels valued at approximately $400 million.

Road Log – Arkadelphia to Camden

As we leave Arkadelphia, the Ouachita River is crossed and the landscape becomes one of broad, flat fields. These excellent croplands are the result of the modern Ouachita River and its ancestor depositing vast amounts of alluvial sediment (gravel, sand, silt, and clay) over the past several thousand years. Scenic 7 roughly parallels the river, crossing the alluvium of the floodplain, until the road climbs onto the river terrace near the Gravel Junction community (Fig. 71). From this location the road remains on the higher elevations of the river terrace to avoid periodic flooding on the river alluvial plain. Scenic 7 remains on this "high ground" until the Amy community is reached.

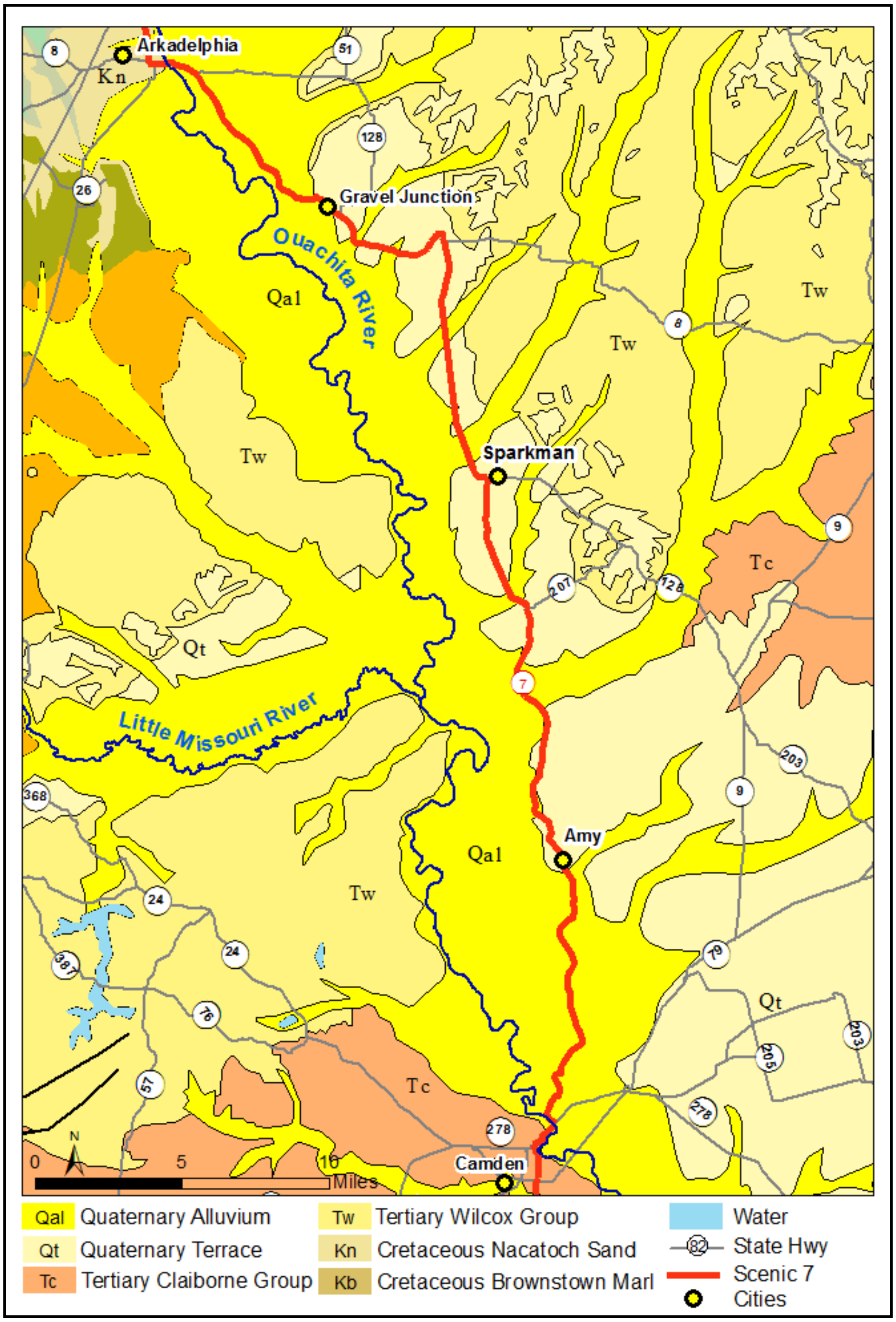

Figure 71. Geologic map from Arkadelphia to Camden
(from Geologic map of Arkansas, 1:500,000 scale)

Approximately 0.5 mile south of Amy, Scenic 7 once again crosses the river alluvium. The "rolling" character of the landscape is due to erosion caused by modern streams, as they cut away at the soft alluvium. The road remains on alluvium the rest of the way to Camden, where we will once again cross the Ouachita River (Fig. 72).

Figure 72. Ouachita River at Camden (33°35′49″N 92°49′05″W)

Road Log – Camden to Louisiana State Line

From Camden to the Louisiana State Line Scenic 7 traverses the Claiborne Group of Tertiary-Eocene Epoch-aged (56 to 34 million years ago) sediment (Fig. 73). This Group is composed of mostly unconsolidated, non-marine sediment (gravel, sand, silt, and clay) (Fig. 74). In some localities the Claiborne contains beds of lignite. Since the Claiborne is unconsolidated few outcrops exist along the road; vegetation covers most of the road right of way along this last 40 miles of Scenic 7.

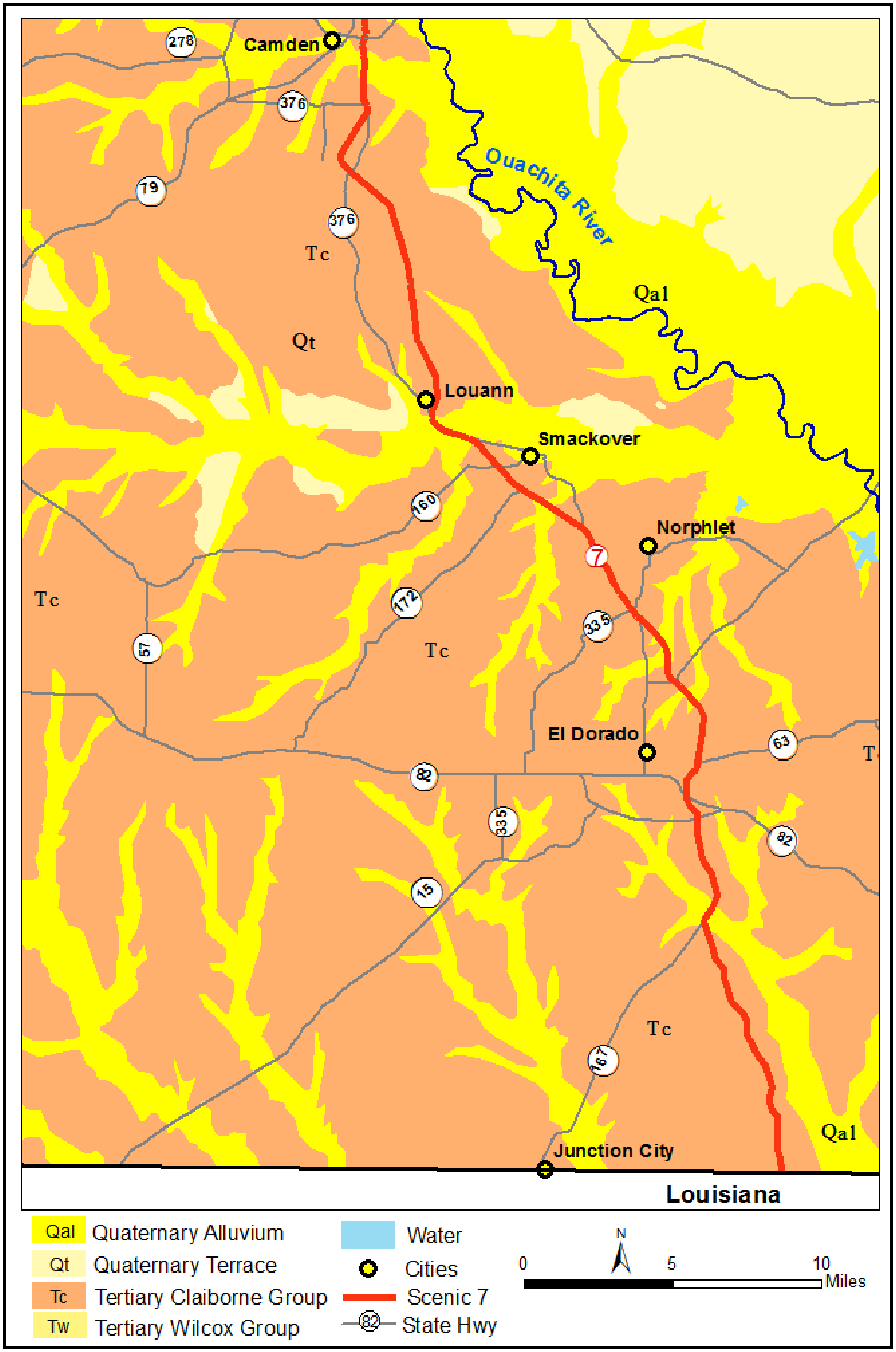

Figure 73. Geologic map from Camden to Louisiana state line
(from Geologic map of Arkansas, 1:500,000 scale)

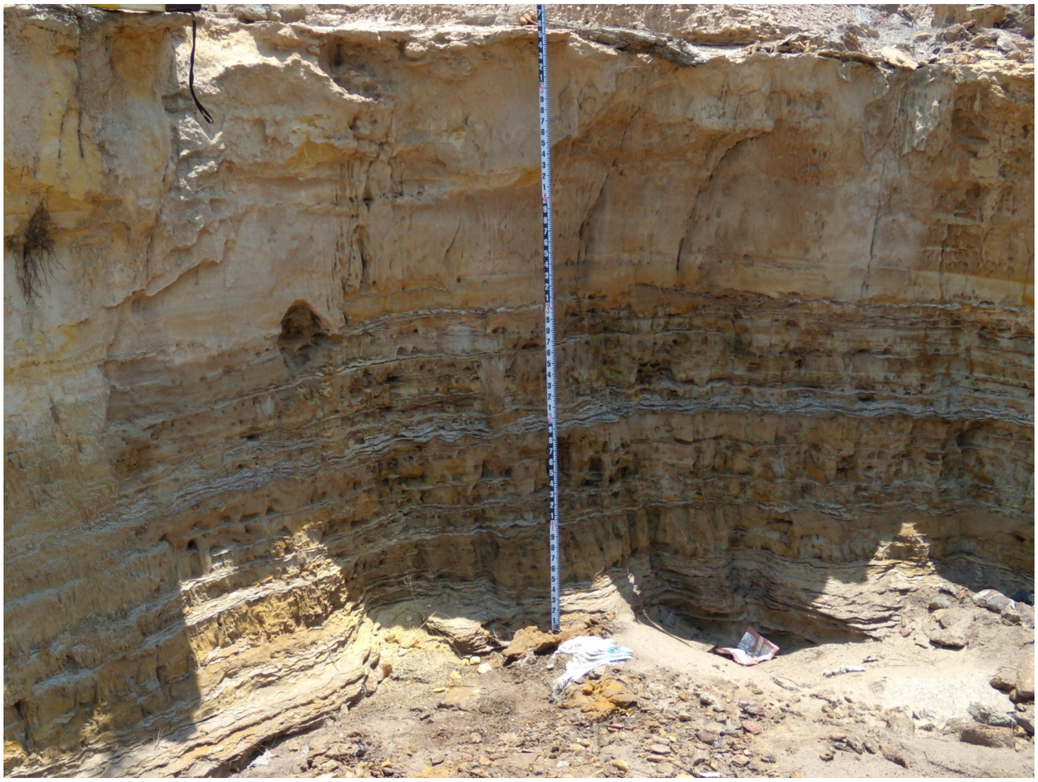

Figure 74. Tertiary Sparta Sand, Claiborne Group, taken near Camden, AR
(courtesy of Doug Hanson, AGS)

Conclusion

Since we began the trip on Scenic 7 at Diamond City on the shore of Bull Shoals Lake and are now crossing into Louisiana, we have traveled almost 300 miles over some of the most varied and complex geologic structures to be found anywhere. As stated at the beginning of the trip, not only has it been a trip across landscapes and sedimentary rocks, it has been a trip through almost 500 million years of time.

We have seen evidence that millions of years ago the Ozark Plateaus were part of a continental shelf covered by shallow sea water that was repeatedly raised above sea level and then submerged. As we approached the Arkansas River Valley, we saw rocks that were deposited in a deepening trough along the edge of the ancient North American Continent. Then farther south in the Ouachita Mountains, we viewed some of the most complex geologic structures in North America. We have seen the results of the process geologists call plate tectonics. The massive folding and faulting of sedimentary strata was caused by compressive forces resulting from the collision of ancestral South America-Africa with ancestral North America.

According to current theory, the energy for such plate tectonic activity is derived from the interior heat of the Earth. The core temperature is estimated to be 12,000^{o} F (6,700^{o} C) and it is postulated that core heat is transferred to the cooler exterior of the Earth by conduction and flow of material in convection currents. A similar phenomenon can be observed in a pan of water as it nears the boiling temperature. Convection currents in the mantle and lower crust could create tension and compression in the rock of the crust and drive plate tectonic movements.

After leaving Caddo Valley, just north of Arkadelphia, we entered another geologic province, the West Gulf Coastal Plain. After the Ouachita mountain-building episode reached its climax the processes of weathering and erosion began their slow actions that cause, even the most durable rocks, to become sediments. However slow the processes, they are very effective when operating over millions of years. The time gap between rocks of the Ouachitas and the overlapping Cretaceous-age sediments of the Coastal Plain is approximately 150 million years.

That time gap was filled with the processes of weathering and erosion of the Ozarks and Ouachitas and deposition of sediments into a newly developing basin on the southern flank of the continent. The heat of the Earth's interior continued to drive the processes of plate tectonics and the Gulf of Mexico developed. Ultimately, the reactivation of the Reelfoot Rift (Mississippi River graben), the one billion years old underlying structure of the Mississippi River Alluvial Plain, caused subsidence of the area and deposition of Cretaceous, Tertiary, and Quaternary-aged sediments (145 million years ago to recent time)to form the West Gulf Coastal Plain.

Today, the details of the processes may be obscured by the vastness of geologic time and the physical dimensions of the problem. However, reasonable explanations have been developed and are continually improved through the careful observation of minerals, rocks, fossils, and stratigraphic and structural relationships using the tools of modern science. That is the job of a geologist.

Additional information concerning the geology of Arkansas can be found by accessing the Arkansas Geological Survey's website at www.geology.ar.gov.