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National Park Service
Natural Resource Stewardship and Science Directorate
Geologic Resources Division

Chickasaw National Recreation Area

GRI Ancillary Map Information Document

Produced to accompany the Geologic Resources Inventory (GRI) Digital Geologic Data for Chickasaw National Recreation Area

chic_geology.pdf

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Geologic Resources Inventory Map Document for Chickasaw National Recreation Area

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Geologic Resources Inventory Map Document

Chickasaw National Recreation Area, Oklahoma

Document to Accompany Digital Geologic-GIS Data

chic_geology.pdf

Version: 7/16/2015

This document has been developed to accompany the digital geologic-GIS data developed by the Geologic Resources Inventory (GRI) program for Chickasaw National Recreation Area, Oklahoma (CHIC).

Attempts have been made to reproduce all aspects of the original source products, including the geologic units and their descriptions, geologic cross sections, the geologic report, references and all other pertinent images and information contained in the original publication.

National Park Service (NPS) Geologic Resources Inventory (GRI) Program staff have assembled the digital geologic-GIS data that accompanies this document.

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About the NPS Geologic Resources Inventory Program

Background

Recognizing the interrelationships between the physical (geology, air, and water) and biological (plants and animals) components of the Earth is vital to understanding, managing, and protecting natural resources. The Geologic Resources Inventory (GRI) helps make this connection by providing information on the role of geology and geologic resource management in parks.

Geologic resources for management consideration include both the processes that act upon the Earth and the features formed as a result of these processes. Geologic processes include: erosion and sedimentation; seismic, volcanic, and geothermal activity; glaciation, rockfalls, landslides, and shoreline change. Geologic features include mountains, canyons, natural arches and bridges, minerals, rocks, fossils, cave and karst systems, beaches, dunes, glaciers, volcanoes, and faults.

The Geologic Resources Inventory aims to raise awareness of geology and the role it plays in the environment, and to provide natural resource managers and staff, park planners, interpreters, researchers, and other NPS personnel with information that can help them make informed management decisions.

The GRI team, working closely with the Colorado State University (CSU) Department of Geosciences and a variety of other partners, provides more than 270 parks with a geologic scoping meeting, digital geologic-GIS map data, and a park-specific geologic report.

Products

Scoping Meetings: These park-specific meetings bring together local geologic experts and park staff to inventory and review available geologic data and discuss geologic resource management issues. A summary document is prepared for each meeting that identifies a plan to provide digital map data for the park.

Digital Geologic Maps: Digital geologic maps reproduce all aspects of traditional paper maps, including notes, legend, and cross sections. Bedrock, surficial, and special purpose maps such as coastal or geologic hazard maps may be used by the GRI to create digital Geographic Information Systems (GIS) data and meet park needs. These digital GIS data allow geologic information to be easily viewed and analyzed in conjunction with a wide range of other resource management information data.

For detailed information regarding GIS parameters such as data attribute field definitions, attribute field codes, value definitions, and rules that govern relationships found in the data, refer to the NPS Geology-GIS Data Model document available at: http://science.nature.nps.gov/im/inventory/geology/GeologyGISDataModel.cfm

Geologic Reports: Park-specific geologic reports identify geologic resource management issues as well as features and processes that are important to park ecosystems. In addition, these reports present a brief geologic history of the park and address specific properties of geologic units present in the park.

For a complete listing of Geologic Resource Inventory products and direct links to the download site visit the GRI publications webpage http://www.nature.nps.gov/geology/inventory/gre_publications.cfm

GRI geologic-GIS data is also available online at the NPS Data Store Search Application: http://irma.nps.gov/App/Reference/Search. To find GRI data for a specific park or parks select the appropriate park

(s), enter “GRI” as a Search Text term, and then select the Search Button.

For more information about the Geologic Resources Inventory Program visit the GRI webpage: http://www.nature.nps.gov/geology/inventory, or contact:

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The Geologic Resources Inventory (GRI) program is funded by the National Park Service (NPS) Inventory and Monitoring (I&M) Division.

GRI Digital Map and Source Map Citation

The GRI digital geologic-GIS map for Chickasaw National Recreation Area, Oklahoma (CHIC):

Digital Geologic Map of Chickasaw National Recreation Area and Vicinity, Oklahoma (*GRI MapCode CHIC*)

Blome, C.D., Lidke, D.J., Wahl, R.R., and Golab, J.A., 2013, Geologic Map of Chickasaw National Recreation Area, Murray County, Oklahoma, U.S. Geological Survey, Scientific Investigations Map SIM-3258, 1:24000 scale. (Scientific Investigations Map SIM-3258). (*GRI Source Map ID 75748*).

Note: The information provided herein depicts unit descriptions, ancillary figures and tables extracted from the source map PDF. That map and the accompanying pamphlet can be found here: http://pubs.usgs.gov/sim/3258/. The pamphlet includes a detailed report of regional geology along with additional pictures and tables. GIS data associated with the source map was used for all features in the GRI GIS data except fault and fold symbology, which was captured from a georeferenced copy of the source map.

Additional information pertaining to each source map is also presented in the GRI Source Map Information (CHICMAP) table included with the GRI geology-GIS data.

Map Unit List

The geologic units present in the digital geologic-GIS data produced for Chickasaw National Recreation Area, Oklahoma (CHIC) are listed below. Units are listed with their assigned unit symbol and unit name (e.g., Qaf - Artificial fill). Units are listed from youngest to oldest. No description for water is provided. Information about each geologic unit is also presented in the GRI Geologic Unit Information (CHICUNIT) table included with the GRI geology-GIS data. Some source unit symbols, names and/or ages may have been changed in this document and in the GRI digital geologic-GIS data. This was done if a unit was considered to be the same unit as one or more units on other source maps used for this project, and these unit symbols, names and/or ages differed. In this case a single unit symbol and name, and the unit's now recognized age, was adopted. Unit symbols, names and/or ages in a unit descriptions, or on a correlation of map units or other source map figure were not edited. If a unit symbol, name or age was changed by the GRI the unit's respective source map symbol, name and/or age appears with the unit's source map description within this document.

Cenozoic Era

Quaternary Period

Qaf - Artificial fill
Qac - Alluvium and colluvium, undifferentiated

Paleozoic Era

Permian Period

Ps - Stratford Formation

Pennsylvanian Period

PNvs - Vanoss Formation, upper shale facies
PNvc - Vanoss Formation, lower limestone conglomerate facies
PNd - Deese Group, undifferentiated
PNaw - Atoka and Wapanucka Formations, undifferentiated

Pennsylvanian Period and Mississippian Period

PNMs - Springer Formation

Mississippian Period

Mc - Caney Shale

Mississippian Period and Devonian Period

MDsw - Sycamore Limestone, Welden Limestone and Woodford Shale, undifferentiated

Devonian Period, Silurian Period and Ordovician Period

DSOh - Hunton Group, undifferentiated

Devonian Period

Dhu - Upper part of Hunton Group, undifferentiated

Silurian Period and Ordovician Period

SOhl - Lower part of Hunton Group, undifferentiated

Ordovician Period

Osv - Sylvan Shale and Viola Group, undifferentiated
Os - Sylvan Shale
Ov - Viola Group
Obm - Bromide, Tulip Creek and McLish Formations, undifferentiated
Ooj - Oil Creek and Joins Formations, undifferentiated
Ow - West Spring Creek Formation
Owk - West Spring Creek and Kindblade Formations

Map Unit Descriptions

Descriptions of all geologic map units, generally listed from youngest to oldest, are presented below.

Qaf - Artificial fill (Quaternary)

Unconsolidated sand, silt, clay, and gravel used as artificial fill at the Lake of the Arbuckles dam site. (*GRI Source Map ID 75748)* (Scientific Investigations Map SIM-3258).

Qac - Alluvium and colluvium, undifferentiated (Quaternary)

Unconsolidated sand, silt, clay, and gravel along rivers and streams that are inundated regularly; includes some terrace deposits and includes small alluvial fan and colluvial deposits along the flanks of major valleys. Thickness varies; ranges from about 3 to 50 ft (1 to 15 m). (*GRI Source Map ID 75748)* (Scientific Investigations Map SIM-3258).

Pontotoc Group (Lower Permian and Upper Pennsylvanian)

Divided into three units in descending stratigraphic order: Konawa Formation (not present in the mapped area), Stratford Formation, and Vanoss Formation. The Pontotoc Group ranges from 1,200 to 1,500 ft (366 to 457 m) in thickness. Named after Pontotoc County, Oklahoma. No type section designated (Morgan, 1924). (*GRI Source Map ID 75748)* (Scientific Investigations Map SIM-3258).

Ps - Stratford Formation (lower Permian)

Red shale and sandstone containing the Hart Limestone Member at its base in the Sulphur area. Grades into limestone conglomerate and arkose towards mountains west of Sulphur. Only exposed in the northwest corner of map area. Middle formation of the Pontotoc Group. Unit about 400 ft (122 m) thick in Stonewall County, Okla. Named after town of Stratford, western part of Stonewall quadrangle, Garvin County, Okla. (Morgan, 1924). (*GRI Source Map ID 75748)* (Scientific Investigations Map SIM-3258).

Vanoss Formation (Upper Pennsylvanian, Virgilian)

Sandstone, conglomerate, shale, and a few thin limestone beds. Underlies Hart Limestone Member of the Stratford Formation in the Sulphur area. Lower unit of Pontotoc Group. Divided into upper shale facies (PNvs) and lower limestone conglomerate facies (PNvc). In the western part of the Arbuckle Mountains, the upper shale facies is partly equivalent to the Stratford Formation. In the Sulphur area, the lower limestone conglomerate facies may include strata equivalent to the Ada Formation. Up to 650 ft (198 m) thick. Named after the town of Vanoss, Pontotoc County, Okla. (Morgan, 1924). (*GRI Source Map ID 75748)* (Scientific Investigations Map SIM-3258).

PNvs - Vanoss Formation, upper shale facies (Upper Pennsylvanian, Virgilian)

Principally shale and silty shale with some arkosic sandstone interbeds that are more common in lower part. Locally contains thin beds of gray limestone conglomerate. Shale is light in color, ranging through shades of green and gray and locally red and maroon. Arkosic sandstone interbeds are tan to reddish brown, poorly sorted, and fine- to coarse-grained. Sandstone can be so arkosic that it appears granitic. Grades into limestone conglomerate and arkose towards the mountains west of Sulphur. Contact with underlying lower conglomerate facies (PNvc) is gradational. Thickness of unit ranges from 30 to 80 ft (9 to 24 m) thick. (*GRI Source Map ID 75748)* (Scientific Investigations Map SIM-3258).

PNvc - Vanoss Formation, lower limestone conglomerate facies (Upper Pennsylvanian, Virgilian)

Gray, thick to massive bedded limestone conglomerate consisting of limestone boulders, cobbles, and pebbles in a calcareous matrix with finely dispersed clay. Disconformably overlies the Deese Group (PNd) and most of the other older rock units in the map area. Thickness 100 to 500 ft (30 to 152 m); average is 100 ft (30 m) thick. (*GRI Source Map ID 75748)* (Scientific Investigations Map SIM-3258).

PNd - Deese Group, undifferentiated (Middle Pennsylvanian, middle Desmoinesian)

Typical lithologies include thick bedded to massive sandstone, gray and red shale, limestone conglomerate, and fossiliferous, light-colored, gray to white limestone. Exposed in the southeastern part of the map area within the Mill Creek syncline, along and near the banks of the Lake of the Arbuckles, and the northern flank of the Arbuckle anticline west of the map area. Deese Group includes, in descending stratigraphic order, the Devils Kitchen Conglomerate, Milsap Lake Formation, and West Arm Formation (undifferentiated in map area). Fossils include crinoids, endothyrids, brachiopods, and mollusks. Disconformably overlies the Springer Formation (PNMs) in southeast part of map area and Caney Shale along the northern flank of the Arbuckle anticline west of the map area. Is inferred (based on regional data) to disconformably overlie other older rock units in the subsurface of the map area (see cross section B-B', map sheet). Maximum thickness of over 9,000 ft (2,743 m). Named for the town of Deese, Carter County, Okla. (Goldston, 1922). (*GRI Source Map ID 75748)* (Scientific Investigations Map SIM-3258).

PNaw - Atoka and Wapanucka Formations, undifferentiated (Lower to Middle Pennsylvanian, Morrowan to Atokan)

Upper part of this undifferentiated unit (Atoka Formation) is typified by unfossiliferous sandstone and gray to brown shale. The lower part (Wapanucka Formation) includes massive, gray to tan to white limestone and interbedded shale and siltstone. Thickness ranges from 950 to 1,420 ft (290 to 433 m). Unit as a whole thins westwardly. Only occurs as fault-bounded wedge in southeast part of map area. Both formations occur separately (outside of mapped area) in the eastern part of the Hunton anticline and are described below.

Atoka Formation (Middle Pennsylvanian, Atokan)
Unfossiliferous, sandstone and dark-gray to -brown siderite-bearing shale. Mapped separately in the eastern part of the Hunton anticline where the total thickness of the Atoka Formation ranges from 950 to 1,260 ft (290 to 384 m). Most likely named for town of Atoka, Atoka County, Okla.

(Taff, 1901)

Wapanucka Formation (Lower Pennsylvanian to Middle, Morrowan to Atokan) Fossiliferous, massive, gray to tan to white limestone that is partly oolitic at top of unit interbedded with shale and siliceous siltstone. Base of unit contains calcareous and cherty sandstone. Fossils include sponges, corals, brachiopods, foraminifers, and ostracodes. Mapped separately only in the northern and eastern parts of the Hunton anticline area where the maximum thickness is about 160 ft (49 m). Origin of name unknown but probably named for town of Wapanucka, Johnston County, Okla. (Taff, 1901).

(*GRI Source Map ID 75748)* (Scientific Investigations Map SIM-3258).

PNMs - Springer Formation (Upper Mississippian to Lower Pennsylvanian, Chesterian to Morrowan)

Dark (black to blue) fissile, bituminous shale separated by thin beds of sandstone and limestone. Contains siderite, ferruginous, and calcareous concretions. Sandstone beds vary from a few feet to tens of feet thick. Maximum thickness to 6,000 ft (1,829 m), but underlies Middle Pennsylvanian unconformity and preserved thickness can be much less. Includes Goddard Shale Member at its base and includes Union Valley Sandstone Member and equivalents north and east of the map area. Overlies the Caney Shale (Mc) in southeast part of map area. Springer Formation is best exposed in the Criner Hills area, a mountain range which climbs to an altitude of 978 ft (298 m) in Carter County, Okla.; the Criner Hills are located southwest of CNRA and just southwest of the town of Ardmore, Okla. Fossils include various species of brachiopods, bryozoans, and bivalves. Type area located at the village of Springer, Carter County, Okla. (Tomlinson, 1929). (*GRI Source Map ID 75748)* (Scientific Investigations Map SIM-3258).

Mc - Caney Shale (Middle to Upper Mississippian, Meramecian to Chesterian)

Dark-gray to black, laminated, fissile and friable shale containing septarian and phosphatic concretions. Because the shale is friable, individual outcrops are rarely observed; usually expressed as lush, grassy fields and slopes. Concretions vary in size, up to 3 ft or more in diameter. Unit varies from 90 ft (27 m) thick in the north to over 200 ft (61 m) thick in the south part of the Hunton anticline area and to over 400 ft (122 m) thick in the southwest part of the map and adjacent Arbuckle anticline areas. Invertebrate fossils include conodonts, pelecypods, gastropods, ostracodes, goniatites, and cephalopods. Overlies the Sycamore Limestone (upper part of MDsw) in southeast part of map area. Type section located in Johnston County, Okla. (Elias and Branson, 1959). Named for Johns Valley, formerly called Caney Basin or Cove, Pushmataho County, Okla. (*GRI Source Map ID 75748)* (Scientific Investigations Map SIM-3258).

MDsw - Sycamore Limestone, Welden Limestone and Woodford Shale, undifferentiated (Devonian to Mississippian)

Exposures typical of the Sycamore Limestone contain shale and argillaceous cherty to silty limestone overlain by shale and marly limestone. Welden Limestone generally not exposed in the Arbuckle Mountains or thinly exposed (<7 ft or 2 m). Typical Woodford Shale exposures are characterized by dark, fissile shale, siliceous shale, bedded chert, and black bituminous shale. Locally, chert and siliceous shale compose most of the Woodford Shale. Unit ranges from 330 to over 1,000 ft (101 to over 305 m) thick in the Hunton anticline area. Mapped together over much of the Arbuckle Mountains as the

contact between the Woodford Shale and Sycamore Limestone is rarely observed, and the Welden Limestone is very thin to absent and rarely exposed. The individual formations composing this undifferentiated map unit are described separately below.

Sycamore Limestone (Middle to Lower Mississippian, Meramecian to Kinderhookian)
Lower part of formation composed of gray shale and argillaceous cherty and spicular, silty limestone, and calcareous siltstone that is overlain by gray shale and tan-weathering marlstone; limestone fine-grained to silty, weathers to yellowish colors. Unit varies from 130 to 350 ft (40 to 107 m) in thickness in the Hunton anticline area. Named for Sycamore Creek, Johnston County, Okla. (Taff, 1903).

Welden Limestone (Lower Mississippian)
Limestone, generally not exposed in the Arbuckle Mountains, or is very thin and commonly misidentified as part of the much thicker Sycamore Limestone (Elias, 1956). Includes light-green, blocky, glauconitic, yellowish weathering shale at base. In the Lawrence uplift area to the northeast of the map area (fig. 3), the Welden Limestone consists of 0 to 5 ft (to 2 m) of light-gray to buff, crystalline, argillaceous, fossiliferous limestone, which weathers to a yellow or orange color. This thin limestone also contains scattered phosphatic nodules similar to those observed in some areas in the upper part of the Woodford Shale. Unit was named by Cooper (1931) for exposures along Welden Creek, Pontotoc County, Okla.

Woodford Shale (Lower Mississippian, Kinderhookian to Upper Devonian)
Light- to dark-gray, fissile shale, siliceous shale, bedded chert, and black, fissile bituminous shale. Locally, siliceous shale and bedded chert make up most of the formation. Chert and phosphatic concretions occur in the lower part of the unit. Thickness varies from 200 to 700 ft (61 to 213 m); increases in thickness to the south in the Arbuckle Mountains. Derivation of name unknown but assumed to be for the town of Woodford, Carter County, Okla. (Taff, 1902).

(*GRI Source Map ID 75748)* (Scientific Investigations Map SIM-3258).

DSOh - Hunton Group, undifferentiated (Upper Ordovician, Cincinnatian to Lower Devonian)

White limestone and calcareous marlstone. At the base of the unit are white, oolitic limestone beds, silicified in places. Above the oolitic limestone are blueish- and beige-colored limestone and marlstone, with a maximum thickness of 100 ft (30 m) or more. Upper 50 ft (15 m) of unit contains thin-bedded marlstone that is fossiliferous, with some beds composed mainly of shell fragments. Chert nodules also occur in the Hunton Group exposures. Total thickness of the Hunton Group varies greatly and ranges from 125 ft (38 m) to 550 ft (168 m). This undifferentiated map unit includes as many as seven, thin (locally absent) formations that consist predominantly of varying amounts of limestone, marl, and interbedded shale. In descending stratigraphic order, these seven formations are: the Frisco, Bois d'Arc, Haragan, Henryhouse, Clarita, Cochrane, and Keel Formations. Frisco Formation is not exposed in the map area. Throughout most of the map area and regions nearby, poor exposures and the thin character of these formations require that they be mapped together as one undifferentiated unit. However, in the southeast part of the map area directly southeast of the Lake of the Arbuckles, exposures are adequate to allow subdivision of the Hunton Group (DSOh) into upper and lower parts (Dhu and SOhl, respectively). These parts of the Hunton Group and the formations they comprise are described below. Named for the village of Hunton, Johnston County, Okla. (Taff, 1902). (*GRI Source Map ID 75748)* (Scientific Investigations Map SIM-3258).

Dhu - Upper part of Hunton Group, undifferentiated (Lower Devonian)

Alternating blueish to white shales and thin-bedded, argillaceous limestone that weathers to yellowish to tan mudstone overlain by thin-bedded, crystalline and noncrystalline limestone with occasional chert and marly lentils and intercalated yellowish shale. Thickness varies from 0 to 256 ft (to 78 m), averages 160 ft (49 m). Mapped separately from Hunton Group (DSOh) only in the southeast part of map area where the Hunton Group is best exposed. Includes two undifferentiated formations of the Hunton Group, the Bois d'Arc and Haragan Formations, which are described separately below.

Bois d'Arc Formation
Thin-bedded, crystalline and noncrystalline limestones with occasional chert and marly lentils and thin beds of intercalated yellow-weathering shale. Uppermost formation of the Hunton Group in the map area. Characteristic fossils include sponges, anthozoans, crinoids, brachiopods, gastropods, crustaceans, and locally corals. Thickness varies from 0 to 90 ft (to 27 m), averages 60 ft (18 m). Type area designated along Bois d'Arc Creek in the Arkoma basin, Pontotoc County, Okla. (Reeds, 1911).

Haragan Formation
Alternating blueish to white shale, thin-bedded, argillaceous limestone, and yellow- to tan-weathering mudstone. Common fossils are sponges, anthozoans, crinoids, brachiopods, gastropods, and crustaceans. Thickness varies from 0 to 166 ft (to 51 m), averages 100 ft (31 m). Type section in the White Mound region, along Haragan Creek, located 3 to 4 miles southeast of Dougherty. Named for Haragan Creek, 4 miles southeast of the village of Dougherty, Murray County, Okla. (Reeds, 1911).

(*GRI Source Map ID 75748)* (Scientific Investigations Map SIM-3258).

SOhl - Lower part of Hunton Group, undifferentiated (Upper Ordovician to Silurian)

Fossiliferous, oolitic limestone, and fine-grained, micritic limestone overlain by white to blueish and greenish-gray, massive limestone and thin to thick-bedded, crystalline to argillaceous limestone, with interbedded shale in the upper parts of the unit. Thickness varies greatly, reaching a maximum thickness of 295 ft (90 m); average thickness is 125 ft (38 m). Mapped separately from Hunton Group (DSOh) only in the southeast part of map area where the Hunton Group is best exposed. Includes four undifferentiated formations of the Hunton Group: Henryhouse, Clarita, Cochrane, and Keel Formations, that are described separately below.

Henryhouse Formation (Silurian)
Blueish, yellowish, and reddish-brown, thin- to thick-bedded limestone and argillaceous limestone with interbeds of yellowish shale in the lower half of unit. Light-gray argillaceous limestone dominates the upper part. Characteristic fossils include anthozoans, crinoids, brachiopods, gastropods, and crustaceans. Thickness varies from 0 to 220 ft (to 67 m), averages 90 ft (27 m). Named for Henryhouse Creek, Carter County, Okla. (Reeds, 1911).

Clarita Formation (Silurian)
Fossiliferous, coarse- to fine-grained, argillaceous limestone, with most of the limestone fine-grained and argillaceous. Divided into two formal members, the Prices Fall Member, a shale and marl of Early Silurian age, and the overlying Fitzhugh Member, a biomicritic limestone of Middle Silurian age. Contact with the underlying Cochrane Formation marked by shale and thin-bedded limestone. Unit includes foraminifers, conodonts, crinoids, ostracodes, and brachiopods. Maximum thickness 45 ft. Type locality located 3 miles west of the village of Clarita, Coal

County, Okla. (Amsden, 1957).

Cochrane Formation (Silurian)
White to blueish- and greenish-gray, massive-bedded, crystalline limestone containing spherules of glauconite. Unit is, on average, 12 to 15 ft (4 to 5 m) thick. Type locality located in Pontotoc County, Okla. (Amsden, 1957).

Keel Formation (Upper Ordovician, Cincinnatian)
Fossiliferous, oolitic limestone, and fine-grained, micritic limestone, sometimes recrystallized. Thickness ranges from 0 to 15 ft (to 5 m), generally 5 ft (2 m) or less thick. Although generally thought to be Early Silurian in age, conodont biostratigraphy (Barrick and others, 1990) indicates that the unit is of Late Ordovician (Cinncinatian) age.

(*GRI Source Map ID 75748)* (Scientific Investigations Map SIM-3258).

Osv - Sylvan Shale and Viola Group, undifferentiated (Upper Ordovician, Cincinnatian)

This undifferentiated map unit has a shaley upper part (Sylvan Shale) and a thicker, limestone-rich lower part (Viola Group). Limestone cherty with occasional chert nodules. Viola Group contains limestone of the Welling Formation and Viola Springs Formation. Cumulative thickness to 1,000 ft (305 m). Basal limestone of the Viola Group overlies limestone and interbedded shale of the upper Simpson Group in many places in the eastern and southern parts of the map area. Throughout the map area and regions nearby, poor exposures require that the Sylvan Shale and Viola Group be mapped together as one undifferentiated unit. However, in the southern part of the map area, south of the Lake of the Arbuckles, exposures are adequate to allow mapping of the Sylvan Shale separately from the Viola Group. (*GRI Source Map ID 75748)* (Scientific Investigations Map SIM-3258).

Os - Sylvan Shale (Upper Ordovician, Cincinnatian)

Principally green to gray or tan, fissile, calcareous and dolomitic shale that weathers easily and is rarely exposed. Commonly forms swales or subtle rolling hills between resistant underlying and overlying limestone units; locally is silty or siliceous; contains graptolites and chitinozoans (Decker, 1936). Thickness varies from 50 ft (15 m) to up to 300 ft (91 m) in the Arbuckle Mountains. Named for the village of Sylvan, Johnston County, Okla. (Taff, 1902). (*GRI Source Map ID 75748)* (Scientific Investigations Map SIM-3258).

Ov - Viola Group (Upper Ordovician, Cincinnatian)

Composed of limestones of the Welling and Viola Springs Formations. Welling Formation (previously Fernvale Limestone) is gray, coarse-grained, fossiliferous limestone. The Viola Springs Formation is white to blueish-gray, cherty, fine- to medium-grained, locally very fossiliferous limestone with thin interbeds of green to gray, fissile shale; limestone may contain chert nodules in its lower and middle parts. Thickness to 700 ft (213 m). Named for the village of Viola, Johnson County, Okla. (Taff, 1902). (*GRI Source Map ID 75748)* (Scientific Investigations Map SIM-3258).

Simpson Group (Middle Ordovician)

Sandstone and fossiliferous limestone with interbedded greenish shale and marl. Thick, massive brown sandstone lentils occur throughout and range to 100 ft (30 m) thick. Interbedded limestone and marl lentils are thinner, yellow or blueish, with green, marly shale layers. Simpson Group includes as many as six formations that consist predominantly of limestone, sandstone, and shale. In descending stratigraphic order, these formations are the Bromide, Tulip Creek, McLish, Oil Creek, Joins, and Corbin Ranch Formations. Corbin Ranch Formation is not present in the Hunton anticline and CNRA map areas. These formations are commonly mapped together as two undifferentiated map units, dividing the Simpson Group into upper and lower parts. Basal Simpson Group strata overlie upper Arbuckle Group strata near the southeast corner and east-central border of the map area. Ranges in thickness from 1,000-2,300 ft (305-700 m). Probably named for the village of Simpson, located north of Pontotoc, Johnston County, Okla. (Taff, 1902). (*GRI Source Map ID 75748)* (Scientific Investigations Map SIM-3258).

Obm - Bromide, Tulip Creek and McLish Formations, undifferentiated (Middle Ordovician)

Alternating sandstone, green shale, and limestone. Limestone is buff; shale, grayish-green; sandstone, brown to white and fine- to medium-grained. Includes the upper three formations of the Simpson Group that are described separately below. Tulip Creek not recognized in the eastern part of the Hunton anticline. Thickness is 750?1,400 ft (229?427 m), thinning eastwardly. Decker and Merritt (1931) recognized all three of these formations in their regional summary of the Simpson Group.

Bromide Formation
Mostly interbedded limestone and shale with basal quartzose sandstone. Limestone buff-colored, shale grayish-green, and sandstone brown to white. Limestone is commonly fossiliferous with brachiopods and ostracodes. Limestone and minor dolomite in the upper part of the unit are informally called the "upper Bromide limestone." Cooper (1956, p. 120-121) divided the Bromide Formation into two members, the Mountain Lake Member (lower) and the Poolville Member (upper). Thickness of the formation varies, from 315 ft (96 m) to over 600 ft (183 m); thickest in the western part of Arbuckle Mountains where it measures 647 ft (197 m); the basal sandstone unit can vary greatly in thickness, to 300 ft (91 m) thick. Named for the town of Bromide, Johnston County, Okla. Type locality on a hill northwest of the Galbraith Hotel, Bromide, Okla. (Decker and Merritt, 1931).

Tulip Creek Formation
Mostly shale and sandstone with minor limestone. Shale predominates in the upper part of the unit with sandstone in the lower part. Unit grades upward into the overlying basal sandstone of the Bromide Formation. Commonly has basal sandstone that overlies limestone of the underlying McLish Formation. Unit thickness ranges from 300-400 ft (91-122 m) along the U.S. I-35 corridor (Fay, 1989).

McLish Formation
Comprises the lower part of the undifferentiated Obm map unit in the upper part of the Simpson Group. Mostly interbedded limestone and shale above a quartzose sandstone at the base of the unit; the basal sandstone thins from east to west in the Arbuckle Mountains. Some of the limestone is dense with small blebs of calcite and it is informally termed "birdseye" limestone. Basal sandstone overlies limestone of the underlying Oil Creek Formation. Maximum thickness is 450 ft (137 m) in the eastern parts of the Arbuckle Mountains and 400.500 ft (122-152 m) thick along the U.S. I-35 corridor (Fay, 1989).

(*GRI Source Map ID 75748)* (Scientific Investigations Map SIM-3258).

Ooj - Oil Creek and Joins Formations, undifferentiated (Middle Ordovician)

Limestone, gray to tan, granular, with greenish-gray shale and brown, fine- to medium-grained sandstone. Includes the lower two formations of the Simpson Group that are described separately below. Thickness is 600-1,100 ft (183-335 m), decreasing eastward. Decker and Merritt (1931) also recognized both the Oil Creek and Joins Formations in their regional summary of the Simpson Group.

Oil Creek Formation
Basal quartz arenite sandstone overlain by limestone and shale. Upper part of unit may also contain some calcite-cemented sandstone. Although sometimes absent in parts of the Arbuckle Mountains, the basal Oil Creek sandstone is the thickest (up to 400 ft or 122 m thick) of the Simpson Group sandstones and is locally petroliferous (tar sand was mined in the eastern part of the map area) and, in places, is argillaceous or calcareous. Unit averages 750 ft (229 m) thick. Basal sandstone overlies limestone of the underlying Joins Formation.

Joins Formation
Thin-bedded limestone and shale with a persistent thin conglomerate at base of unit. Basal conglomerate overlies, and is derived from, the underlying West Spring Creek Formation. Absent in the eastern part of the Hunton anticline. Unit can be as much as 300 ft (91 m) thick on the south side of the Arbuckle Mountains.

(*GRI Source Map ID 75748)* (Scientific Investigations Map SIM-3258).

Arbuckle Group (Upper Cambrian to Lower Ordovician)

Includes up to 6,700 ft (2,042 m) of thin- to massive-bedded limestone and dolomite, with some sandstone and shale, locally subdivided into eight formations (for example, Fay, 1989). The eight formations are, in descending stratigraphic order: the West Spring Creek, Kindblade, Cool Creek, and McKenzie Hill Formations, Butterly Dolomite, Signal Mountain Formation, Royer Dolomite, and Fort Sill Limestone. Throughout much of the Arbuckle Mountains, these formations are commonly lumped together and mapped as three undifferentiated map units that define upper, middle, and lower parts of the Arbuckle Group. Upper and middle parts of the Arbuckle Group are Early Ordovician in age, lower part is Early Ordovician and Late Cambrian in age. Only the West Spring Creek and Kindblade Formations, which compose the upper part of the Arbuckle Group, are exposed in the map area. The Arbuckle Group underlies the Simpson Group in the map area and overlies the Timbered Hills Group elsewhere in the Arbuckle Mountains. “Arbuckle limestone” was first described by Taff (1902). (*GRI Source Map ID 75748)* (Scientific Investigations Map SIM-3258).

Ow - West Spring Creek Formation (Lower Ordovician)

Gray to tan, fine-grained, thick- to thin-bedded, laminated dolomitic limestone and some tan to gray sandstone and shale. Only mapped separately from the Kindblade Formation along northern part of the eastern map border and throughout the core of the Hunton anticline east of the map area. Unit is 1,515 ft (462 m) thick along the U.S. I-35 corridor (Fay, 1989). Named for a creek in southwestern part of Murray County, 4-5 miles southeast of Poolville, Okla. (*GRI Source Map ID 75748)* (Scientific Investigations Map SIM-3258).

Owk - West Spring Creek and Kindblade Formations (Lower Ordovician)

Predominantly fine-grained limestone that grades westward into greenish to tan dolomite with minor sandstone and shale lentils. Principally limestone in the western part of the Arbuckle Mountains and principally dolomite in the eastern part. In the map area (central Arbuckle Mountains), dolomitic limestone predominates. Interbeds of sandstone are common and more abundant and thicker in the eastern Arbuckle Mountains. These two upper Arbuckle Group formations are mapped together as one undifferentiated unit in the map area, including exposures in the southeast corner and along the central part of the eastern map border. The West Spring Creek Formation is mapped separately where it occurs along the northern part of the eastern border. The Kindblade Formation is only mapped separately east of the map area in the Hunton anticline.

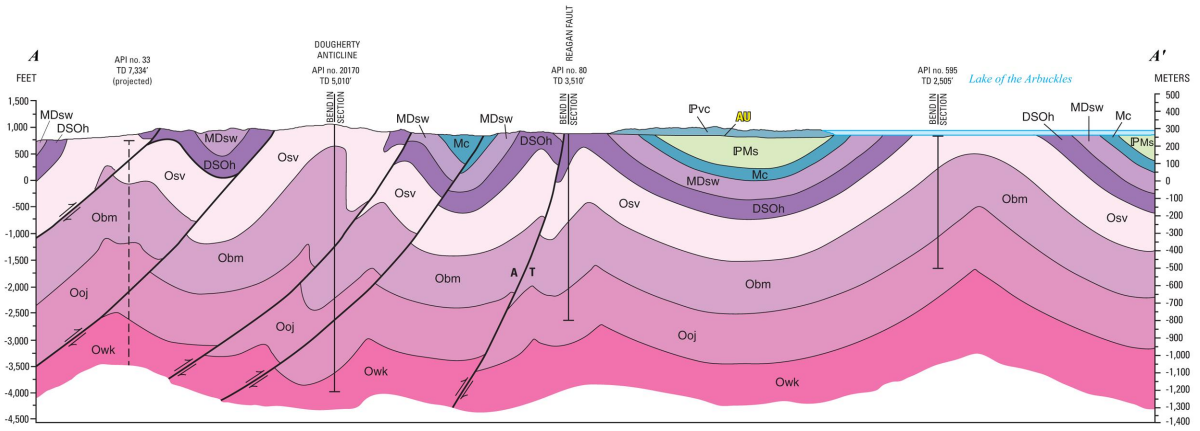
Kindblade Formation
Predominately gray to tan, fine-grained, thick-bedded dolomitic limestone and some sandstone and shale. Only mapped separately where differentiated from the West Spring Creek Formation in the Hunton anticline, east of the map area. Unit is 1,410 ft (430 m) thick along the U.S. I-35 corridor (Fay, 1989) and generally thins to the east. Derivation of name unknown but assumed to be from the Kindblade Ranch, northeastern Wichita Mountains, Okla.

(*GRI Source Map ID 75748)* (Scientific Investigations Map SIM-3258).

Geologic Cross Sections

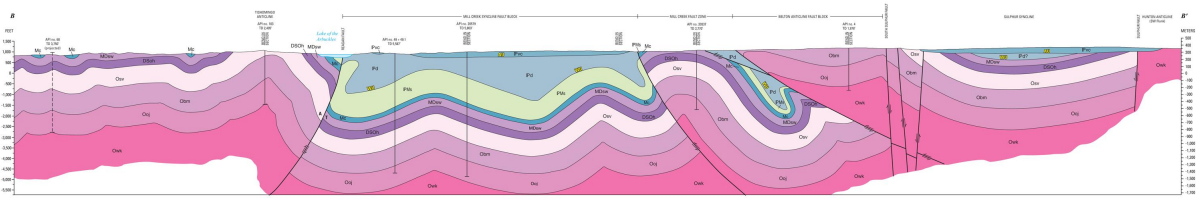
The geologic cross sections present in the GRI digital geologic-GIS data produced for Chickasaw National Recreation Area, Oklahoma (CHIC) are presented below. Cross section graphics were scanned at a high resolution and can be viewed in more detail by zooming in (if viewing the digital format of this document).

Cross Section A-A'



Extracted from: Scientific Investigations Map SIM-3258.

Cross Section B-B'



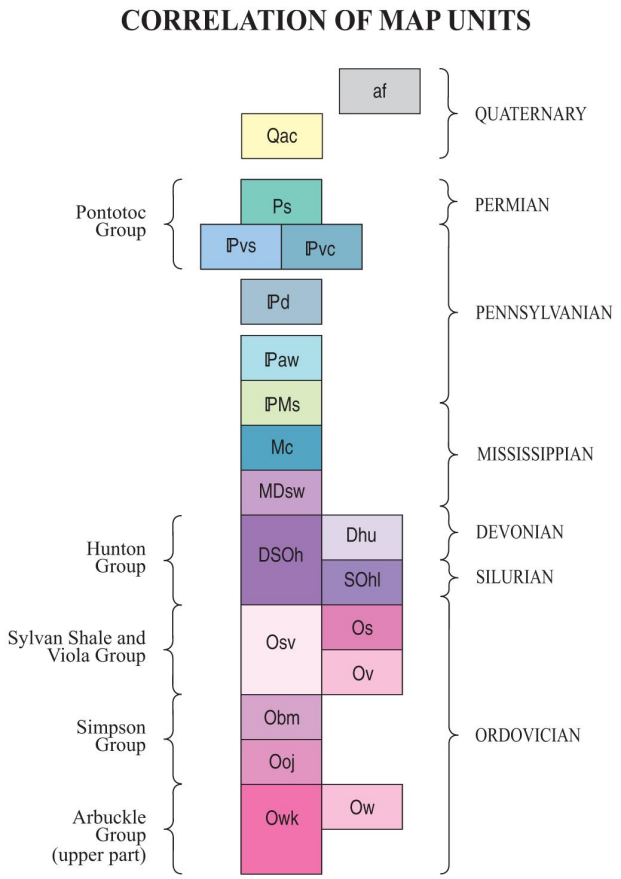
Extracted from: Scientific Investigations Map SIM-3258.

Scientific Investigations Map SIM-3258

Blome, C.D., Lidke, D.J., Wahl, R.R., and Golab, J.A., 2013, Geologic Map of Chickasaw National Recreation Area, Murray County, Oklahoma, U.S. Geological Survey, Scientific Investigations Map SIM-3258, 1:24000 scale. (*GRI Source Map ID 75748*).

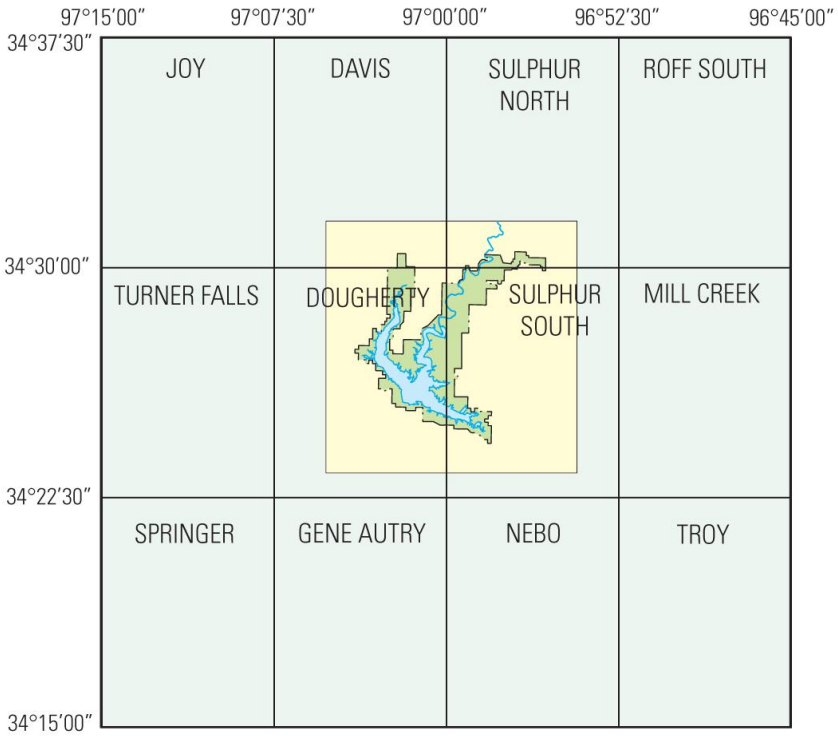
Note: The information provided herein depicts ancillary figures and tables extracted from the source map PDF. There is a U.S. Geological Survey pamphlet that accompanies the map which can be found here: http://pubs.usgs.gov/sim/3258/. The pamphlet includes a detailed report of regional geology along with additional pictures, tables and references.

SIM-3258 Correlation



Extracted from: Scientific Investigations Map SIM-3258.

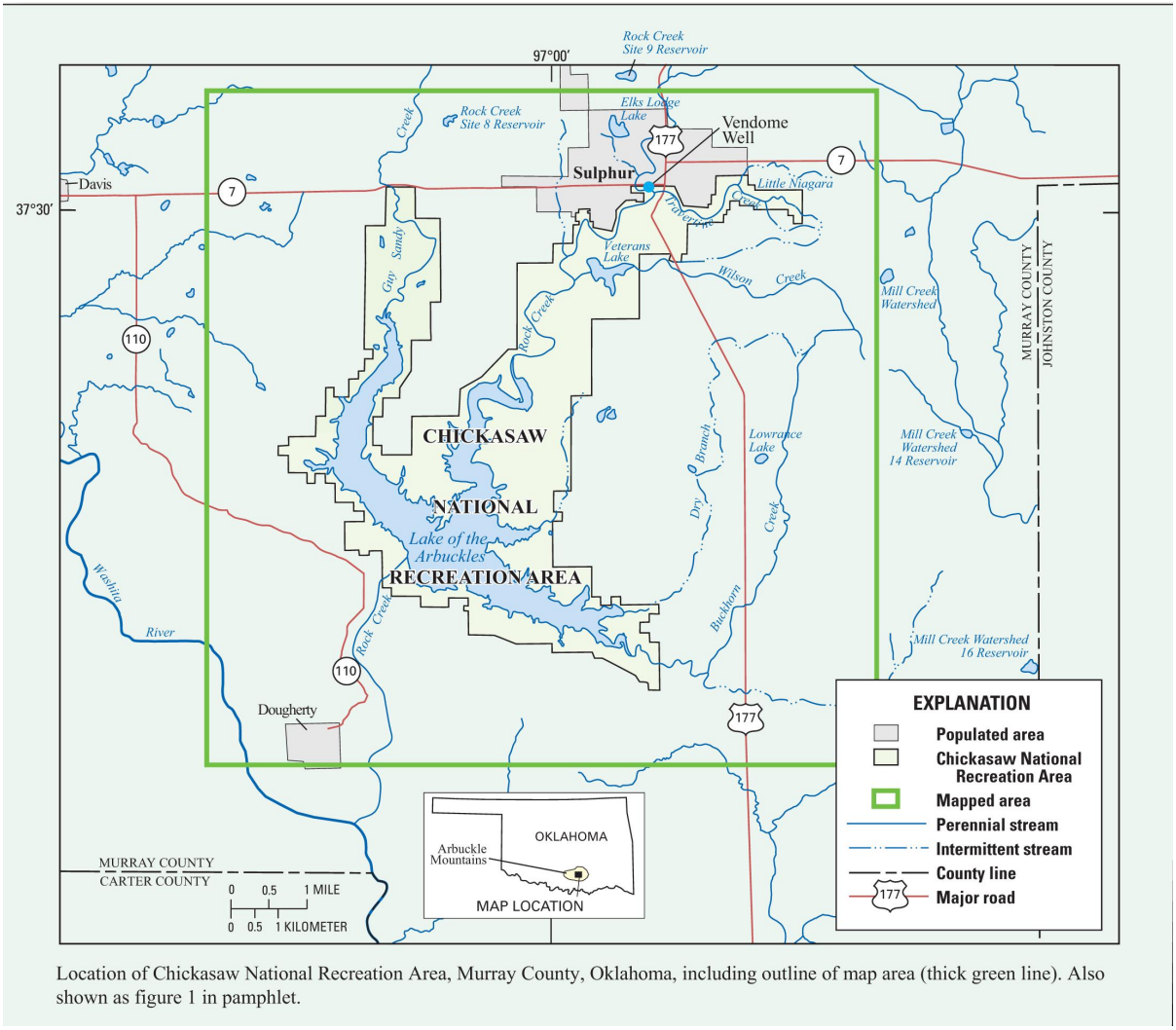
SIM-3258 Index Map



Index map showing map area in yellow, Chickasaw National Recreation Area in green, Lake of the Arbuckles in blue, and the U.S. Geological Survey 7.5-minute quadrangles.

Extracted from: Scientific Investigations Map SIM-3258.

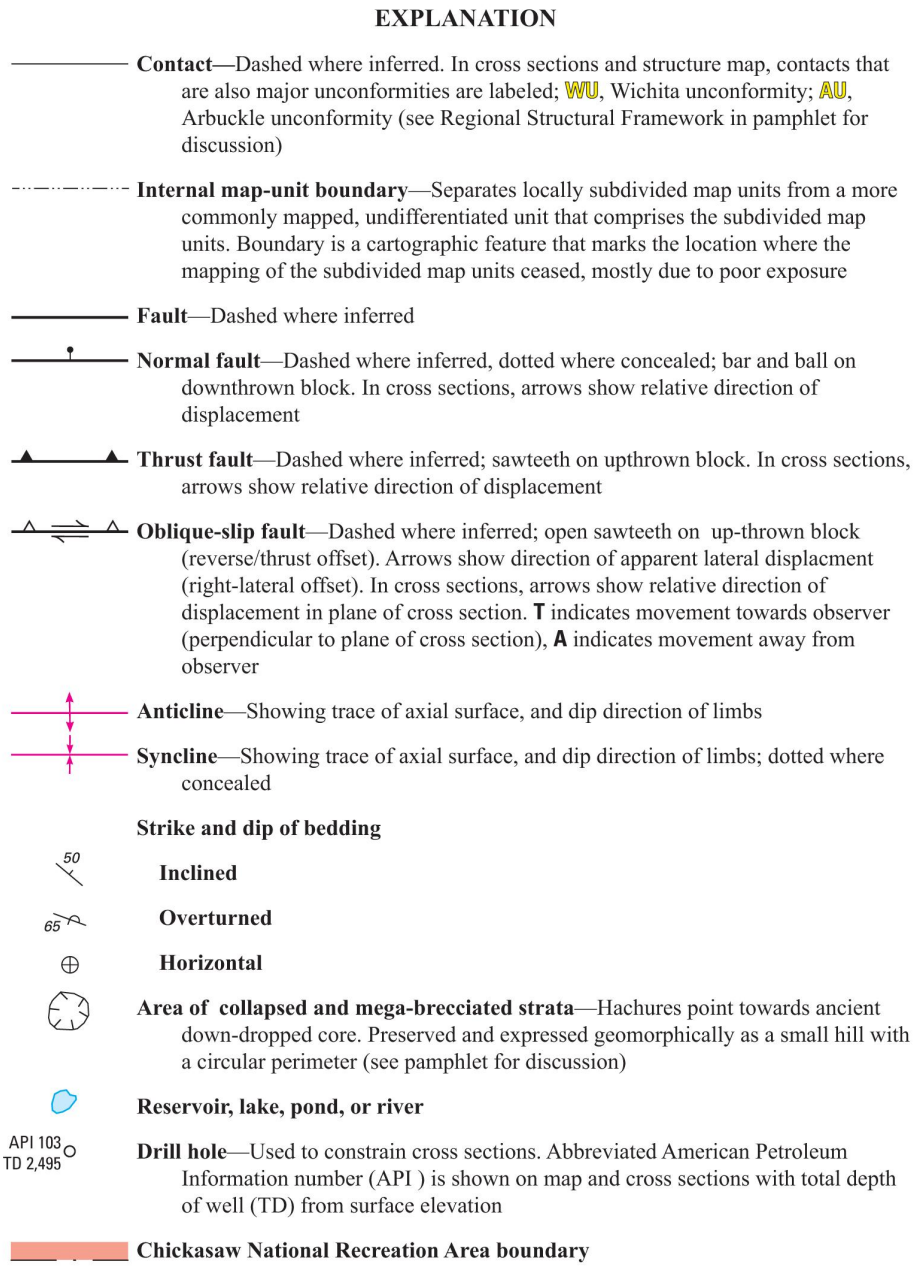
SIM-3258 Location Map



Location of Chickasaw National Recreation Area, Murray County, Oklahoma, including outline of map area (thick green line). Also shown as figure 1 in pamphlet.

Extracted from: Scientific Investigations Map SIM-3258.

SIM-3258 Map Legend



Extracted from: Scientific Investigations Map SIM-3258.

SIM-3258 Report

See U.S. Geological Survey SIM-3258 pamphlet for detailed report on regional geology. Available at: http://pubs.usgs.gov/sim/3258/.

GRI Digital Data Credits

This document was developed and completed by Derek Witt (Colorado State University) for the NPS Geologic Resources Division (GRD) Geologic Resources Inventory (GRI) Program. Quality control of this document by Jim Chappell (Colorado State University).

The information in this document was compiled from the GRI source map, and intended to accompany the digital geologic-GIS map(s) and other digital data for Chickasaw National Recreation Area, Oklahoma (CHIC) developed by Derek Witt and Jim Chappell (Colorado State University) (see the GRI Digital Map and Source Map Citation section of this document for all sources used by the GRI in the completion of this document and related GRI digital geologic-GIS map).

GRI finalization by Jim Chappell (Colorado State University).

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