U.S. Department of the Interior
National Park Service
Natural Resource Stewardship and Science Directorate
Geologic Resources Division

Ozark National Scenic Riverways

GRI Ancillary Map Information Document

Produced to accompany the Geologic Resources Inventory (GRI) Digital Geologic Data for Ozark National Scenic Riverways

ozar_geology.pdf

Version: 8/2/2016

Geologic Resources Inventory Map Document for Ozark National Scenic Riverways

Table of Contents

Geologic Resources Inventory Map Document 1
About the NPS Geologic Resources Inventory Program 2
GRI Digital Map and Source Map Citation 4
Map Unit List 5
Map Unit Descriptions 6
Qa - Alluvium (Holocene) 6
Qm - Muck and clayey silt (Holocene and Pleistocene?) 6
Qls - Landslide deposits (Holocene and Pleistocene?) 6
Qc - Colluvium (Holocene and Pleistocene) 6
Qt - Terrace deposits (Holocene and Pleistocene?) 6
Qtl - Loess-covered terrace deposits (Pleistocene?) 6
Ql - Loess (Pleistocene) 7
QTrr - Residuum derived from Roubidoux Formation (Quaternary and Tertiary) 7
QTr - Peck Ranch unit (Quaternary and Tertiary, and Mesozoic?) 7
QTtrc - Residual and colluvial material on terrace-like landforms (Quaternary and Tertiary) 7
QTg - Upland gravel deposit (Quaternary and Tertiary) 7
Ojc - Jefferson City Dolomite (Lower Ordovician) 8
Or - Roubidoux Formation (Lower Ordovician) 8
Og - Gasconade Dolomite (Lower Ordovician) 8
Ce - Eminence Dolomite (Upper Cambrian) 9
Cp - Potosi Dolomite (Upper Cambrian) 9
Yg - Big Spring quad granite (Mesoproterozoic) 9
Yrm - Rhyolite of Russell Mountain (Mesoproterozoic) 10
Yvc - Volcaniclastic conglomerate, breccia, and sandstone (Mesoproterozoic) 10
Ysc - Rhyolite of Sutton Creek (Mesoproterozoic) 10
Ysi - Rhyolite of Shut-In Mountain (Mesoproterozoic) 10
Ysm - Rhyolite of Stegall Mountain (Mesoproterozoic) 11
Ymm - Tuff of Mule Mountain (Mesoproterozoic) 11
Yltm - Tuff of Little Thorny Mountain (Mesoproterozoic) 11
Ycu - Upper Coot Mountain unit (Mesoproterozoic) 12
Ycl - Lower Coot Mountain unit (Mesoproterozoic) 12
Digital Geologic Map of the Ozark National Scenic Riverways and Adjacent Areas along the Current and Jacks Fork Rivers, Missouri 13
Correlation of Map Units 13
Index Map 14
Bedrock Stratigraphic Column 15
Report 16
References 18
GRI Digital Data Credits 21

Geologic Resources Inventory Map Document

Ozark National Scenic Riverways, Missouri

Document to Accompany Digital Geologic-GIS Data

ozar_geology.pdf

Version: 8/2/2016

This document has been developed to accompany the digital geologic-GIS data developed by the Geologic Resources Inventory (GRI) program for Ozark National Scenic Riverways, Missouri (OZAR).

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.

For information about the status of GRI digital geologic-GIS data for a park contact:

Tim Connors
Geologist/GRI Mapping Contact
National Park Service Geologic Resources Division
P.O. Box 25287
Denver, CO 80225-0287
phone: (303) 969-2093
fax: (303) 987-6792
email: Tim_Connors@nps.gov

For information about using GRI digital geologic-GIS data contact:

Stephanie O'Meara
Geologist/GIS Specialist/Data Manager
Colorado State University Research Associate, Cooperator to the National Park Service
1201 Oak Ridge Drive, Suite 200
Fort Collins, CO 80525
phone: (970) 491-6655
fax: (970) 225-3597
e-mail: stephanie.omeara@colostate.edu

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:

Bruce Heise
Inventory Coordinator
National Park Service Geologic Resources Division
P.O. Box 25287
Denver, CO 80225-0287
phone: (303) 969-2017
fax: (303) 987-6792
email: Bruce_Heise@nps.gov

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 Ozark National Scenic Riverways, Missouri (OZAR):

Digital Geologic Map of Ozark National Scenic Riverways and Vicinity, Missouri (*GRI MapCode OZAR*)

Weary, D.J., Orndorff, R., Harrison, R., Weems, R.E., 2014, Digital Geologic Map of the Ozark National Scenic Riverways and adjacent areas along the Current and Jacks Fork Rivers, Missouri, U.S. Geological Survey, unpublished digital data, scale 1:24,000. (Digital Geologic Map of the Ozark National Scenic Riverways and Adjacent Areas). (*GRI Source Map ID 75805*).

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

Of note, as per communication with the senior map author, David Weary, the 2014 digital (GIS) data is the same as a more recent 2016 release of the digital (GIS) data.

Weary, D.J., Orndorff, R.C., Harrison, R.W., and Weems, R.E., 2016, Digital Geologic Map Data for the Ozark National Scenic Riverways and adjacent areas along the Current River and Jacks Fork, Missouri: U.S. Geological Survey; digital data; scale 1:24,000, https://www.sciencebase.gov/catalog/item/5698119de4b039675d04911f

Map Unit List

The bedrock and surficial geologic units present in the digital geologic-GIS data produced for Ozark National Scenic Riverways, Missouri (OZAR) are listed below. Units are listed with their assigned unit symbol and unit name (e.g., Qa - Alluvium). Units are listed from youngest to oldest. Information about each geologic unit is also presented in the GRI Geologic Unit Information (OZARUNIT) table included with the GRI geology-GIS data.

Cenozoic Era

Quaternary Period

Qa - Alluvium
Qm - Muck and clayey silt
Qls - Landslide deposits
Qc - Colluvium
Qt - Terrace deposits
Qtl - Loess-covered terrace deposits
Ql - Loess

Quaternary and Tertiary Periods

QTrr - Residuum derived from Roubidoux Formation
QTtrc - Residual and colluvial material on terrace-like landforms
QTg - Upland gravel deposit

Cenozoic and Mesozoic Eras

Quaternary Period, Tertiary Period, and Mesozoic Era?

QTr - Peck Ranch unit

Paleozoic Era

Lower Ordovician Period

Ojc - Jefferson City Dolomite
Or - Roubidoux Formation
Og - Gasconade Dolomite

Upper Cambrian Period

Ce - Eminence Dolomite
Cp - Potosi Dolomite

Mesoproterozoic Eon

Yg - Big Spring quad granite
Yrm - Rhyolite of Russell Mountain
Yvc - Volcaniclastic conglomerate, breccia, and sandstone
Ysc - Rhyolite of Sutton Creek
Ysi - Rhyolite of Shut-In Mountain
Ysm - Rhyolite of Stegall Mountain
Ymm - Tuff of Mule Mountain
Yltm - Tuff of Little Thorny Mountain
Ycu - Upper Coot Mountain unit
Ycl - Lower Coot Mountain unit

Map Unit Descriptions

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

Qa - Alluvium (Holocene)

Gravel, sand, and clay along the bed and active flood plains of modern stream valleys. Material consists mostly of subrounded to subangular chert, sandstone, and quartzite clasts in a matrix of sand containing silt and clay. Thickness ranges from 0 to as much as 20 ft. (*GRI Source Map ID 75805)* (Digital Geologic Map of the Ozark National Scenic Riverways and Adjacent Areas).

Qm - Muck and clayey silt (Holocene and Pleistocene?)

Silt, reworked loess, clay, and organic-rich muck filling sinkholes that intermittently retain water. Thickness unknown. (*GRI Source Map ID 75805)* (Digital Geologic Map of the Ozark National Scenic Riverways and Adjacent Areas).

Qls - Landslide deposits (Holocene and Pleistocene?)

Chaotic jumble of dolomite, chert, sandstone, and quartzite clasts in a clayey and silty matrix. Includes large landslides and large-scale slump bodies with hummocky topography, 20 to 100 ft thick. Only mapped in the Van Buren North quadrangle, but similar deposits occur in other areas of steep topography. (*GRI Source Map ID 75805)* (Digital Geologic Map of the Ozark National Scenic Riverways and Adjacent Areas).

Qc - Colluvium (Holocene and Pleistocene)

Boulders, cobbles, and pebbles of sandstone derived from weathering of the Roubidoux Formation, forms gravity-creep deposits a few feet thick on steep slopes in the upper part of the Gasconade Dolomite below Roubidoux residuum. Only mapped as a unit in the Powder Mill Ferry quadrangle (McDowell and Harrison, 2000). Widely distributed, common on steep slopes; shown on map only where thickest and most extensive. (*GRI Source Map ID 75805)* (Digital Geologic Map of the Ozark National Scenic Riverways and Adjacent Areas).

Qt - Terrace deposits (Holocene and Pleistocene?)

Large cobble-size to sand-size, subrounded to subangular chert, sandstone, and quartzite clasts within a matrix of sand, silt, and clay. In some locations a significant fraction of the matrix is silt-size reworked loess. Deposited on relatively flat areas along floors and walls of modern stream valleys, but above normal seasonal floods of present streams. Terraces along the major streams usually stand at least 6 to 10 ft above stream level. Thickness at least 10 ft and possibly more along larger stream courses. (*GRI Source Map ID 75805)* (Digital Geologic Map of the Ozark National Scenic Riverways and Adjacent Areas).

Qtl - Loess-covered terrace deposits (Pleistocene?)

Predominantly silt with lesser sand and clay. Only mapped as a unit in the Stegall Mountain (Harrison and others, 2002) and the Van Buren South quadrangles (Weary and Schindler, 2004). Occurs on slopes above the valleys of various large streams and also is preserved in a few large sinkholes. A well-developed soil horizon (probably equivalent to the Sangamon Geosol) occurs beneath the loess.

Windblown silt, as much as 1 ft thick, mantles clay, silt, sand, and minor pebbles. May be as much as 40 ft thick. (*GRI Source Map ID 75805)* (Digital Geologic Map of the Ozark National Scenic Riverways and Adjacent Areas).

Ql - Loess (Pleistocene)

Silt. This unit was only mapped in one location in the Stegall Mountain quadrangle but also occurs as small areas of thin veneer in other places (Harrison and others, 2002). Discontinuous patches on hill crests and ridges, including some of the highest parts of Thorny Mountain. Silt is commonly mixed with residuum, probably because of bioturbation. As much as 3 ft thick. (*GRI Source Map ID 75805)* (Digital Geologic Map of the Ozark National Scenic Riverways and Adjacent Areas).

QTrr - Residuum derived from Roubidoux Formation (Quaternary and Tertiary)

Red and reddish-orange sandy clay containing angular sandstone and chert cobbles and boulders as much as 6 ft in diameter. Sandstone cobbles and boulders, fine- to coarse-grained, poorly sorted, and locally containing symmetrical and asymmetrical ripple marks. Chert cobbles and boulders, light- to medium-gray consisting of banded, sandy, oolitic, and porcelaneous varieties. This unit is widespread but was not mapped in all quadrangles. Occurs on hilltops where bedrock of the Roubidoux Formation has been deeply weathered. Roubidoux residuum was mapped only in areas where it directly overlies older formations and no in situ Roubidoux bedrock was inferred; unmapped Roubidoux residuum exists virtually everywhere that the Roubidoux Formation occurs. This unit was not mapped in all quadrangles and in those it was mapped in, only locations where it was identified via ground traverse are indicated. As much as 40 ft thick. (*GRI Source Map ID 75805)* (Digital Geologic Map of the Ozark National Scenic Riverways and Adjacent Areas).

QTr - Peck Ranch unit (Quaternary and Tertiary, and Mesozoic?)

Brown, red, and reddish-orange sandy clay containing angular blocks, cobbles, and pebbles of sandstone, and various varieties of chert. Insoluble, residual material derived from intense in situ weathering of Paleozoic rocks from Roubidoux Formation down through the upper Eminence Dolomite. This unit was only mapped in the Stegall Mountain quadrangle (Harrison and others, 2002). Crude stratigraphic sequence is generally preserved. At least 200 ft thick. (*GRI Source Map ID 75805)* (Digital Geologic Map of the Ozark National Scenic Riverways and Adjacent Areas).

QTtrc - Residual and colluvial material on terrace-like landforms (Quaternary and Tertiary)

Silt, clay, sand, and gravel. This unit was only mapped in the Stegall Mountain quadrangle (Harrison and others, 2002). Terrace-like landforms are found most commonly adjacent to knobs of Mesoproterozoic volcanic rocks in northern part of quadrangle. In part residual and in part colluvial in nature. Commonly have a thin veneer of loess, as much as 5 ft thick. A well-developed soil horizon (possibly equivalent to the Sangamon geosol) occurs commonly beneath the loess. Gradational into Quaternary terrace deposits (Qt, Qtl). As much as 60 ft thick. (*GRI Source Map ID 75805)* (Digital Geologic Map of the Ozark National Scenic Riverways and Adjacent Areas).

QTg - Upland gravel deposit (Quaternary and Tertiary)

Gravel deposits, as high as 300 ft above the modern stream flood plains, containing mostly subrounded to rounded clasts of chert, sandstone, and quartzite in a matrix of silty sand. Mapped only on the Van

Buren North quadrangle (Weary and Weems, 2004). Clasts of fossiliferous Mississippian chert rare to abundant. Thickness generally less than 10 ft. (*GRI Source Map ID 75805)* (Digital Geologic Map of the Ozark National Scenic Riverways and Adjacent Areas).

Ojc - Jefferson City Dolomite (Lower Ordovician)

Dolomite, quartz sandstone and chert. Dolomite is light brown medium to fine grained, argillaceous, and thin to thick bedded; commonly weathers powdery-pale-yellow. Lenses of quartz sandstone and orthoquartzite as well as beds and nodules of white chert are also common. In some areas an interval of brown, medium-grained, thick- to massive, siliceous, pitted-weathering dolomite informally known as the "Quarry Ledge" crops out. The "Quarry Ledge" occurs between 25 and 40 ft (8–12 m) above the base of the Jefferson City Dolomite, making it a useful marker for the Roubidoux-Jefferson City contact, which is seldom exposed. The Jefferson City Dolomite weathers to a characteristic yellowish color and produces a more silty, less sandy soil than the underlying Roubidoux Formation. Residual sandstone and orthoquartzite float from the Jefferson City are usually less tabular in shape than those produced from the Roubidoux. These characteristics enable differentiation between Roubidoux and Jefferson City bedrock in areas having no outcrop. The Jefferson City Dolomite is sparsely fossiliferous, but has yielded trilobites and conodonts as reported by Repetski and others (1998). This formation has an average thickness of about 200 ft (61 m) (Thompson, 1995). Typically, considerably less than the full thickness of this unit is exposed in the ONSR area. (*GRI Source Map ID 75805)* (Digital Geologic Map of the Ozark National Scenic Riverways and Adjacent Areas).

Or - Roubidoux Formation (Lower Ordovician)

Sandstone, orthoquartzite, dolomite, sandy dolomite, and chert. Sandstone is white to pale orange, fine to coarse grained, thin to thick bedded, generally poorly sorted, and commonly crossbedded and ripple marked; weathers light brown to reddish brown. Dolomite is light to medium gray, very fine to coarse grained, and thin to medium bedded. Chert is white to medium gray, locally sandy and oolitic; occurs in thin beds, lenses, and nodules. Typically formation is highly weathered and not well exposed. Thickness ranges up to as much as 250 ft (76 m). (*GRI Source Map ID 75805)* (Digital Geologic Map of the Ozark National Scenic Riverways and Adjacent Areas).

Og - Gasconade Dolomite (Lower Ordovician)

Dolomite, chert, sandstone, and orthoquartzite. Formation can be divided into three informal units (fig. 2), the lower, middle, and upper, which are not shown separately on this map. Upper unit is typically light-gray, medium- to coarse-grained, thick-bedded, vuggy dolomite. Weathered surfaces are commonly pitted. Middle unit is further divided into lower, middle, and upper parts. The upper part of the middle unit is typically light-gray, fine- to coarse-grained, medium- to thick-bedded dolomite, and contains white to light-gray chert nodules and lenses. The uppermost bed of the upper part of the middle unit is a persistent white Cryptozoon chert, 2 to 10 ft (.6–3 m) thick, commonly used to map the Roubidoux/Gasconade contact, which rarely is exposed. This contact is placed at approximately 80 to 100 ft (24–30 m) above the Cryptozoon chert, which is an average of observed intervals. The middle part of the middle unit is light-gray to very light gray, medium- to coarse-grained, medium-bedded dolomite containing chert as nodules, stringers, and beds. Chert varieties are porcelaneous, oolitic, porous with druse, and stromatolitic. A locally persistent oolite bed, occurring at the base of the middle part of the middle unit (Orndorff and Harrison, 2001), defined the top of the Van Buren Formation of Bridge (1930). Beds of the lower part of the middle unit, formerly called the Van Buren Formation by Bridge (1930), are light-gray to yellowish-gray, fine- to medium-grained, thin- to medium-bedded dolomite. The lower unit of the Gasconade Dolomite, called the Gunter Sandstone Member, is a light-gray to white sandstone, sandy dolomite, or orthoquartzite interbedded with light-gray to tan, fine-grained, thin-bedded dolomite. The Gunter Sandstone Member ranges from 10 to 25 ft (3–8 m) in thickness. In some localities the

sandstones in the Gunter thin and exist only as discontinuous thin lenses. In some locations there is no quartz sandstone, making identification of the base of the Gasconade difficult. The thickness of the Gasconade Dolomite ranges from as much as about 770 ft (235 m) to as little as 148 ft (45 m) in areas adjacent to the Proterozoic volcanic knobs. The Gasconade is the youngest Paleozoic unit observed in contact with Mesoproterozoic igneous rocks in the Current River basin. Contact with the underlying Eminence Dolomite, which is unconformable, is placed at the base of the lowest sandstone or sandy dolomite of the Gunter Sandstone Member. (*GRI Source Map ID 75805)* (Digital Geologic Map of the Ozark National Scenic Riverways and Adjacent Areas).

Ce - Eminence Dolomite (Upper Cambrian)

Dolomite, sandstone, and chert. Dolomite is light gray, medium to coarse grained, massive to thick bedded and commonly stromatolitic. It typically weathers bluish gray and medium gray, has a pitted surface, and commonly crops out as small knobs or pinnacles. Many fresh surfaces contain oxidized rust-colored mottles. Unit contains variable amounts of chert throughout, commonly as light-gray and white stringers and nodules. In downstream areas of the Current River basin, a 10–20 ft (3–9 m)-thick interval consisting of interbedded thin, friable to silicified quartz sandstone and sandy dolomite occurs 50 to 80 ft (15–24 m) below the upper contact. The thickness of the Eminence Dolomite is variable in part because of the unconformity at the top of the unit and in part because of thinning near knobs of Mesoproterozoic volcanic rocks; thickness ranges from about 80 ft (24 m) to as much as about 919 ft (280 m). Contact with the underlying Potosi Dolomite is indistinct, a condition that is likely related to secondary alteration (silicification) rather than to primary deposition. (*GRI Source Map ID 75805)* (Digital Geologic Map of the Ozark National Scenic Riverways and Adjacent Areas).

Cp - Potosi Dolomite (Upper Cambrian)

Dolomite with chert. Dolomite is light brown, brown, and light gray, fine to medium grained, massive to thick bedded, and contains quartz druse in vugs. Brown dolomite has fetid odor when freshly broken. Quartz druse is developed as botryoidal masses of chalcedony and small quartz crystals coating surfaces. White to light-gray chert forms nodules and stringers. Locally, a 1- to 3- ft (0.3–1 m) thick bed of rusty-weathering porous chert occurs at or close to the contact with the overlying Eminence Dolomite. The Potosi is the oldest sedimentary unit exposed in the ONSR area. The Potosi ranges from about 50 to 575 ft (15–175 m) thick in the Current River basin with up to about 180 ft (55 m) exposed in the map area. (*GRI Source Map ID 75805)* (Digital Geologic Map of the Ozark National Scenic Riverways and Adjacent Areas).

Yg - Big Spring quad granite (Mesoproterozoic)

Granite of Sims' (1990) Y1g province and Kisvarsanyi's (1981) Silvermine-Slabtown-type granite (Granite of Weary and McDowell (2006), known informally as Big Spring granite). Granite, red, medium-grained and seriate, with clots of altered amphibole set in a semi-graphic intergrowth of quartz and alkali feldspar. The alkali feldspar exhibits Carlsbad twinning and some relict perthite of the herringbone type. Most perthite is disturbed and shows patch texture, chessboard character, and swapped rims. Accessory mineral phases include fluorite, zircon, and magnetite accompanied by secondary clay, sericite, and epidote. Only outcrops in one locatlity in the map area in the Big Spring 7.5' quadrangle (sec. 29, T. 27 N., R. 1 E.). The outcrop in the Big Spring quadrangle (Weary and McDowell, 2006) has a U-Pb age of 1,461.8±5.5 Ma (Harrison and others, 2000). Other reported U-Pb ages from drill-hole samples collected near the map area for unit Y1g are 1,473±15 Ma (Van Schmus and others, 1993) in the Van Buren South quadrangle (Weary and Schindler, 2004); 1,480±42 Ma (Van Schmus and others, 1993) in the Winona quadrangle (Orndorff and Harrison, 2001); and 1,473±15 Ma (Bickford and others, 1981) in the Round Spring quadrangle (Orndorff and Weary, 2009). These ages are consistent with other reported ages for unit Y1g elsewhere in the Missouri Ozarks (see Van Schmus and others, 1993 and

Bickford and others, 1981). (*GRI Source Map ID 75805)* (Digital Geologic Map of the Ozark National Scenic Riverways and Adjacent Areas).

Yrm - Rhyolite of Russell Mountain (Mesoproterozoic)

Ash-flow tuff. Named for exposures on Russell Mountain which spans sec. 2, T. 28 N., R. 2 W. of the Stegall Mountain 7.5-minute quadrangle (Harrison and others, 2002) and sec. 35, T. 29 N., R. 2 W. of the Powder Mill Ferry 7.5-minute quadrangle (McDowell and Harrison, 2000). Unit is moderately crystal rich, containing 10 to 20 percent (by volume) pink alkali feldspar phenocrysts of that are locally altered pale green, sparse to no quartz, and 5 to 10 percent magnetite and hematite grains. Unit is typically densely welded with well-developed flow banding and eutaxitic texture, although locally it is massive with poorly developed or no flow banding. This ash-flow tuff is interpreted to consist of multiple flows of both simple and compound cooling units. Primary foliations are typically steeply dipping and generally strike N. 40° –50° W. The steep dip of foliations (ranging from 25° to 90° and averaging about 76°; n=27) is interpreted to have been produced from rotation during caldera collapse (Harrison and others, 2000). Relation to the Rhyolite of Little Thorny Mountain (Yltm) is uncertain but is possibly in part correlative. Thickness of this unit is difficult to determine because of rotation, but it is at least several thousand feet (1,000 m). (*GRI Source Map ID 75805)* (Digital Geologic Map of the Ozark National Scenic Riverways and Adjacent Areas).

Yvc - Volcaniclastic conglomerate, breccia, and sandstone (Mesoproterozoic)

Interbedded volcaniclastic conglomerate, breccia, and sandstone. Conglomerate consists of subrounded cobbles, 3 to 5 in. (8-13 cm) in diameter, and large pebbles derived from the rhyolite of Sutton Creek (Ysc), upper unit of Coot Mountain (Ycu), and unidentified volcanic rocks. Matrix strongly altered, greenish, fine-grained volcaniclastic material. Conglomerate is overlain by strongly silicified volcanic breccia, possibly an autobrecciated flow, that consists of aphanitic pink rhyolite and quartz clasts in a quartz matrix. Sandstone is coarse to medium grained. Grains consist of quartz, lithics, and minor feldspar. Volcaniclastic unit only observed only on southern side of Coot Mountain, in secs. 22 and 23, T. 29 N., R. 3 W., in the Eminence and Power Mill Ferry quadrangles (Orndorff and others, 1999; McDowell and Harrison, 2000). Contacts with other units not exposed. (*GRI Source Map ID 75805)* (Digital Geologic Map of the Ozark National Scenic Riverways and Adjacent Areas).

Ysc - Rhyolite of Sutton Creek (Mesoproterozoic)

Lava(?) of alkali rhyolite to rhyolite; composition that is generally not flow layered, although flow layering is observed locally. Phenocrysts of 7 to 15 percent pink feldspar in a dark-pink matrix; 15 to 20 percent disseminated magnetite. Contains trace to 10 percent conspicuous, large (as much as 0.4 in) (1 cm) aggregates (possibly xenoliths) of small pink feldspar phenocrysts in an apple-green matrix, which alter yellowish white. Named for exposures 0.4 km north of Sutton Creek in the Eminence 7.5-minute quadrangle (Orndorff and others, 1999), in sec. 12, T. 29 N., R. 4 W. Unit is also exposed along the northwest bank of the Current River in a knob 0.8 km southeast of the summit of Tip Top Mountain, and along the south bank of Current River in an unnamed knob 1.6 km upstream from the confluence with the Jacks Fork River. Thickness unknown. (*GRI Source Map ID 75805)* (Digital Geologic Map of the Ozark National Scenic Riverways and Adjacent Areas).

Ysi - Rhyolite of Shut-In Mountain (Mesoproterozoic)

Dense lava of rhyolite to alkali trachyte. Named for exposures on and around Shut-In Mountain in the Stegall Mountain 7.5-minute quadrangle, (secs. 2 and 11, T. 28 N., R. 3 W.). Unit is moderately crystal rich to crystal rich, with phenocrysts ranging from 12 to 30 percent by volume. This unit typically

contains approximately 10 to 15 percent white to pink alkali feldspar; 3 to 5 percent anhedral to euhedral quartz phenocrysts; common (but sporadic) blebs, pods, or disseminations of fluorite; and <1 to 3 percent disseminated magnetite-hematite grains in a dense, light-pink to maroon-red matrix that consists of a cryptocrystalline aggregate of quartz, alkali feldspar, and iron oxides. Flow banding is generally non-existent to poorly developed; however, where present it typically swirls and commonly displays flow folding. Locally, this unit is autobrecciated. Small zones of hydrothermal brecciation also occur locally. Vesicles mineralized with quartz and feldspar are common. This unit is interpreted as coalesced lava flows and domes. Areas of hydrothermal brecciation and inclusion of exotic aphanitic volcanic clasts are interpreted as marking probable vent sites. U-Pb analyses of one multiple-crystal and five single-crystal fractions from this unit yielded an age of 1,470.4±2.7 Ma (Harrison and others, 2000). In part, this unit is the same as the Stegall Rhyolite of Tolman and Robertson (1969, p. 14–15). Minimum thickness 900 ft (275 m). (*GRI Source Map ID 75805)* (Digital Geologic Map of the Ozark National Scenic Riverways and Adjacent Areas).

Ysm - Rhyolite of Stegall Mountain (Mesoproterozoic)

Dense lava of rhyolite to alkali trachyte. Named for exposures on Stegall Mountain in secs. 19 and 20, T. 28 N., R. 2 W., in the Stegall Mountain 7.5-minute quadrangle (Harrison and others, 2002). This unit is a variation of the rhyolite of Shut-In Mountain rhyolite in that it has a lower quartz phenocryst content of 0.5 to 2 percent. Otherwise, it is identical and is interpreted as genetically related. Minimum thickness is 200 ft (61 m). (*GRI Source Map ID 75805)* (Digital Geologic Map of the Ozark National Scenic Riverways and Adjacent Areas).

Ymm - Tuff of Mule Mountain (Mesoproterozoic)

Air-fall tuff. Unit is dense, aphanitic, finely laminated, and commonly silicified. Phenocrysts are rare and consist dominantly of angular quartz. Accretionary lapilli (lapilli-size pellets of ash formed by rainfall through a downwind ash cloud or by accretion from a moisture-laden eruption column) are relatively common. Base of this unit marks an angular unconformity between the upper and lower sequences of volcanic rocks in the Stegall Mountain area. The contact with overlying units (Ysm and Ysi) is sharp and conformable. The contact with the underlying unit (Yltm) is complex and irregular. Unit was mapped only where its thickness exceeds 30 ft (9 m), but it is present everywhere between upper and lower sequences. Thickness ranges from 15 ft (4.5 m) to perhaps as much as 100 ft (30 m). (*GRI Source Map ID 75805)* (Digital Geologic Map of the Ozark National Scenic Riverways and Adjacent Areas).

Yltm - Tuff of Little Thorny Mountain (Mesoproterozoic)

Ash-flow tuff. Named for exposures on Little Thorny Mountain, in the Stegall Mountain 7.5-minute quadrangle (Harrison and others, 2002), in sec. 22, T. 28 N., R. 2 W. Unit is dense, dark maroon to purple, moderately crystal rich to crystal rich, and quartz poor. Phenocryst content varies from 5 to 20 percent and consists almost exclusively of alkali feldspar; quartz is very rare to absent. Magnetite and hematite grains constitute 2 to 10 percent of the rock; fluorite blebs and disseminations are common. Sinha and Kisvarsanyi (1976) describe euhedral phenocrysts of relict fayalite, or possibly an iron pyroxene, which are now altered to hematite, calcite, sericite, and epidote. Unit contains fiamme and eutaxitic texture, is moderately to densely welded, and is commonly, but not everywhere, flow banded. Primary foliations are typically steeply dipping and generally strike N. 40°–50° W. Steeply dipping foliations are interpreted as having been produced by rotation during caldera collapse (Harrison and others, 2000). Thickness of unit is difficult to determine because of rotation, but it is at least several thousand feet thick (1,000 m). (*GRI Source Map ID 75805)* (Digital Geologic Map of the Ozark National Scenic Riverways and Adjacent Areas).

Ycu - Upper Coot Mountain unit (Mesoproterozoic)

Rhyolite to alkali rhyolite to alkali trachyte ash-flow tuff, densely welded, with well-developed flow layering and eutaxitic texture; locally, flow layering is poorly developed. Primary foliations are typically steeply dipping. Generally less than 10 percent phenocrysts of pink feldspar and sparse to no quartz; 4 to 10 percent disseminated magnetite throughout; locally contains disseminated fluorite. Vapor-phase feldspar and quartz mineralization are common in pumice. Unit is exposed principally at the summit and along the northeast side of Coot Mountain, along the eastern side of Jerktail Mountain, and on the summit and slopes of Wildcat Mountain. Unit is approximately the same as the upper unit of Coot Mountain of Fisher (1969). (*GRI Source Map ID 75805)* (Digital Geologic Map of the Ozark National Scenic Riverways and Adjacent Areas).

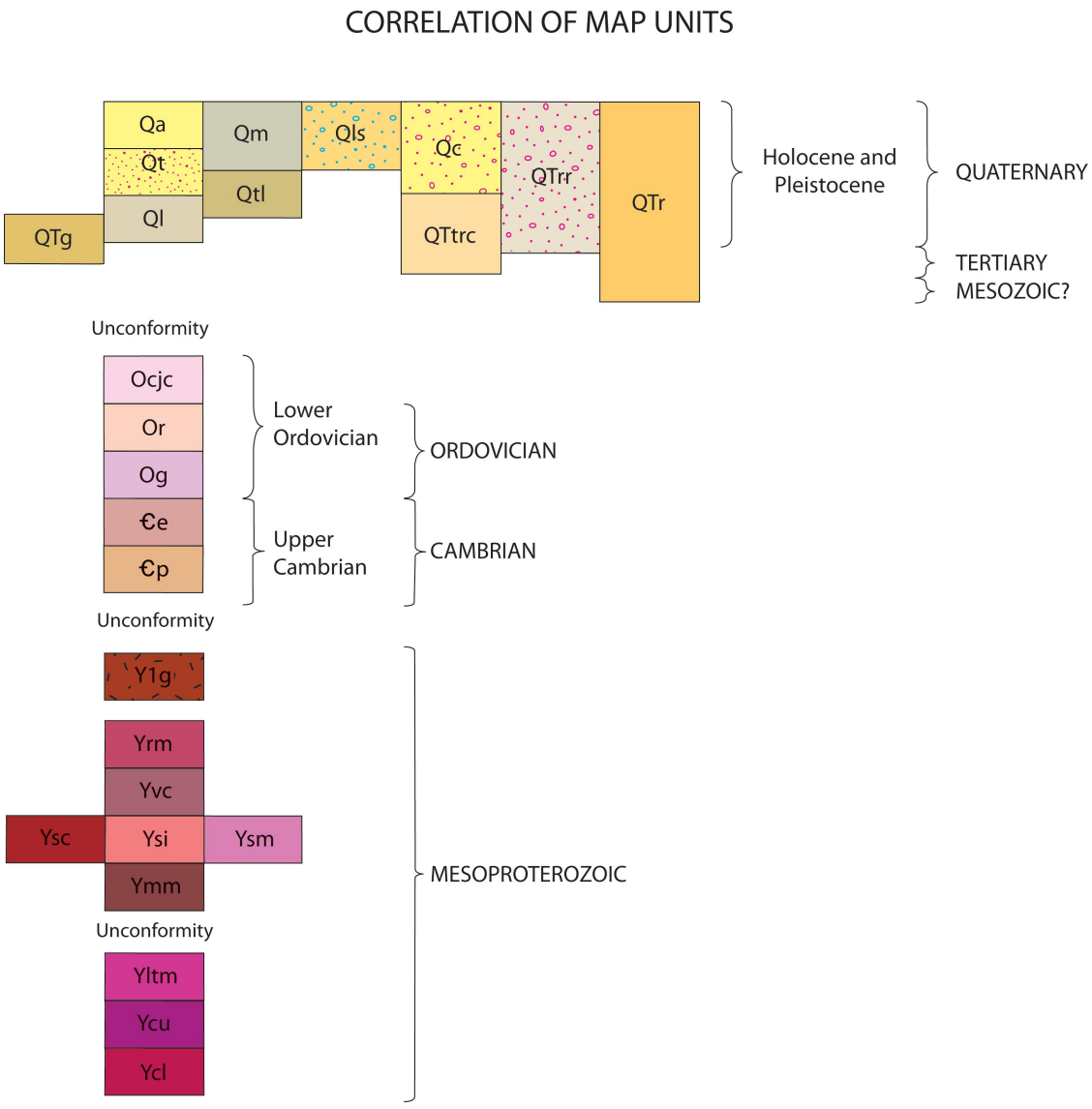
Ycl - Lower Coot Mountain unit (Mesoproterozoic)

Dominantly ash-flow tuff interbedded with air-fall tuff and lava(?). Ash-flow tuff is composed of alkali rhyolite to alkali trachyte to trachyte to rhyolite; commonly massive and dense. Flow layering weakly developed or nonexistent, although moderately developed locally. Five to 25 percent phenocrysts of pink feldspar and sparse to no quartz in a dark-maroon matrix, with 4 to 10 percent disseminated magnetite throughout. Commonly contains quartz veins and infilling of miarolitic cavities, locally spherulitic. Locally, poorly welded to non-welded, pumice-rich, phenocryst-poor ash-flow tuff is interbedded in this interval. Ash-flow tuff is approximately same as the middle unit of Coot Mountain of Fisher (1969). Air-fall tuff is composed of rhyolite; is aphanitic, massive to thin bedded, dark maroon, locally silicified, and contains disseminated pyrite. Petrographically consists of microlites less than 0.0004 in. (0.01 mm) in size and devitrified glass shards. Generally, all primary depositional features have been destroyed. Air-fall tuff is approximately same as the lower unit of Coot Mountain of Fisher (1969). Unit is best exposed along the southwestern side of Coot Mountain, the western side of Jerktail Mountain, and on an unnamed knob exposed along Missouri Route 106, 1.25 mi east of Eminence. (*GRI Source Map ID 75805)* (Digital Geologic Map of the Ozark National Scenic Riverways and Adjacent Areas).

Digital Geologic Map of the Ozark National Scenic Riverways and Adjacent Areas along the Current and Jacks Fork Rivers, Missouri

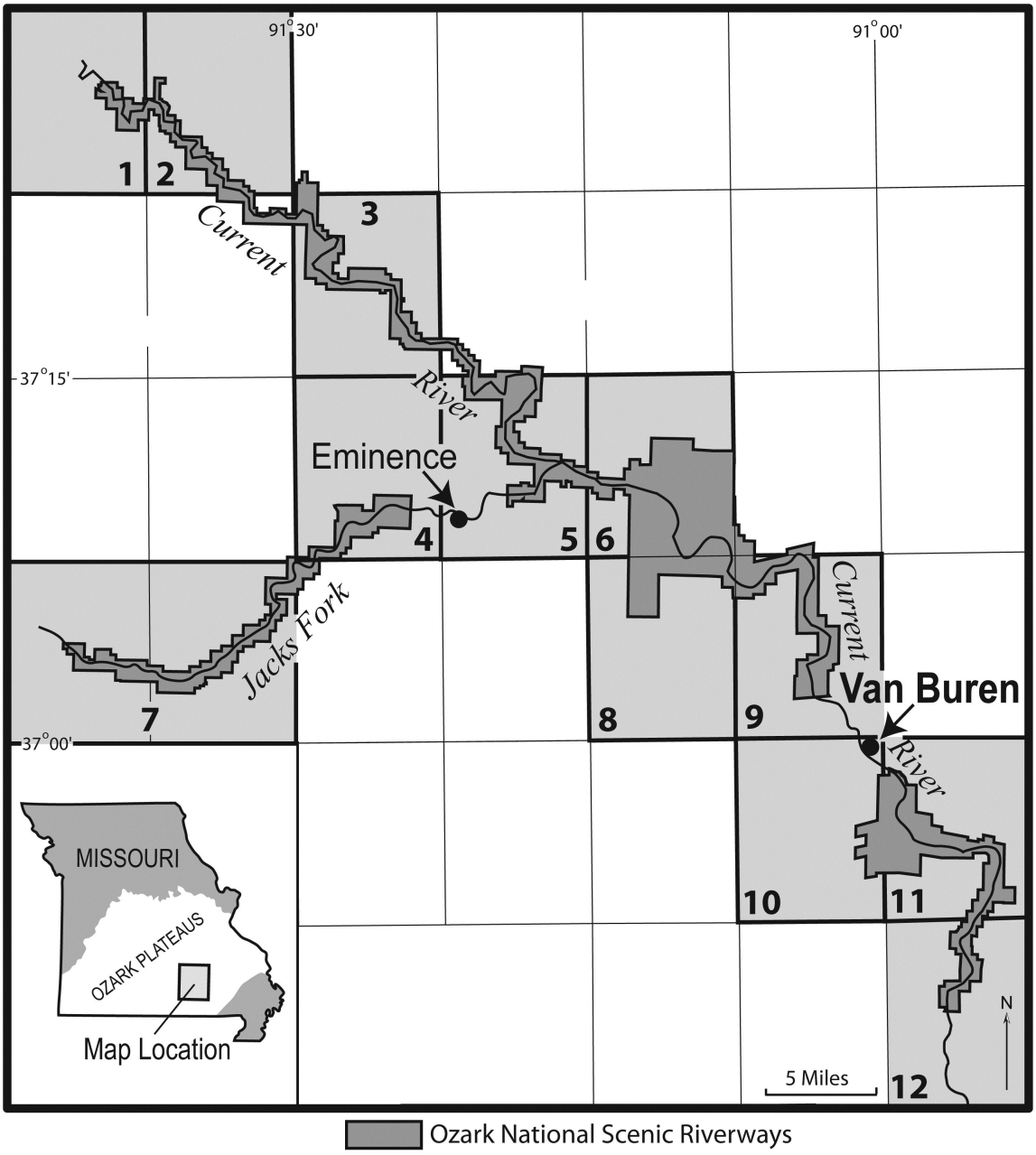
Weary, D.J., Orndorff, R., Harrison, R., Weems, R.E., 2014, Digital Geologic Map of the Ozark National Scenic Riverways and adjacent areas along the Current and Jacks Fork Rivers, Missouri: U.S. Geological Survey, unpublished digital data, scale 1:24,000. (*GRI Source Map ID 75805*).

Correlation of Map Units



Extracted from: (Digital Geologic Map of the Ozark National Scenic Riverways and Adjacent Areas).

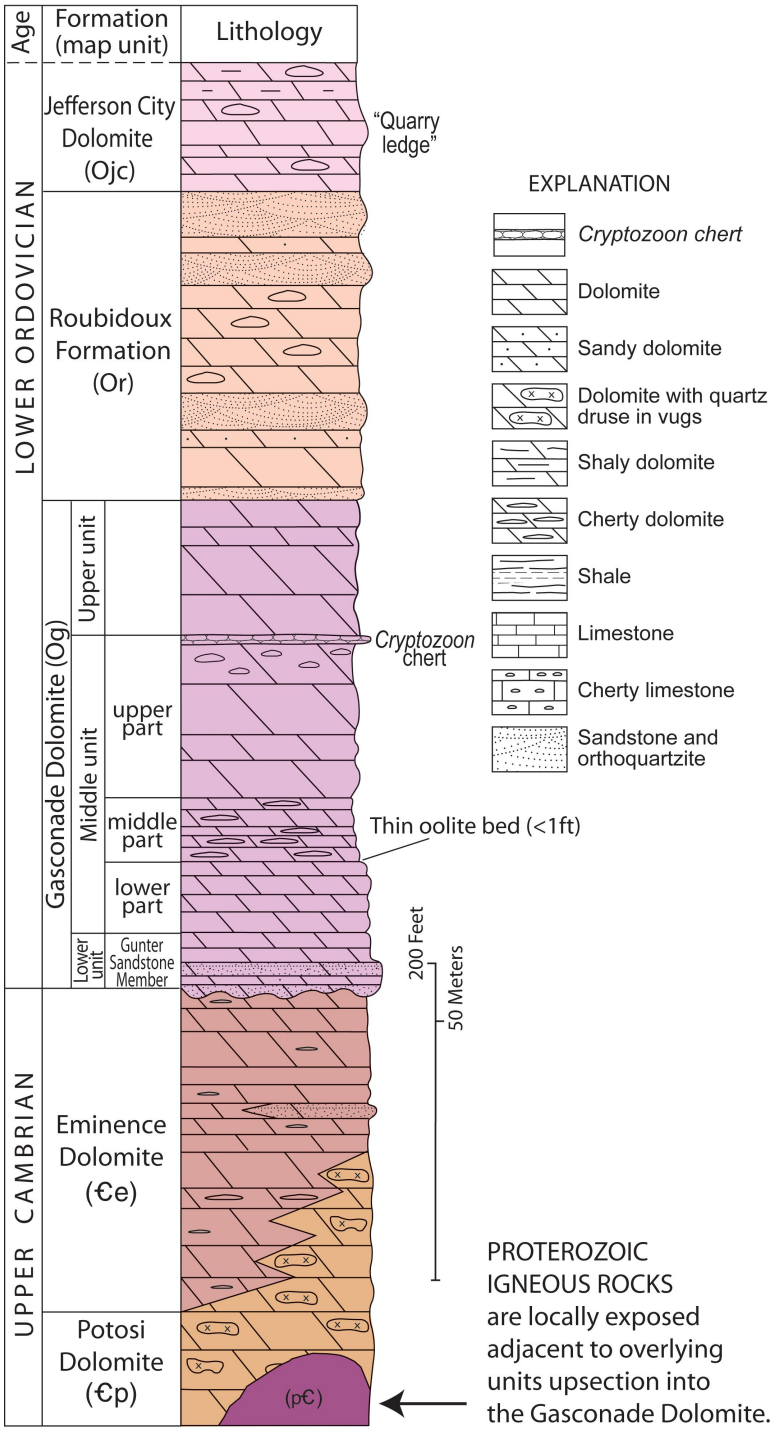
Index Map



**Report Figure 1.

Extracted from: (Digital Geologic Map of the Ozark National Scenic Riverways and Adjacent Areas).

Bedrock Stratigraphic Column



**Report Figure 2.

Extracted from: (Digital Geologic Map of the Ozark National Scenic Riverways and Adjacent Areas).

Report

Introduction

Purpose

This data set was created and compiled to provide a seamless 1:24,000 scale geologic map that contains the entire Ozark National Scenic Riverways park (OZAR) and completes the geologic inventory sponsored by the National Park Service (NPS), Geologic Resources Division. These data are intended to provide basic geologic information to OZAR personnel and their scientific cooperators for use in various natural resource and land classification studies. This report does not include a detailed, comprehensive discussion of the geology of the park area. For more detailed and site-specific geologic descriptions and discussions, refer to the individual 1:24,000 quadrangle reports that are the basis for most of this report. In addition, see Weary and others (2014) for a comprehensive discussion of various geologic aspects of the entire region, and Lowell and others (2010) for detailed descriptions of selected geologic and karst-related features in and around the OZAR area.

Scope of the Data

The spatial extent of these data covers the complete area of the OZAR and also includes areas within approximately 1 mile of the exterior park boundaries. In addition, 4 other areas along the Current River and the Jacks Fork are also included for continuity of coverage along the rivers. These areas are: 1) the headwaters of the Current River in the vicinity of Montauk Springs and Montauk State Park; 2) the headwaters area of the Jacks Fork; 3) The downstream reach of the Jacks Fork near the town of Eminence; and, 4) a reach of the Current River near the town of Van Buren.

These geologic data include: 1) polygons describing the extent and distribution of bedrock units exposed at the surface and areas of overlying surficial deposits, and polygons indicating the location and extents of karst sinkholes; 2) lines marking the traces of mapped faults, mapped fold axes, and the contacts of both the bedrock and surficial map units; and, 3) Points marking the locations of measurement of bedding attitude in sedimentary rocks or foliation in igneous rocks.

Data representing the boundaries of the Ozark National Scenic Riverways and the inclosing 1:24,000 scale USGS topographic quadrangles are also included for geographic reference.
A georeferenced digital raster graphic (DRG) of a mosaic of the USGS 1:24,000 topographic maps is included for user convenience. This DRG was produced by the staff of OZAR, see the metadata associated with these data for more details.

Original Data Sources

The outlines and authorships of the original geologic quadrangle maps compiled into this opus are shown on Figure 1 (Index Map). See the list of references for full citations. These maps were produced chiefly for National Cooperative Geologic Mapping Program projects by the U.S. Geological Survey and by the State of Missouri, Department of Natural Resources, Division of Geology and Land Survey. A substantial portion of the field expenses and publication costs for the USGS maps was provided by the National Park Service, Geologic Resources Division.

Table 1. List of quadrangle maps completed in the Ozark National Scenic Riverways and vicinity by the USGS and the Missouri Geological Survey and used as sources for this compilation. See reference section for full citations. Numbers correspond to quadrangle locations on Figure 1.

Figure 1 Number	Quadrangle(s)	Author(s)	Year of Publication or Status
1	Montauk	Weary	In production, estimated 2014
2	Cedargrove	Weary	2008a
3	Round Spring	Orndorff and Weary	2009
4	Alley Spring	Weary and Orndorff	2012
5	Eminence	Orndorff and others	1999
6	Powder Mill Ferry	McDowell and others	2000
7	Jam Up Cave and Pine Crest	Weary and others	2013
8	Stegall Mountain	Harrison and others	2002
9	Van Buren North	Weary and Weems	2004
10	Van Buren South	Weary and Schindler	2004
11	Big Spring	Weary and McDowell	2006
12	Grandin South West	Baker	1999

Data for the areas of the OZAR park and buffer zone in this compilation not covered by the quadrangle maps (fig. 1; Index Map) were compiled from information collected for a regional geologic map of the area (Weary and others, 2014) or were generated via additional field work by the authors.

Sinkhole location data were derived from data from the published geologic maps and from the USGS 1:24,000 base topographic maps. Sinkholes less than 10 meters in diameter are all represented as 10 meter diameter circular polygons.

Individual mappers of the various 1:24,000 quadrangles discriminated and classified surficial units in different ways so there may be subtle inconsistencies in the portrayal of the extents of these units from quadrangle to quadrangle.. Some units were only mapped in one or two quadrangles. See the description of map units for notes on the limited distribution of some units.

Geologic Description

The OZAR lies in the Ozark Plateaus Province of southeast Missouri (fig. 1; Index Map). The geology of the OZAR comprises a Mesoproterozoic (~1.4 Ga) (giga-annum) age basement of intrusive and extrusive igneous rocks discomformably overlain by relatively flat-lying Cambrian and Lower Ordovician (~500-470 ma)(mega-annum) age sedimentary rocks, on which various surficial and residual sedimentary units are superposed. See figure 2 for a The basement rocks, chiefly granite and rhyolite, are exposed as erosional remnant hills in an uplifted area near the central part of the park area (fig. 2; Bedrock Stratigraphic Column). The Paleozoic sedimentary rocks are chiefly dolomite that contain interlayerings of quartz sandstone and chert. The bedrock is cut by chiefly vertical strike-slip faults of the Ouachita Orogeny to the south. The entire exposed Paleozoic section is pervasively karstified.

Structural Geology

The Mesoproterozoic volcanic rocks exposed in the Ozark National Riverways area exhibit foliation related to original deposition, gravity flows, and post-depositional shearing of the rocks. Measured planes of foliation strike in various directions and typically dip steeply to vertical with the lowest recorded dip value being 30°. Some of these steep to vertical dips are related to strike-sip shearing and to rotation of blocks during caldera collapse of the Eminence caldera (Kisvarsanyi, 1977, 1984).

Most of the sedimentary strata in the Ozark National Scenic Riverways are flat-lying to sub-

horizontal with the vast majority of bedding measurements indicating dips of less than 3° locally. The regional dip for the entire OZAR is generally to the southeast and the gradient of the Current River follows this incline. The sedimentary sequence rocks commonly dip radially away from exposed and buried igneous knobs in the Mesoproterozoic basement. The highest dip value measured in the study area was 57° from beds adjacent to a buried igneous knob in the Powder Mill Ferry quadrangle (McDowell and Harrison, 2000).

Folds are difficult to identify in the map area due to lack of exposure and vegetative cover. These folds are open and symmetrical. Folds were only discretely mapped in a few quadrangles. These include the Montauk, Cedar Grove, Pine Crest, Round Spring, Van Buren North, and, Grandin SW quadrangles.

Faults in the map area are difficult to observe directly, due to vegetation and residuum cover, and usually have to be identified on the basis of indirect evidence. This evidence includes (1) vertical offset of stratigraphically equivalent strata having insufficient observed dip angles to explain the change (vertical stratigraphic offset along faults may reverse in sense as the result of horizontal offset of gentle folds along both sides of the fault) and (2) cataclastic deformation bands observed in float blocks of sandstone. Although only vertical offset was observed on faults in the map area, the faults are interpreted to be predominantly strike-slip on the basis of observations of similar faults exposed in subsurface base-metal mines in nearby quadrangles. Fault movement has occurred over time. Most strike-slip movement probably occurred during the Ouachita orogeny.

Similar to Mesoproterozoic rocks in the St. Francois Mountains, basement rocks in the map area also lack any penetrative structural fabric, indicating that these rocks have never been buried more than a few kilometers (Kisvarsanyi, 1981). In the field area, the observed and inferred fault pattern developed in Paleozoic rocks is similar to that found in basement rocks, leading to the conclusion that the Proterozoic basement fabric exerted a controlling influence on younger Paleozoic structures. Regionally there are two dominant fault trends, one oriented northeast and the other oriented northwest. Lesser north-trending and east-trending faults have been mapped locally. Similar trends in regional strike patterns are described elsewhere in southeastern Missouri (McCracken, 1971; Harrison and Schultz, 2002). This northeast-northwest bimodal structural trend is widely thought to be inherent from structures in the Proterozoic basement rocks (McCracken, 1971; Kisvarsanyi, 1974; Kisvarsanyi and Kisvarsanyi, 1976; Clendenin and others, 1989, 1993; Lowell, 2000; Harrison and Schultz, 2002).

On the basis of tectonically disturbed strata, three broad age groups of faults are discernible: (1) those showing evidence that they were active only in the Mesoproterozoic, (2) those that were active at one or more times prior to deposition of the Ordovician section (that is, Neoproterozoic through Late Cambrian), and (3) those that were active at one or more times in the Phanerozoic and probably during the Proterozoic. From field relations observed in the map area, we can determine that the youngest faulting is post-Ordovician in age. Faults of age group 3, in part, are likely associated with the late Paleozoic ancestral Rocky Mountain-Ouachita-Alleghenian orogenic systems, as the Ouachita front is only about 200 km to the south; see Cox (2009) and Hudson (2000) for analyses of late Paleozoic faulting in the Ozark region. Tectonic features (Craig and Connor, 1979) show that uplift in northwestern and central Missouri had begun in the Late Mississippian, producing an elongated northwest-trending ridge that projects through the map area along the central Missouri tectonic zone of Kisvarsanyi (1981, 1984).

Extracted from: (Digital Geologic Map of the Ozark National Scenic Riverways and Adjacent Areas).

References

Baker, H.W., 1999a, Bedrock geologic map of the Grandin SW 7.5-minute quadrangle: Missouri Geological Survey Map OFM-99-342-GS, 1 sheet, scale1:24,000.

Baker, H.W., 1999b, Surficial material geologic map of the Grandin SW 7.5-minute quadrangle: Missouri Geological Survey Map OFM-99-343-GS, 1 sheet, scale1:24,000.

Clendenin, C.W., Lowell, G.R., and Niewendorp, C.A., 1993, Sequencing Reelfoot extension based on relations from southeast Missouri and interpretations of the interplay between offset preexisting zones of weakness: Tectonics, v. 12 , no. 3, p. 703–712.

Clendenin, C.W., Niewendorp, C.A., and Lowell, G.R., 1989, Reinterpretation of faulting in southeast Missouri: Geology, v. 17, p. 217–220.

Cox, R.T., 2009, Ouachita, Appalachian, and ancestral Rockies deformations recorded in mesoscale structures on the foreland Ozark plateaus: Tectonophysics, v. 474, no. 3-4, p. 674–683.

Craig, L.C., and Connor, C.W., coordinators, 1979, Paleotectonic investigations of the Mississippian System in the United States, Part III: U.S. Geological Survey Professiona Paper 1010, pls. 1–15.

Harrison, R.W., Orndorff, R.C., and Weary, D.J., 2002, Geology of the Stegall Mountain 7.5-minute quadrangle, Shannon and Carter Counties, south-central Missouri: U.S. Geological Survey Geologic Investigations Series Map I–2767, scale 1;24,000. http://pubs.usgs.gov/imap/i2767/

Harrison, R.W., and Schultz, A.P., 2002, Tectonic framework of the southwestern margin of the Illinois basin and its influence on neotectonism and seismicity: Seismological Research Letters, no. 5, v. 73, issue 75, p. 685–718.

Hudson, M.R., 2000, Coordinated strike-slip and normal faulting in the southern Ozark dome of northern Arkansas: deformation in a late Paleozoic foreland: Geology, v. 28, no. 6, p. 511–514.

Kisvarsanyi, E.B., 1974, Operation basement; buried Precambrian rocks of Missouri; their petrology and structure: American Association of Petroleum Geologists Bulletin, v. 58, no. 4, p. 674–684.

Kisvarsanyi, E.B., 1981, Geology of the Precambrian St. Francois terrane, southeastern Missouri (Contribution to Precambrian Geology Number 8): Missouri Geological Survey Report of Investigations 64, 58 p.

Kisvarsanyi, E.B., 1984, The Precambrian tectonic framework of Missouri as interpreted from the magnetic anomaly map: Missouri Geological Survey, Contribution to Precambrian Geology 14, part B, 19 p.

Kisvarsanyi, Geza, 1977, The role of the Precambrian igneous basement in the formation of the stratabound lead-zinc-copper deposits in southeast Missouri: Economic Geology, v. 72, no. 3, p. 435–442.

Kisvarsanyi, Geza, and Kisvarsanyi, E.B., 1976, Ortho-polygonal tectonic patterns in the exposed and buried Precambrian basement of southeastMissouri, in Hodgson, R.A., ed., Proceedings of the 1st International Conference on the New Basement Tectonics: Utah Geological Association Publication 5, p. 169–182.

Lowell, G.R., 2000, Eruptive styles of Mesoproterozoic A-type calderas in southeastern Missouri, U.S.A: Revista Brasileira de Geociências, v. 30, no. 4, p. 745–748.

McCracken, M.H., 1971, Structural features of Missouri: Missouri Geological Survey and Water Resources Report of Investigations 49, 99 p.

McDowell, R.C., and Harrison, R.W., 2000, Geologic map of the Powder Mill Ferry quadrangle, Shannon and Reynolds Counties, Missouri: U.S. Geological Survey Geologic Investigations Series Map I–2722, scale 1:24,000. http://pubs.usgs.gov/imap/i-2722/

Orndorff, R.C., Harrison, R.W., and Weary, D.J., 1999, Geologic map of the Eminence quadrangle, Shannon County, Missouri: U.S. Geological Survey Geologic Investigations Series Map I–2653, scale 1:24,000. Orndorff, R.C., Harrison, R.W., and Weary, D.J., 1999, Geologic map of the Eminence quadrangle, Shannon County, Missouri: U.S. Geological Survey Geologic Investigations Series Map I–2653, scale 1:24,000. http://pubs.usgs.gov/imap/i-2653/

Orndorff, R.C., and Weary, D.J., 2009, Geologic map of the Round Spring quadrangle, Shannon County, Missouri: U.S. Geological Survey Scientific Investigations Map 3073, scale 1:24,000. http://pubs.usgs.gov/sim/3073/

Weary, D.J., 2008, Geologic map of the Cedargrove quadrangle, Dent and Shannon Counties, Missouri: U.S. Geological Survey Scientific Investigations Map 2980, scale 1:24,000. http://pubs.usgs.gov/sim/2980/

Weary, D.J., 2014, Geologic Map of the Montauk quadrangle, Dent, Texas, and Shannon Counties, Missouri: U.S. Geological Survey Scientific Investigations Map. Scale 1:24,000. (in press)

Weary, D.J., Harrison, R.W., Orndorff, R.C., Weems, R.E., Schindler, J.S., Repetski, J.E., and Pierce, H.A., 2014, Bedrock geologic map of the Spring Valley, West Plains, and parts of the Piedmont and Poplar Bluff 30' x 60' quadrangles, Missouri, including the upper Current River and Eleven Point River Drainage basins: U.S. Geological Survey Scientific Investigations Map 3280. Scale 1:100,000. (In Press: IP-033086, Director's approval 12/12/2013)

Weary, D.J., and McDowell, R.C., 2006, Geologic map of the Big Spring quadrangle, Carter County, Missouri: U.S. Geological Survey Scientific Investigations Map 2804, scale 1:24,000. http://pubs.usgs.gov/sim/2006/2804/

Weary, D.J., and Orndorff, R.C., 2012, Geologic Map of the Alley Spring Quadrangle, Shannon County, Missouri: U.S. Geological Survey Scientific Investigations Map 3161, scale 1:24,000. http://pubs.usgs.gov/sim/3161/

Weary, D.J., Orndorff, R.C., and Repetski, J.E., 2013, Geologic Map of the Jam Up Cave and Pine Crest quadrangles, Shannon, Texas, and Howell Counties, Missouri: U.S. Geological Survey Scientific Investigations Map 3248, scale 1:24,000. http://pubs.usgs.gov/sim/3248/

Weary, D.J., and Schindler, J.S., 2004, Geologic map of the Van Buren South quadrangle, Carter County, Missouri: U.S. Geological Survey, Geologic Investigations Series Map 2803, scale 1:24,000. http://pubs.usgs.gov/imap/i2803/

Weary, D.J., and Weems, R.E., 2004, Geologic map of the Van Buren North quadrangle, Carter, Reynolds, and Shannon Counties, Missouri: U.S. Geological Survey Geologic Investigations Series Map 2802, scale 1:24,000. http://pubs.usgs.gov/imap/i2802/

Extracted from: (Digital Geologic Map of the Ozark National Scenic Riverways and Adjacent Areas).

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 Stephanie O'Meara (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 Ozark National Scenic Riverways, Missouri (OZAR) developed by Derek Witt and Stephanie O'Meara (see the Digital Geologic Map of the Ozark National Scenic Riverways and Adjacent Areas 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 Stephanie O'Meara.

GRI program coordination and scoping provided by Bruce Heise and Tim Connors (NPS GRD, Lakewood, Colorado).