Information Series #1, June 1998

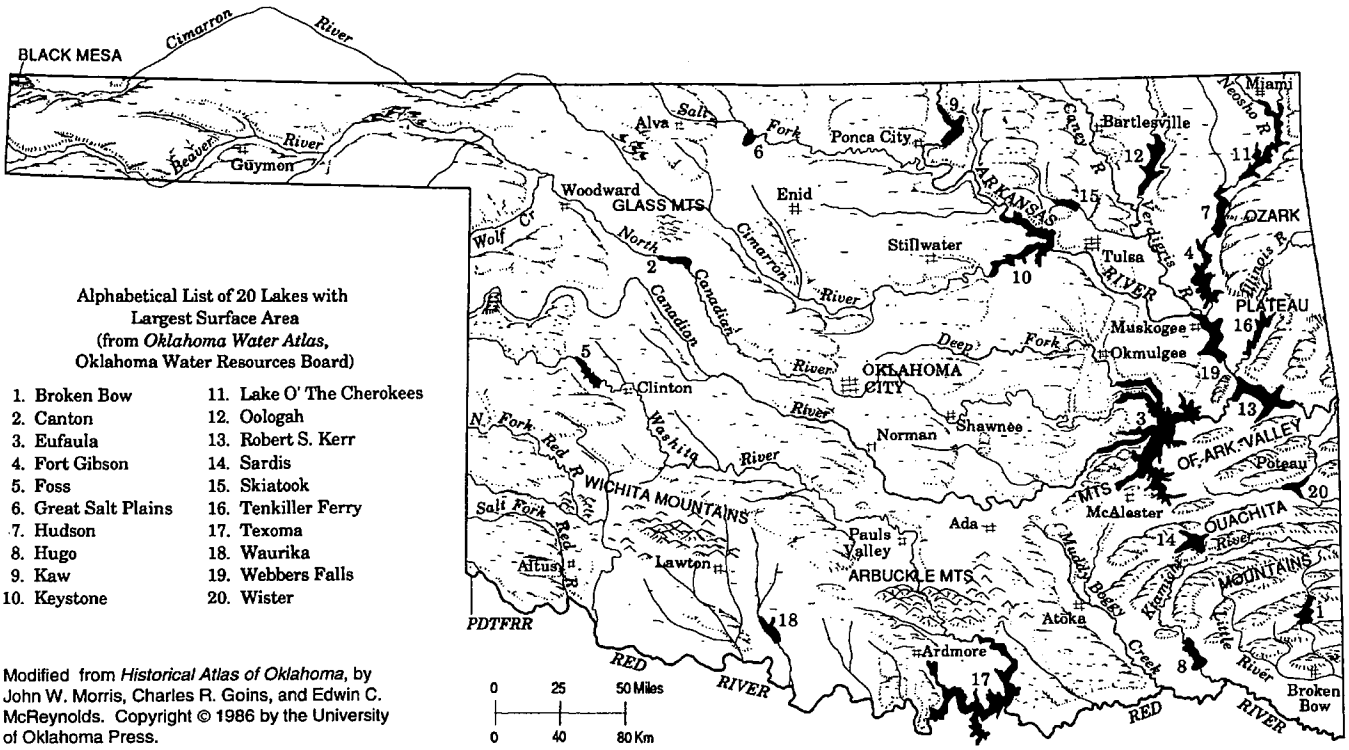
OKLAHOMA GEOLOGICAL SURVEY
A State Agency for research and public service

Mountains, Streams, and Lakes of Oklahoma[1]

Kenneth S. Johnson[2]

INTRODUCTION

Mountains and streams define the landscape of Oklahoma (Fig. 1). The mountains consist mainly of resistant rock masses that were folded, faulted, and thrust upward in the geologic past (Fig. 2), whereas the streams have persisted in eroding less-resistant rock units and lowering the landscape to form broad valleys, hills, and plains throughout most of the remainder of Oklahoma (Fig. 1). All the major lakes and reservoirs of Oklahoma are man-made, and they are important for flood control, water supply, recreation, and generation of hydroelectric power. Natural lakes in Oklahoma are limited to oxbow lakes along major streams and to playa lakes in the High Plains region of the west.



Alphabetical List of 20 Lakes with Largest Surface Area (from *Oklahoma Water Atlas*, Oklahoma Water Resources Board)

1. Broken Bow
2. Canton
3. Eufaula
4. Fort Gibson
5. Foss
6. Great Salt Plains
7. Hudson
8. Hugo
9. Kaw
10. Keystone
11. Lake O' The Cherokees
12. Oologah
13. Robert S. Kerr
14. Sardis
15. Skiatook
16. Tenkiller Ferry
17. Texoma
18. Waurika
19. Webbers Falls
20. Wister

Modified from *Historical Atlas of Oklahoma*, by John W. Morris, Charles R. Goins, and Edwin C. McReynolds. Copyright © 1986 by the University of Oklahoma Press.

Figure 1. Mountains, streams, and principal lakes of Oklahoma.

[1]Reprinted from *Oklahoma Geology Notes* (1993), vol. 53, no. 5, p. 180-188. The *Notes* article was reprinted and expanded from *Oklahoma Almanac, 1993–1994,* Oklahoma Department of Libraries, p. 554–557.

[2]Associate Director, Oklahoma Geological Survey.

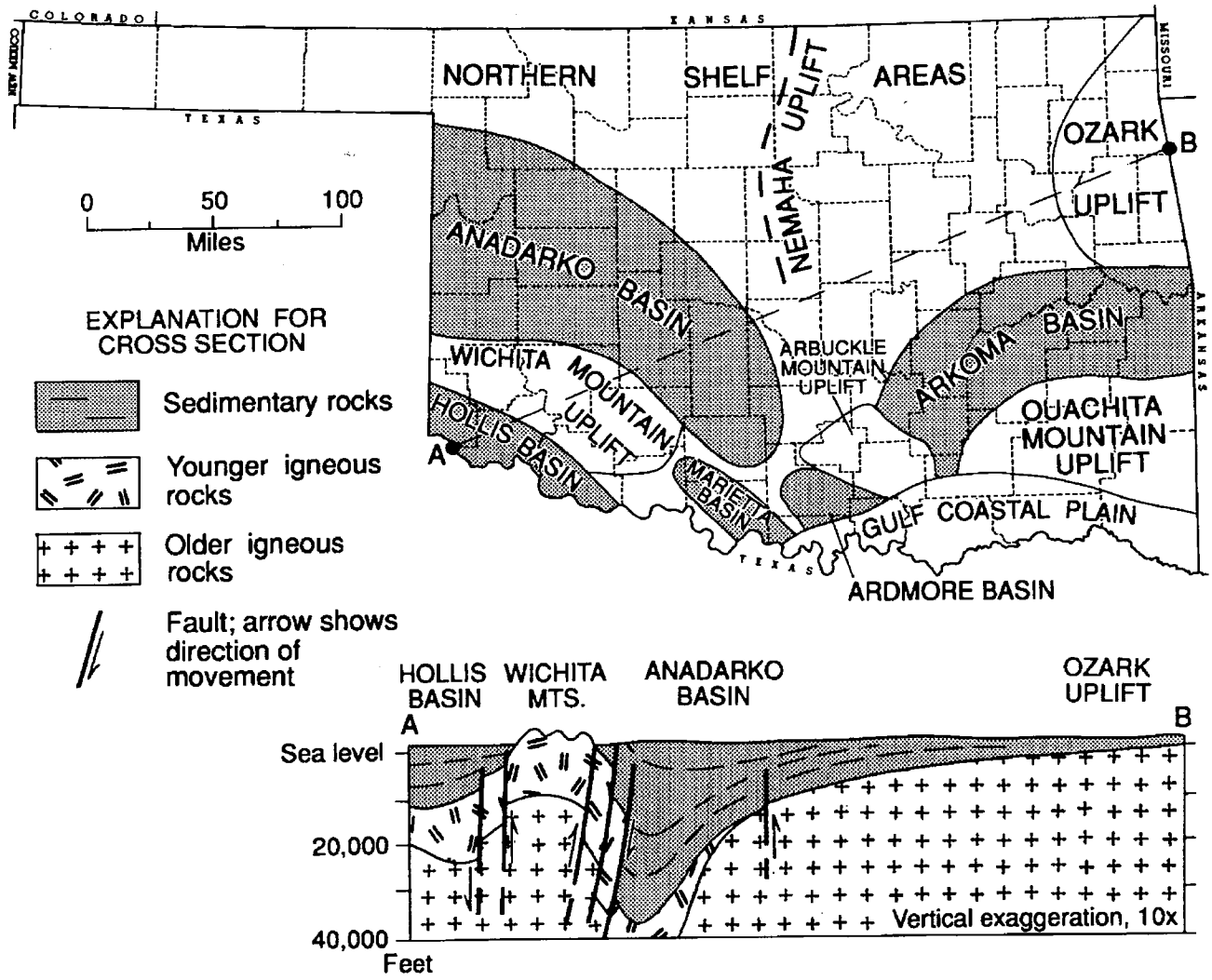


Figure 2. Major geologic provinces of Oklahoma.

MOUNTAINS

The three principal mountain systems (Wichitas, Arbuckles, and Ouachitas) occur in southern Oklahoma, although other mountainous and hilly areas extend across many parts of the State (Fig. 1). Oklahoma's mountains result from geologic processes that acted upon the State in the past, and they are very important areas because they expose much of the mineral wealth needed for the State's growth and industrial development. Areas to be discussed in this section are the Wichita, Arbuckle, and Ouachita Mountains, and mountains of the Arkansas Valley, followed by discussions of the Ozark Plateau, Glass Mountains, and Black Mesa.

Wichita Mountains

The Wichita Mountains in southwest Oklahoma (Figs. 1,2) consist mainly of granite, rhyolite, and other igneous rocks emplaced during the Cambrian Period of geologic time, about 525 mya (million years ago). They are flanked, on the northeast, by thousands of feet of folded and steeply dipping marine limestones and other sedimentary rocks deposited during Late Cambrian and Ordovician time (515–425 mya). The mountains were created during the Pennsylvanian Period (330–290 mya) due to 20,000 ft of local uplift of the Earth's crust; the uplift was accompanied by weathering and erosion, so the mountains probably never towered more than 3,000–5,000 ft above the surrounding plains and seaways that had covered Oklahoma. At present, the relief (the difference in elevation between hilltops or mountain summits and the nearby lowlands or valleys) generally ranges from 400 to 1,100 ft, and the highest elevation is about 2,475 ft above sea level on an unnamed peak 4 mi east–southeast of Cooperton. Mt. Scott is the best-known peak; its summit (2,464 ft), which can be reached by car or bus, commands the most spectacular view of the Wichita Mountains. Much of the mountain area is in the Wichita Mountains National Wildlife Refuge and the Fort Sill Military Reservation; other significant sites in the Wichitas are Quartz Mountain State Park and Great Plains State Park. Important mineral resources produced in the area are granite, limestone, and sand and gravel. The mountains have been prospected (with only limited success) for gold, silver, copper, lead, zinc, aluminum, and iron ores; oil and gas have been produced from sedimentary rocks that surround the mountain area.

Arbuckle Mountains

The Arbuckle Mountains are an area of low to moderate hills in south-central Oklahoma (Figs. 1,2). They contain a core of Precambrian granite and gneiss formed about 1,300 mya; in the western Arbuckles, Precambrian rocks are overlain by at least 5,000 ft of Cambrian rhyolites formed about 525 mya. Most of the Arbuckles consist of 15,000 ft of folded and faulted limestones, dolomites, sandstones, and shales deposited in shallow seas from Late Cambrian through Pennsylvanian time (515–290 mya). Folding and uplift of the mountains occurred during several mountain-building episodes in the Pennsylvanian Period. The complex mountain area probably was never more than several thousand feet above the surrounding plains and seaways. Relief in the area now ranges from 100 to 600 ft, and the highest elevation, about 1,415 ft, is in the West Timbered Hills, about 9 mi west–southwest of Davis. Although the relief in this mountain area is low, it is still impressive because it is six times greater than any other topographic feature between Oklahoma City and Dallas, Texas. Two significant features in the mountains are the deep road cuts on Interstate 35, and the "tombstone topography." The road cuts are as much as 156 ft deep and provide spectacular exposures of rock units that are of strong interest to geologists, partly because they yield great amounts of oil and gas and other mineral and water resources throughout the southwestern United States. "Tombstone topography," which looks like rows of tombstones in a field, results from differential weathering and erosion of alternating layers of hard and soft limestone that dip steeply into the ground. Important scenic sites in the Arbuckle Mountains are the Chickasaw National Recreation Area, Turner Falls, Price Falls, and the Arbuckle Wilderness Park. The Arbuckles contain the most diverse suite of mineral resources in Oklahoma: limestone, dolomite, glass sand, granite, sand and gravel, shale, cement, iron ore, lead, zinc, tar sands, and oil and gas; all these minerals are, or have been, produced commercially.

Ouachita Mountains

The Ouachita (pronounced "Wa-she-tah") Mountains of southeast Oklahoma and western Arkansas make up an arcuate belt of forested mountain ridges and subparallel valleys (Figs. 1,2). The Ouachitas are the central part of a great chain of mountains that include the Appalachian Mountains of eastern United States and the Marathon Mountains of West Texas and northern Mexico. Connections between these three exposed mountain systems are buried beneath thousands of feet of younger rock and sediments in the Mississippi embayment (to the east) and Texas (to the south and west). Rocks making up the Ouachitas are mostly thick units of sandstone and shale, with lesser amounts of chert and novaculite (a fine-grained silica rock, like flint), deposited in a deep sea that covered the area from Late Cambrian through Early Pennsylvanian time (515–315 mya). The area was then folded and faulted in such a manner that resistant beds of sandstone, chert, and novaculite now form long, sinuous mountain ridges that tower 500–1,500 ft above adjacent valleys formed in easily eroded shales. The highest elevation is 2,666 ft, on Rich Mountain. Major prominent ridges within the Ouachita system are Winding Stair, Rich, Kiamichi, Blue, Jackfork, and Blackjack Mountains. The Ouachita National Forest covers a large part of the mountain area; other important scenic sites in the Ouachitas include the McCurtain County Wilderness Area, and state parks at Beavers Bend, Hochatown, Pine Creek, McGee Creek, Talimena, and Clayton Lake. Mineral resources that are, or have been, produced in the Ouachitas include limestone, quartzite, sand and gravel, asphaltite, lead, and oil and gas.

Mountains of the Arkansas River Valley

Another group of mountains are scattered in the Arkansas River Valley of east-central Oklahoma (Fig. 1). They include Sans Bois, Cavanal, Sugar Loaf, Poteau, Beaver, Hi Early, and Rattlesnake Mountains, among others, in parts of Le Flore, Latimer, Pittsburg, Haskell, Sequoyah, Muskogee, and McIntosh Counties. The mountains typically are broad features capped by thick and resistant sandstones that stand 300–2,000 ft above the wide, hilly plains formed on thick shale units. These sandstones and shales were deposited in shallow seas and coastal areas that covered eastern Oklahoma in Early and Middle Pennsylvanian times (330–310 mya), and this area was broadly uplifted and gently folded during the Middle and Late Pennsylvanian uplift of the Ouachita Mountains. The largest mountain area is the Sans Bois Mountains, north of Wilburton and Red Oak. The highest summit is Sugar Loaf Mountain, 8 mi east of Poteau; it is 2,568 ft high and rises about 2,000 ft above the surrounding plains. Sites of interest include Heavener Runestone, Wister, Robbers Cave, Arrowhead, Fountainhead, and Spiro Mounds State Parks; also, the Sequoyah Wildlife Refuge at Robert S. Kerr Reservoir. Principal mineral resources of the area are coal, oil and gas, shale, clay, building stone, sand and gravel, and volcanic ash.

Ozark Plateau

The Ozarks of northeast Oklahoma (Figs. 1,2) are best described as a deeply dissected plateau. Bedrock units in the area are mostly flat-lying limestones and cherts deposited in shallow seas during the Mississippian Period (365–330 mya). Southern and southwestern parts of the Ozarks include outcrops of sandstones and shales deposited in shallow seas and coastal areas during Early Pennsylvanian time (330–315 mya); this area embraces the Brushy Mountains or Boston Mountains. Broad and gentle uplifting of the area during, and since, Pennsylvanian time has caused streams to be incised into the bedrock. Relief in the Ozarks typically is 50–400 ft, and the highest elevation, about 1,745 ft, is on Workman Mountain, 8 mi east–southeast of Stilwell. The beauty of the Ozarks and the abundant clear-water lakes have spawned many state parks, including Beaver Spring, Twin Bridges, Bernice, Honey Creek, Little Blue–Disney, Cherokee, Spavinaw, Upper Spavinaw, Snowdale, Salina, Rocky Ford, Sequoyah, Sequoyah Bay, Adair, Cherokee Landing, Greenleaf, Tenkiller, Sallisaw, and Brushy Creek State Parks. Important mineral resources include limestone, shale, cement, tripoli, and sand and gravel; minor

amounts of oil and gas also have been produced. In the north is the world-famous Tri-State lead/zinc mining district (in the Miami/Picher area), which led the United States in zinc production almost every year from 1918 to 1945; the last of these mines finally was closed down in 1970.

Glass Mountains

The Glass Mountains are in north-central Major County, about 6 mi west of Orienta, in an area of badlands topography (Fig. 1). Outcropping rocks are red-brown shales and siltstones capped by a bed of resistant white gypsum; all these strata were deposited during the Permian Period (about 270 mya). The red-brown bluffs and slopes are littered with crystals and fragments of gypsum that weather out of the shale. Much of the gypsum looks like colorless glass fragments, and hence the name "Glass Mountains." It is a misnomer to call these "mountains;" they are, instead, prominent mesas, buttes, and escarpments. The local relief generally ranges from 150 to 200 ft, and the elevation at the top of the high buttes is about 1,585 ft. The Glass Mountains are a prominent feature of the Blaine escarpment that extends southeast to northwest across northwest Oklahoma. Flat-lying beds of caprock gypsum and underlying shales originally extended far to the north and east, but the Blaine escarpment is being eroded back to the south and west. Once the protective caprock is eroded, the underlying shale is rapidly worn down into irregular badlands features.

Black Mesa

Black Mesa, in the northwest corner of the Oklahoma Panhandle (Fig. 1), is the highest point in the State; it has an elevation of 4,973 ft. It is not a mountainous area, but is a plateau that rises about 600 ft above the adjacent Cimarron River and North Carrizo Creek. The Oklahoma portion of Black Mesa is 0.5–1 mi wide and 3 mi long; it is the erosional remnant of a finger-like basaltic lava flow extruded from a volcano in southeast Colorado. The lava flow occurred during late Tertiary (Pliocene) time, about 2–4 mya, and it occupied what was then a broad valley. Since Tertiary time, the local topography has been reversed; less-resistant sandstone and shale uplands that were adjacent to the basalt flow have been deeply incised by the Cimarron River system, whereas the resistant basalt, that once occupied a valley, now stands high above the surrounding terrain. Black Mesa and Black Mesa State Park are located 3 mi northwest of Kenton and about 30 mi northwest of Boise City.

STREAMS AND LAKES

The term "stream" refers to any body of running water, great or small (from large rivers down to small rills), that flows under the influence of gravity to progressively lower elevations in a relatively narrow, but clearly defined, channel. Each major drainage system in the State consists of a principal river, with a large number of smaller tributary rivers, streams, and creeks that funnel water to the main river.

Oklahoma's stream systems of today are temporary (in terms of geologic time) as to location and flow rates. In time, the streams will cut deeper and will cut laterally into their banks, their tributaries will erode nearby uplands, and their positions will thereby be shifted. Major drainage systems of today were initiated during the Pleistocene Epoch of geologic time (the last 1.65 million years, or so). Streams had flowed across Oklahoma for many millions of years prior to that time, of course, but they finally began carving out today's major drainage basins during the Pleistocene. The shifting early positions of these streams within their drainage basins are now marked by old alluvial deposits that were left as terraces, high above the current flood plains, as the streams eroded deeper into the Earth.

The Pleistocene Epoch is characterized as a time of erosion in Oklahoma. Rocks and loose sediments at the land surface have been weathered to soil, and the soil particles are then carried away to the streams. In this way, mountains, hills, and plains are being worn down, and sediment is transported to the Gulf of Mexico or is temporarily deposited on the banks and in the bottoms of streams and lakes. Sand, silt, clay, and gravel deposits associated with Pleistocene and Holocene (the last 10,000 years) rivers and lakes typically are unconsolidated and are 25–100 ft thick. Finding Pleistocene terrace deposits 100 ft to >300 ft above modern flood plains attests the great amount of erosion and downcutting performed by major rivers in the past 1.65 million years.

All of the major streams in Oklahoma are characterized by broad, sand-filled channels, with the active water courses occupying only a small portion of the river bed or flood plain. These broad, sand-filled channels reflect the large changes in discharge (floods) that have occurred through time. With the development of many man-made dams on the major streams and their tributaries, the frequency and magnitude of flooding is decreasing, causing a gradual stabilization of the active water courses within the broad stream beds.

There are a great many lakes and reservoirs in Oklahoma. Most of them are man-made and were created by constructing dams across streams. They were made mainly for flood control, water supply, recreation, fish, wildlife, and hydroelectric power. Lakes on the Arkansas and Verdigris Rivers also aid in maintaining navigation along the McClellan–Kerr Navigation System. Major lakes in Oklahoma have been constructed by the U.S. Army Corps of Engineers, U.S. Bureau of Reclamation, and the Grand River Dam Authority; other large lakes are owned and operated by various state and federal agencies, by cities, and by other entities. Additionally, a great number of smaller lakes and ponds have been built by farmers and other landowners.

The only natural lakes in Oklahoma are a series of oxbow lakes and playa lakes (Oklahoma Water Resources Board, 1990). Oxbow lakes, which typically are crescent-shaped lakes in abandoned channels (oxbows) of a meandering stream, occur mainly in floodplains of major

rivers, such as the Red, Arkansas, Washita, North Canadian, and Verdigris Rivers in eastern and central Oklahoma. Oklahoma has 62 oxbow lakes that cover at least 10 acres, and the largest, near Red River in McCurtain County, is 272 acres (Oklahoma Water Resources Board, 1990).

Playa lakes form in shallow, saucer-like depressions that are scattered across the semiarid High Plains region of northwestern Oklahoma and the Panhandle. They are characterized by internal drainage and have no outflow: they hold water during and after rainy seasons, and most of them lose all their water through evaporation and/or infiltration into the ground. These intermittent or ephemeral playa lakes number about 600 following thunderstorms, but only a few of them last year-round (Oklahoma Water Resources Board, 1990).

Oklahoma is totally embraced within two major drainage basins, the Red and Arkansas River basins (Fig. 1). These two rivers, and their many tributaries, flow into Oklahoma from all six of the State's neighbors; however, all the surface water leaving the State flows into Arkansas, via the Red, Arkansas, and Little Rivers, and Lee Creek. Major rivers and their tributaries flow mainly to the east and southeast across Oklahoma. Among the special aspects of Oklahoma's rivers are its six scenic rivers in the east and the several natural salt plains and saline rivers in the west. The following data on major streams and lakes in the Red and Arkansas River basins are mainly from the Oklahoma Water Resources Board (1990).

Red River Basin

Red River and its tributaries drain essentially the southern one-third of the State (Fig. 1), and the basin's total drainage area in Oklahoma is about 23,000 mi^2. The westernmost headwaters of Red River is a small tributary (Frio Draw) that begins in eastern New Mexico, about 30 mi south of Tucumcari. The main stem of the river flows across the Texas Panhandle through Palo Duro Canyon, and marks Oklahoma's southern border (517 river-miles long) with Texas. It then flows through Arkansas and into Louisiana, where it joins the Atchafalaya River before entering Atchafalaya Bay and the Gulf of Mexico.

At the southwest corner of Oklahoma, the main stem is called Prairie Dog Town Fork Red River (PDTFRR); 2 mi to the east it is joined by Buck Creek, and from that point eastward it officially is called Red River. Lake Texoma is the only reservoir on the main stem of Red River in Oklahoma: it holds the largest volume of water (>2.6 million acre-ft) in the State, and has the second largest surface area (88,000 acres). The tributaries to Red River have many other important lakes and reservoirs (such as, from west to east, Altus, Foss, Ellsworth, Waurika, Arbuckle, McGee Creek, Sardis, Hugo, Pine Creek, and Broken Bow), and four of them are among the 20 largest lakes in the State (Fig. 1).

Major Oklahoma tributaries to Red River (from west to east) include Salt Fork Red River, North Fork Red River, and Washita River, all of which contribute flow into Lake Texoma (Fig. 1); others are Muddy Boggy Creek, and Kiamichi and Little Rivers. All of these rivers have their own tributary systems, and there are many other rivers and creeks that flow directly into Red River. The lowest elevation in Oklahoma (287 ft) is where Little River enters Arkansas, some 20 mi north of the southeast corner of the State (at the southeast corner of the State, Red River has an elevation of 305 ft).

Arkansas River Basin

Arkansas River and its tributaries drain the northern two-thirds of Oklahoma (Fig. 1), with a drainage area in Oklahoma of nearly 47,000 mi^2. The source of Arkansas River is near the town of Leadville, in the Rocky Mountains of central Colorado. The river flows eastward across southeast Colorado and through western and central Kansas. It then turns southeast, entering Oklahoma in Kay County, north of Ponca City, and crosses northeast Oklahoma to leave the State at Fort Smith, Arkansas. Arkansas River continues southeastward through Little Rock to its confluence with the Mississippi River, which then flows south through New Orleans to the Gulf of Mexico. The river's name is pronounced "Ar-Kansas" in the State of Kansas, but is pronounced "Arkansas" (the same as the State) in Colorado, Oklahoma, and Arkansas.

Much of Arkansas River has a series of locks and dams (McClellan–Kerr Navigation System) that link Oklahoma with barge traffic from the Port of Catoosa (on the Verdigris River, northeast of Tulsa) down to the Mississippi River, and then to ocean-going vessels at New Orleans. Major lakes and reservoirs on the main stem of Arkansas River include (from the southeast): Robert S. Kerr, Webbers Falls, Keystone, and Kaw, each of which is among the 20 largest lakes in Oklahoma. Eufaula Lake, on the Canadian River in eastern Oklahoma, has the largest surface area (105,500 acres) and the second largest volume (>2.3 million acre-ft) in the State. Tributaries to Arkansas River have many other important lakes and reservoirs (such as, from west to east, Canton, Great Salt Plains, Hefner, Overholser, Thunderbird, Carl Blackwell, Hulah, Skiatook, Oologah, Fort Gibson, Hudson, Tenkiller Ferry, and Wister), and 10 of them are among the 20 largest in the State (Fig. 1).

Major tributaries to Arkansas River (from southwest to northeast) include Canadian River, North Canadian River (called Beaver River in the Panhandle, west of Wolf Creek), and Deep Fork, all of which flow into Eufaula Lake (Fig. 1); others are Cimarron, Salt Fork, Caney, Verdigris, Neosho (Grand), and Illinois Rivers. There are tributary systems to each of these rivers, and many other rivers and creeks flow directly into Arkansas River. The lowest elevation along Arkansas River (385 ft) is where it flows into Arkansas at Fort Smith.

Scenic Rivers

Six of Oklahoma's free-flowing streams have such exceptional beauty and recreational value that they have been officially designated as "scenic rivers," protected by the State Legislature. One scenic river is in the Red River system—the upper part of Mountain Fork, which flows

into Broken Bow Lake in McCurtain and Le Flore Counties, in the Ouachita Mountains. The other five scenic rivers are in the Arkansas River system, and are located in Adair, Cherokee, Delaware, and Sequoyah Counties, in the Ozark Plateau; they include parts of the Illinois River, and parts of Flint, Baron Fork, Lee, and Little Lee Creeks.

Salt Plains and Saline Rivers

Natural dissolution of bedded salt (deposited during the Permian Period, about 270 mya) occurs at shallow depths in several parts of northwest and southwest Oklahoma. The resultant high-salinity brine seeps to the surface, creating a series of small to large, natural salt plains or salt flats in some of the State's rivers. In the Arkansas River drainage, Great Salt Plains on Salt Fork covers about 25 mi^2 and is the largest salt flat. Others in northwest Oklahoma are Big Salt Plain and Little Salt Plain, on Cimarron River, and Ferguson Salt Plain, just north of Watonga in Blaine County. In the Red River drainage, the Chaney, Kiser, and Robinson Salt Plains are on Elm Fork in northern Harmon County, south of Erick. All Oklahoma salt plains, and others along Red River tributaries in Texas, discharge natural brines to the Arkansas and Red River systems, thus degrading the river waters and making them generally unsuitable for industrial, municipal, or irrigation uses in parts of western and central Oklahoma. The saline river waters are diluted by fresh-water inflow downstream from the salt plains, and thus the water is largely usable for water-supply, livestock, and industrial purposes by the time it reaches Keystone Lake and Lake Texoma.

REFERENCES CITED

Morris, J. W.; Goins, C. R.; and McReynolds, E. C., 1986, Historical atlas of Oklahoma: University of Oklahoma Press, Norman.

Oklahoma Water Resources Board, 1990, Oklahoma water atlas: Oklahoma Water Resources Board Publication 135, 360 p.

A State Agency for Research and Public Service
Oklahoma Geological Survey
100 E. Boyd, Rm. N-131
Norman, OK 73019-0628

Publication Sales 405/360-2886
Main Office 405/325-3031
http://www.ou.edu/special/ogs-pttc/

This publication, printed by the Oklahoma Geological Survey, Norman, Oklahoma, is issued by the Oklahoma Geological Survey as authorized by Title 70, Oklahoma Statutes 1981, Section 3310, and Title 74, Oklahoma Statutes 1981, Sections 231-238. 1,000 copies have been prepared for distribution at a cost of $59.73 to the taxpayers of the State of Oklahoma. Copies have been deposited with the Publications Clearinghouse of the Oklahoma Department of Libraries.