GEOLOGICAL SURVEY

Geologic Map of the Mammoth Spring Quadrangle, Fulton County, Arkansas

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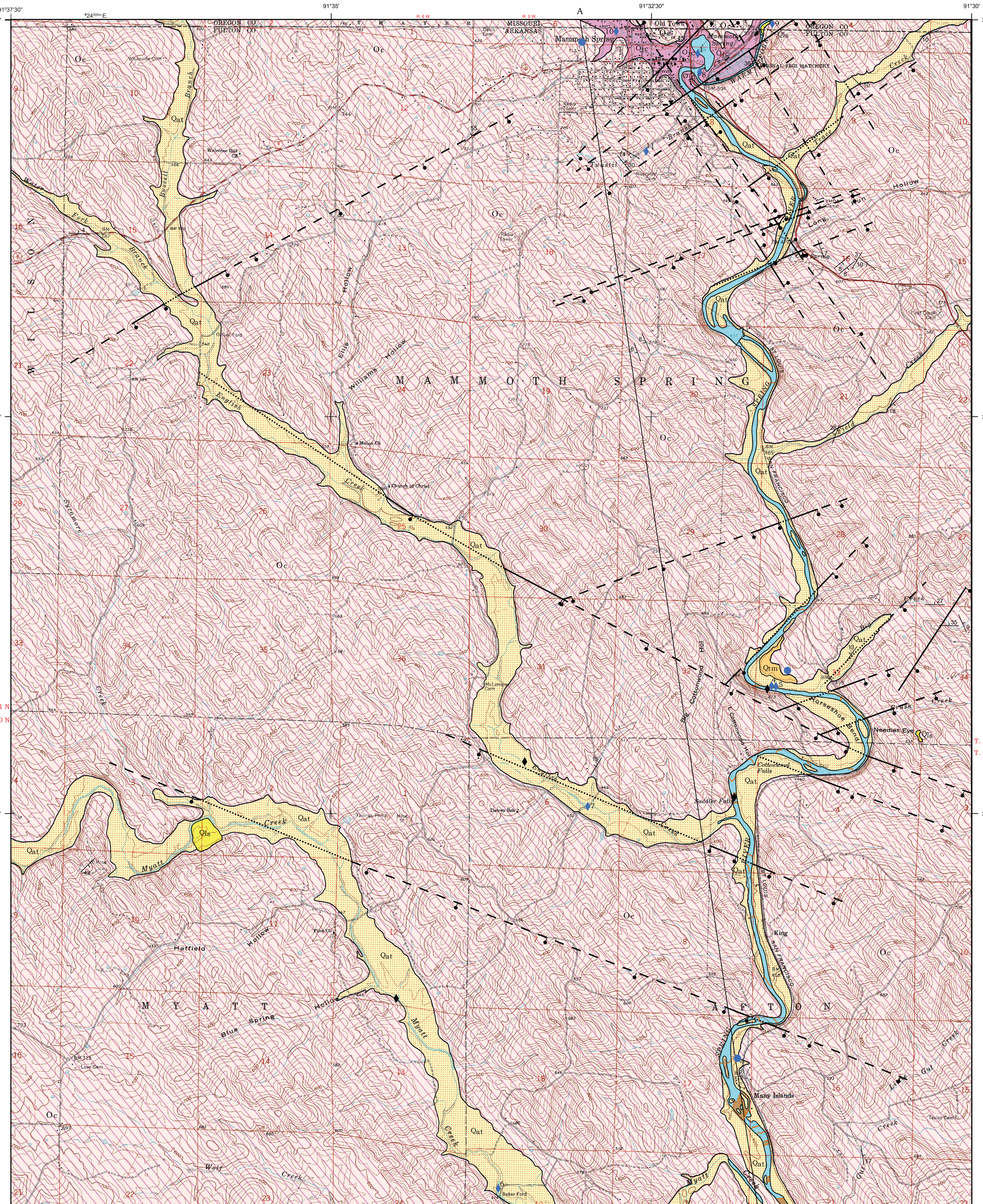
2020

Bekki White, Director and State Geologist



Mapped, edited, and published by the Geological Survey

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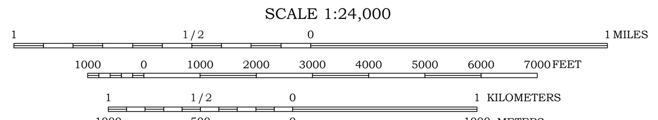
Topography by photogrammetric methods from aerial photographs taken 1959. Field checked 1962

Polyconic projection. 1927 North American datum
10,000-foot grid based on Arkansas coordinate system, north zone
1000-meter Universal Transverse Mercator grid ticks, zone 15, shown in blue

Fine red dashed lines indicate selected fence and field lines where generally visible on aerial photographs This information is unchecked.

Approximate mean declination 2020

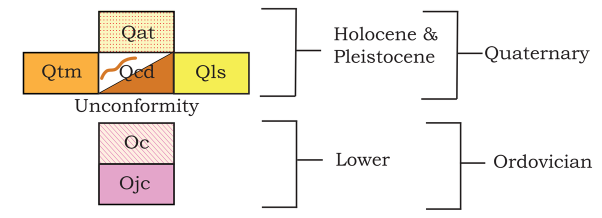
SCALE 1:24,000



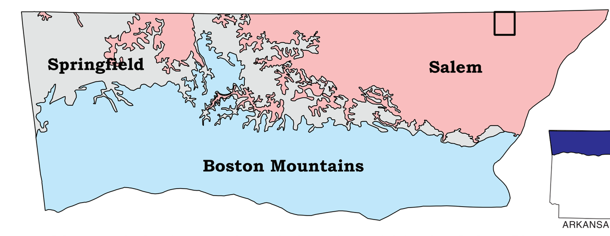
Contour Interval 20 Feet
Datum is Mean Sea Level

Quadrangle Location

Correlation of Map Units



Ozark Plateaus



Mammoth Spring quadrangle location within the Salem Plateau.

Introduction

This map depicts the bedrock and surficial geology of the 7.5-minute Mammoth Spring quadrangle. In this area, approximately 400 feet (122 meters) of Lower Ordovician carbonate and clastic rocks are exposed. These rocks, primarily limestone and sandstone, were deposited as sediments in a warm, shallow epeiric sea. Through time, groundwater processes have chemically altered and replaced these rocks with dolostone and chert. The quadrangle is situated on the Salem Plateau, the northernmost of three broad plateau surfaces in northern Arkansas known as the Ozark Plateaus Province, part of the Interior Highlands Physiographic Region. The Salem Plateau developed by differential erosion of Paleozoic sedimentary units deposited on the flanks of the Ozark Dome, a structural high centered in southeast Missouri that formed due to volcanic activity during the Precambrian.

Springs are a common feature in the karst landscape that has developed here. Mammoth Spring, which is the largest spring in Arkansas, third largest in the Ozark Plateaus, and seventh largest in the world, has a discharge of approximately 550 feet3/second (16 meters3/second) and produces nine million gallons (thirty-four million liters) of water per hour. Where it flows to the surface, it is impounded in a pool that measures 250 feet (76 meters) wide, covers 10 acres (4 hectares), and extends 70 to 100 feet (21 to-30 meters) below ground. The impoundment was used to power a grist mill and later to generate hydroelectric power. The water maintains a nearly constant temperature of 14.5°C (58°F) year round and is supersaturated with dissolved nitrogen, which readily bubbles out when exposed to the relatively low pressure at the surface. Just downstream, the flow from the spring joins Warm Fork and is thereafter called the Spring River - a very popular destination for recreational activities. Approximately 12 miles (19 kilometers) of the Spring River lies on this quadrangle.

Carbonate deposits in the form of tufa dams spanning the riverbed in several places is a distinguishing feature of the Spring River. Along the stretch on this quadrangle, approximately twenty-eight tufa dams have developed beginning approximately 3.1 miles (5 kilometers) downstream of Mammoth Spring. This is unusual in that tufa is typically deposited near the mouth of a spring. The tufa dams create rapids and falls along the course of the river and locally, small vegetated islands have developed which are completely covered by tufa growth. Smaller dams have developed in some tributaries near their confluence with the Spring River. Samples were taken monthly for chemical analysis to see if changes in chemistry or distance downstream from Mammoth Spring plays a role in the growth of the tufa deposits in terms of size and frequency (Table 1.). Interpretation of the data is ongoing.

The major drainages within the mapping area include the Spring River, Myatt Creek, and English Creek. Construction of a BNSF Railway line along the Spring River has exposed several faults and paleokarst collapse features. Dolostone exposures in Myatt and English Creeks display various dip orientations, which taken together can be characterized as broadly undulating.

Previous mapping in this area includes a geologic worksheet by E. E. Glick in 1974 and a master's thesis by W. J. Hedden whose mapping of an area to the north included the town of Mammoth Spring. The current mapping project is based primarily on data collected from field observations made between July, 2019 and March, 2020. These data, along with site locations, were recorded in a geodatabase on a portable data collector/global positioning satellite receiver. Representative rock samples were collected to aid in classification and for future petrographic and stratigraphic studies.

Description of Map Units

Qat **Alluvium and terrace deposits (Quaternary)** — unconsolidated clay, silt, sand, and gravel in the active channel of the Spring River and its major tributaries overlying bedrock which is locally exposed. Gravel is mostly chert. Along the Spring River, there is generally an unsorted alluvial deposit of mixed composition. English and Myatt Creeks have at least two terraces: an upper which ranges up to 5 feet (1.5 meters) thick composed of brown, silty to sandy clay with a basal gravel and a lower of similar thickness composed of silty clay with either a gravel or a discontinuous gray clay at the base. From this basal clay were collected woody samples from Myatt Creek that were dated to 2120 years before present and charcoal samples from English Creek that were dated to 5500 years before present using carbon-14 methods. Total thickness ranges up to 10 feet (3 meters) on these tributaries and up to 12 feet (3.6 meters) along the Spring River.

Qtm **Medial terrace deposit (Quaternary)** — unconsolidated veneer of gravel and cobbles in a stranded terrace located approximately 30 to 40 feet. (9 to 12 meters) above the Spring River in Section 33, T21N, R5W.

Qcd **Carbonate deposits (tufa dams) (Quaternary)** — dissolved calcium carbonate precipitating in stream beds as coatings and buildups on alluvial gravel, mostly chert and dolostone, and organic debris. Carbon-14 dating indicates that these deposits are between 4600 and 4700 years old. Dam formation seems to be initiated by gravel becoming trapped behind broken, undulating dolomitic rock exposed in the stream bed. The resulting turbulent flow allows the process of precipitation to begin, eventually coalescing to form a dam. The thickness of the coatings is typically less than ¼ inch (6 millimeters) on tributaries but up to 4 feet (1.2 meters) on the Spring River. The dams generally form a series of cascades with drops varying from 1 to 4 feet (0.3 to 1.2 meters) and usually span the entire river, the largest being approximately 450 feet (137 meters) across. The carbonate material is commonly porous, unstable, and easily undermined by stream flow. Overhangs, cavities, and collapses are common and can become hazardous for recreational users.

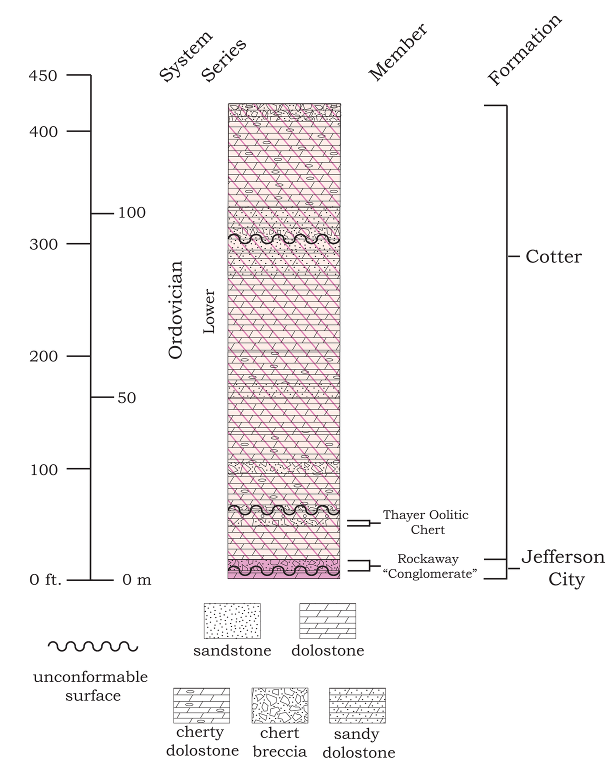
Qls **Landslide deposits (Quaternary)** — unsorted, unconsolidated rock and debris resulting from failure of oversteepened slopes.

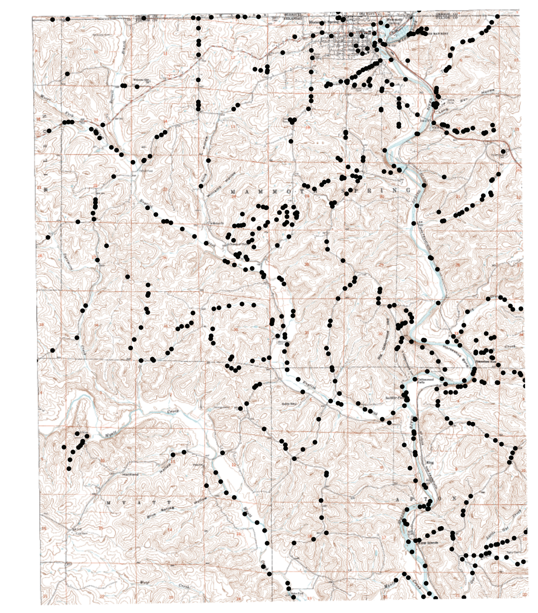
Oc **Cotter Dolomite (Lower Ordovician)** — thin- to thick-bedded, very finely to coarsely crystalline, gray to buff to beige dolostone with interbedded, very thinly laminated green to gray shale, brown to reddish brown sandstone, and tan, white, gray, or blue chert . Locally, the dolostone contains networks of fine dolomite veins and small, dolomite-lined vugs. Chert nodules and thin, discontinuous chert beds are common. Higher in stratigraphic section, the dolostone is sandy and laminated, and locally contains quartz-filled vugs that weather out as geodes. Discontinuous sandstone beds are present at multiple intervals forming lenses up to 5 feet (1.5 meters) thick. Sandstone is typically orthoquartzitic and composed of fine, well-sorted, well-rounded, mature grains. It is typically well indurated by quartz-cement, but is locally iron cemented and friable. Locally, the sandstone contains ripplebeds and chert nodules, and near faults, deformation bands are present. Chert beds range up to 5 feet (1.5 meters) thick and typically crop out as brecciated boulders. It is opaque or translucent and locally oolitic. Deposits of iron ore in weathered chert and clay residue was historically mined in the area. Total thickness is approximately 400 feet (122 meters). The *Thayer Oolitic Chert* forms a marker bed approximately 28 feet (8.5 meters) above the *Rockaway Conglomerate* of the Jefferson City (Hedden, 1968). It is a blue-gray, oolitic chert bed, approximately 6 to 8 inches (15 to 20 centimeters) thick containing vugs lined with clear, drusy quartz.

Ojc **Jefferson City Dolomite (Lower Ordovician)** — Consists mostly of coarse to fine-grained crystalline dolostone that is tan to light gray in color but weathers to dark gray with beds and nodules of mottled white to tan chert. The chert tends to be translucent and is often brecciated. Bedding ranges from massive to thin with only the upper 20 to 30 feet (6 to 9 meters) of the unit exposed at the surface. Subsurface water well data indicates that the total thickness ranges from 110 to 170 feet (33 to 52 meters). The *Rockaway Conglomerate* is a marker unit located at the contact with the Cotter. It is composed locally of chert breccia that is silica-cemented. The chert ranges from white to shades of light gray or tan and is transclucent and oolitic. It is deposited on an irregular erosional surface and ranges up to 12 feet (3.6 meters) thick.

Water sampling at Mammoth Spring, Arkansas.

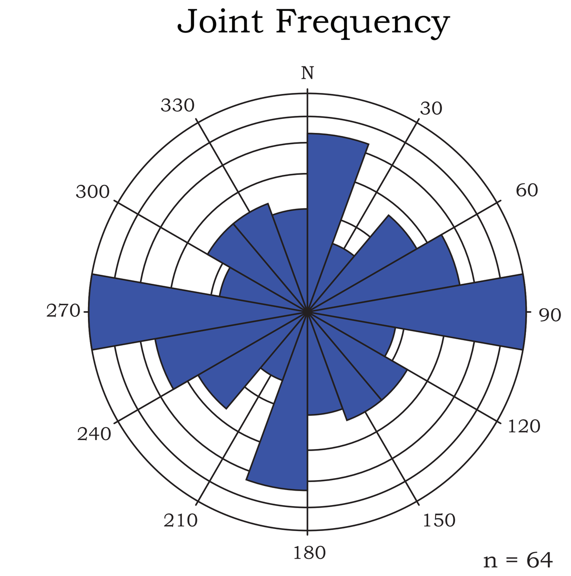
Stratigraphic Column





Topographic map of the Mammoth Spring quadrangle showing location of data collection points.

Joint Frequency



Rose diagram of strike frequency of joints recorded with the Mammoth Spring quadrangle.

Symbols

Contact

Inclined bedding showing strike and dip

Normal fault - ball and bar on downthrown side. Dashed where inferred. Dotted where concealed.

A — A' Line of cross-section

Water sample site

Carbon-14 sample site

Water well

Tufa dams at Saddler Falls on the Spring River. Foreground dam had flow diverted through channel after remediation of a collapse that formed a hazardous whirlpool.

Boulders of the Rockaway "Conglomerate" chert exposed on the northwest side of Mammoth Spring near the Old Town spring.

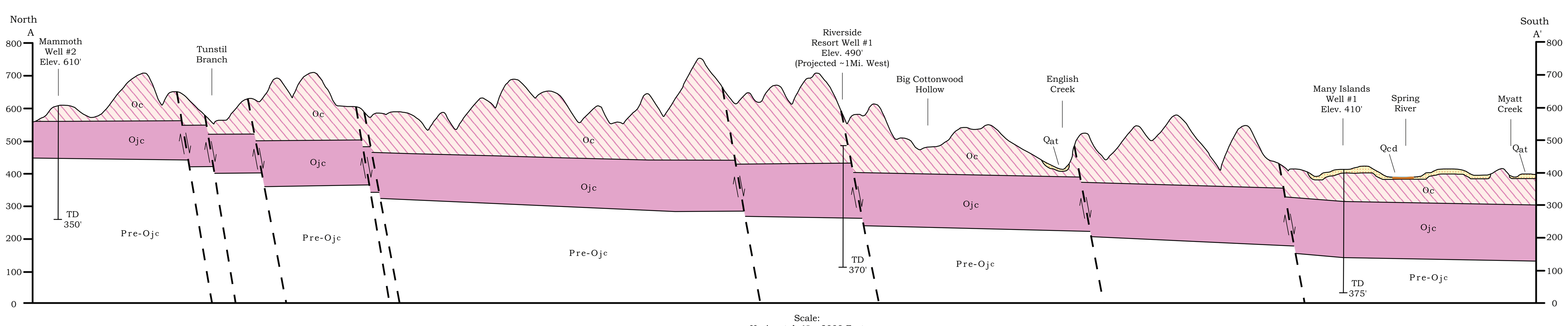
Basal gray clay in terrace deposit on English Creek where charcoal samples were taken.

Fault in the Cotter Formation along the BSNF rail line north of Horseshoe Bend.

Table 1. Descriptive chemical statistics from selected surficial and groundwater sites.

	Site	Water Temp °C	pH	Specific Conductance uS/cm	Calcium mg/L Dissolved / Total	Sulfate SO4 mg/L	Nitrate NO3+N O2 mg/L	Sampling Period Month/ Year
1	Mammoth Spring	15.29	7.25	397	46.99 / 48.09	3.95	1.38	Jul 2019 - Jun 2020
2	Raccoon Spring *	18.05	7.20	509	60.5 / 63.72	4.04	0.16	Jul 2019 - Jun 2020
3	Roaring Spring *	17.43	7.22	502	58.86 / 59.77	3.89	0.18	Jul 2019 - Jun 2020
4	Riverside Spring River 1	19.20	8.17	450	54.10 / 57.60	3.41	0.93	Jul - Sep 2019
5	Riverside Spring River 2	19.15	8.17	432	53.33 / 57.60	3.37	0.94	Jul - Sep 2019
6	Myatt Creek	17.90	8.02	477	50.96 / 52.50	3.52	0.21	Sep - Dec 2019
7	English Creek	17.90	8.07	531	55.73 / 59.66	3.58	0.21	Sep - Dec 2019
8	Warm Fork Spring River 1	11.03	7.71	438	50.63 / 49.36	3.54	0.99	Jan - Mar 2020
9	Warm Fork Spring River 2	10.50	7.98	440	49.43 / 49.30	3.43	0.95	Jan - Mar 2020
10	Old Town Spring	14.57	7.88	565	63.67 / 64.73	4.52	1.53	Apr - Jun 2020
11	Washam Spring	16.56	7.33	594	65.57 / 66.83	4.17	0.49	Apr - Jun 2020

* Not on quadrangle (Stuart Quadrangle)



Scale:
Horizontal: 1" = 2000 Feet
Vertical: 1 Inch = 200 Feet (Exaggeration : 10x)

References

Cullison, J. S., 1944, The stratigraphy of some Lower Ordovician formations of the Ozark Uplift: University of Missouri, School of Mines and Metallurgy, Bulletin Technical Series vol., XV, no. 2.

Glick, E. E., 1974, Geologic map of the Mammoth Spring quadrangle, Arkansas: Arkansas Geological Survey, 7.5-minute series Geologic Worksheet, 1:24,000-scale, 1 sheet.

Hedden, W. J., 1968, The geology of the Thayer area emphasizing the stratigraphy of the Cotter and Jefferson City Formations: University of Missouri-Rolla, Master's Thesis, 159 p., 14 pl.

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Limitations: This map, like all geologic maps, is based on interpretations which were made from the data available at the time it was created. As work continues and new information is collected, the contacts, structures, and other features depicted on this map may be changed.

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Map and cross-section digitized by Brian Kehner.