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Bedrock Geologic Map of the Spring Valley, West Plains, and Parts of the Piedmont and Poplar Bluff 30′×60′ Quadrangles, Missouri, Including the Upper Current River and Eleven Point River Drainage Basins

By David J. Weary, Richard W. Harrison, Randall C. Orndorff, Robert E. Weems, J. Stephen Schindler, John E. Repetski, and Herbert A. Pierce

Pamphlet to accompany

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Cover. View looking downstream along Jacks Fork in the Jam Up Cave 7.5-minute quadrangle, Missouri. The Gasconade Dolomite crops out on the lower slopes of the bluff flanking the river and the Roubidoux Formation crops out on the upper slopes. The formation contact is about 100 feet above river level near the top of the cliff in the middle distance. As is typical of the upper parts of Jacks Fork and the upper parts of the nearby Current River, local flow tends to be in the direction of the dip of the bedrock, which here is toward the southeast. The small light-colored area on the cliff in the middle distance is a relatively fresh rockfall scar. Photograph by Victoria Grant, National Park Service, March 2007.

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Inch/Pound to SI

Multiply	By	To obtain
	Length	
inch	2.54	centimeter (cm)
inch	25.4	millimeter (mm)
foot (ft)	0.3048	meter (m)
mile (mi)	1.609	kilometer (km)
	Area	
square mile (mi^2)	2.590	square kilometer (km^2)
	Volume	
cubic mile (mi^3)	4.168	cubic kilometer (km^3)

SI to Inch/Pound

Multiply	By	To obtain
	Length	
centimeter (cm)	0.3937	inch
millimeter (mm)	0.03937	inch
meter (m)	3.281	foot (ft)
kilometer (km)	0.6214	mile (mi)
	Area	
square kilometer (km^2)	0.3861	square mile (mi^2)
	Volume	
cubic kilometer (km^3)	0.2399	cubic mile (mi^3)

Temperature in degrees Celsius (°C) may be converted to degrees Fahrenheit (°F) as follows:

$$°F = (1.8 \times °C) + 32$$

Vertical coordinate information is referenced to the National Geodetic Vertical Datum of 1929 (NGVD 29).

Horizontal coordinate information is referenced to the North American Datum of 1983 (NAD 83).

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Introduction

This geologic map covers the drainage basins of the upper Current River and the Eleven Point River in the Ozark Plateaus physiographic province, southeastern Missouri (figs. 1; 2*A,B*). The two surface drainage basins are contiguous in their headwaters regions, but are separated in their lower reaches by the lower Black River basin in the southeast corner of the map area. Numerous dye-trace studies that are summarized by Imes and Kleeschulte (1995) and Kleeschulte (2000) demonstrate that in the contiguous headwaters areas of the Eleven Point and Current Rivers, groundwater flows from the Eleven Point River basin into the Current River basin. Much of the groundwater discharge of the Eleven Point River basin emanates from Big Spring, located on the Current River (fig. 2*A*) (Aley and Aley, 1987; Imes and Kleeschulte, 1995). This geologic map and cross sections were produced to help fulfill a need to understand the geologic framework of the region in which this subsurface flow occurs.

In addition to depicting the geology of the study area, this map shows prominent linear anomalies in regional magnetic trends, derived from a residual magnetic field map (see figure 3) that was produced in 1996 by T.G. Hildenbrand of the U.S. Geological Survey (USGS) for this study. These anomalies are tentatively interpreted to be representative of faulting in basement rocks. This text pamphlet summarizes the regional geologic framework and highlights some of the more significant findings of this work. Additional detailed descriptions, data, and interpretations of karst features, hydrogeology, stratigraphy, Mesoproterozoic igneous and tectonic geology, audio-magnetotelluric surveys, and tectonics can be found in other publications produced during our study of the region (Lowell and others, 2010; Orndorff and others, 2006; Weary and Orndorff, 2001; Orndorff and others, 2001; Lowell and Harrison, 2001; Orndorff and others, 2000; Repetski and others, 2000; Harrison and others, 2000; Šebela and others, 1999; Repetski and others, 1998). Published geologic maps of 7.5-minute quadrangles produced for this study are listed in table 1 below.

This map includes all of the Ozark National Scenic Riverways (fig. 2*A*), a national park created by an Act of Congress in 1964 to protect 134 miles (mi) (216 kilometers (km)) of the Current and Jacks Fork Rivers in south-central Missouri. Located within the park are numerous large springs, including Big Spring, the largest spring in Missouri and one of the ten largest springs in the world.

Also within the map area is Greer Spring, which is the main source of the Eleven Point River that flows through the Eleven Point Unit of the Mark Twain National Forest (U.S. Forest Service) (fig. 2*A*). Greer Spring is the largest spring on National Forest land in the United States. During flood, flow from Greer Spring is almost as large, volumetrically, as that of Big Spring, making Greer Spring also one of the largest springs in the world. Acknowledging a 44-mi (77-km) section of the Eleven Point River below Greer Spring as one of "certain selected rivers of the Nation which, with their immediate environments, possess outstandingly remarkable scenic, recreational, geologic, fish and wildlife, historic, cultural, or other similar values," the Wild and Scenic Rivers Act in 1968 established the Eleven Point National Scenic River, which is entirely within the boundaries of this map (fig. 2*A*).

Potentially economic mineral resources are present in the subsurface in the map area. Exploration drill-hole data indicate that anomalously high concentrations of base-metal sulfides locally occur within the Cambrian Bonneterre Formation (see table 3). The geologic setting of these anomalous concentrations is similar to that found in the Viburnum Trend (Economic Geology, 1977), which is contained in the southeast Missouri lead mining district, the largest lead mining

Table 1. Geologic maps of 7.5-minute quadrangles in the study area that have been published to date at 1:24,000 scale by the U.S. Geological Survey.

[Information on ordering published maps can be obtained by calling the U.S. Geological Survey at 1–888–ASK–USGS (1–888–275–8747) or by visiting the USGS online at *http://www.usgs.gov/pubprod*]

Quadrangle name	USGS map series number	Reference (see References Cited)	URL for online access
Greer	I–2618	McDowell (1998)	*http://pubs.usgs.gov/imap/i-2618/*
Eminence	I–2653	Orndorff and others (1999)	*http://pubs.usgs.gov/imap/i-2653/*
Powder Mill Ferry	I–2722	McDowell and Harrison (2000)	*http://pubs.usgs.gov/imap/i-2722/*
Winona	I–2749	Orndorff and Harrison (2001)	*http://pubs.usgs.gov/imap/i2749/*
Stegall Mountain	I–2767	Harrison and others (2002)	*http://pubs.usgs.gov/imap/i2767/*
Low Wassie	I–2719	Weems (2002)	*http://pubs.usgs.gov/imap/i2719/*
Wilderness and Handy	I–2801	Harrison and McDowell (2003)	*http://pubs.usgs.gov/imap/i2801/*
Fremont	I–2775	Orndorff (2003)	*http://pubs.usgs.gov/imap/i2775/*
Van Buren North	I–2802	Weary and Weems (2004)	*http://pubs.usgs.gov/imap/i2802/*
Van Buren South	I–2803	Weary and Schindler (2004)	*http://pubs.usgs.gov/imap/i2803/*
Big Spring	SIM 2804	Weary and McDowell (2006)	*http://pubs.usgs.gov/sim/2006/2804/*
Cedargrove	SIM 2980	Weary (2008)	*http://pubs.usgs.gov/sim/2980/*
Piedmont Hollow	SIM 2979	Weary (2008)	*http://pubs.usgs.gov/sim/2979/*
Round Spring	SIM 3073	Orndorff and Weary (2009)	*http://pubs.usgs.gov/sim/3073*
Alley Spring	SIM 3161	Weary and Orndorff (2012)	*http://pubs.usgs.gov/sim/3161/*
Jam Up Cave and Pine Crest	SIM 3248	Weary and others (2013)	*http://pubs.usgs.gov/sim/3248/*

district in the world. The southernmost part of the Viburnum Trend (fig. 2*A*) extends into the northern part of the map area and is exploited by the Sweetwater Mine. Undeveloped and potentially economic occurrences of base metals are known also beneath Blair Creek (Kisvarsanyi, 1977; Hagni, 1989), which is a tributary to the Current River in the north-central part of the map area.

Previous Work

Few detailed geologic maps were available for much of the upper Current River basin or the Eleven Point River basin prior to this project. A portion of the upper Current River basin was mapped at 1:62,500 scale during the 1920s by Bridge (1930), and the northern half of the upper Current River basin was compiled to 1:250,000 scale through reconnaissance mapping conducted mostly during the 1970s and 1980s (Pratt and others, 1992). The geology of approximately 30 mi^2 (78 km^2) in and around the Irish Wilderness Roadless Area, Oregon County, was mapped at 1:24,000 scale by Heyl and others (1983) as part of a mineral resource potential map. Partly concurrent with field investigations for the present report, the Missouri Department of Natural Resources, Geological Survey and Resource Assessment Division, mapped three contiguous 7.5-minute quadrangles in the southeast corner of the study area (fig. 2*A*); they are Grandin SW (Baker, 1999), Briar (Starbuck, 1999), and Poynor (Wedge, 1999). After making some modifications we compiled the data from these three maps into the present report. Fisher (1969) and Sinha and Kisvarsanyi (1976) mapped parts of the Mesoproterozoic volcanic rock exposures on Stegall and Mule Mountains. A small, structurally complex area near the town of Thayer, located in the extreme south-central part of the map area, was mapped by Hedden (1968), and with some reinterpretations his mapping was incorporated into the final map. Miscellaneous unpublished reconnaissance geologic maps at various scales that provide coverage for various parts of the study area exist in the archives of the Missouri Department of Natural Resources in Rolla, Mo. A preliminary geologic map of the Spring Valley 30'×60' quadrangle, which encompasses most of the upper Current River basin, was produced by Orndorff and Harrison (1997).

Geologic Map Preparation

The majority of the field data and interpretations presented in this report were compiled and synthesized from prior, chiefly USGS, geologic mapping and field observations, which represent almost 15 years of effort. Compilation for this report includes both detailed data, at 1:24,000 scale, and reconnaissance data, collected at 1:100,000 scale. For the parts of the study area that were mapped by the USGS at 1:24,000 scale, geologic contacts were identified and traced in the field and locations were determined by global positioning system (GPS) measurements and relations to topography. In areas of poor exposure, structure contours of individual stratigraphic horizons were drawn from observed point data, and contacts then were drawn to match equal-values intersections of the structure contours and topographic elevations.

Table 1 provides a list of the 1:24,000-scale 7.5-minute geologic map quadrangles that have been published to date by the USGS and used in the preparation of this report.

Data from all earlier geologic investigations in the study area, including dozens of unpublished field sheets on file at the Missouri Department of Natural Resources, Geological Survey and Resource Assessment Division, Rolla, were utilized in the preparation of this report. We drove the majority of roads in the reconnaissance area and collected geologic information from observed outcrops and float. Appendix 1 gives some of the drill-hole data that we incorporated into map preparation; in addition, we used well logs from a database compiled by the Missouri Department of Natural Resources, Division of Geology and Land Survey. Those logs are now available online at *http://www.dnr.mo.gov/env/wrc/logmain/index.html*. Most contacts in areas mapped by reconnaissance were drawn based on structure contours derived from limited outcrop and well data.

Only a few of the faults shown in areas of reconnaissance mapping were directly observed in the field; most faults, therefore, are considered to be inferred and approximately located. Criteria used for establishing the existence and trend of faults include (1) continuation of faults from areas mapped in detail, (2) disruptions of regional stratigraphy, (3) stratigraphic offsets indicated by drill-hole data or by faults penetrated by drill holes, and (4) field evidence indicative of cataclasis. Juxtaposition of different geologic units, deformation bands in sandstone, tectonic brecciation, and slickensides were the most common types of fault evidence observed in the field and used in delineating the traces of faults in areas mapped in detail. Some inferred faults shown on the map are drawn on magnetic linear features (see figure 3). Because of extensive vegetation and residuum cover and the overall paucity of exposures, intersections between two or more faults and crosscutting fault relationships portrayed on the geologic map are mostly interpretative.

This report depicts prominent linear anomalies in regional aeromagnetic data derived from a compiled map of the residual magnetic field (fig. 3) produced by T.G. Hildenbrand (USGS, Menlo Park, Calif., deceased) in 1996 for this study. The compiled map followed earlier publication of statewide magnetic anomaly maps by the USGS (Hildenbrand and Kucks, 1991, 1992). Information on the source datasets and on procedures used to process and compile the data is available in a digital report by Kucks and Hill (2005). Both ground-based and aeromagnetic data were used in this compilation. The mapped magnetic data were examined independently of the geology and apparent linear anomalies were then drawn over it. Only those anomalies that do not coincide with mapped or inferred faults are shown on the final geologic map.

Discussion

Stratigraphy

The stratigraphic section in the map area comprises several thousand feet of nearly flat-lying Cambrian and Ordovician marine sedimentary strata that, with angular unconformity, overlie a basement of dominantly Mesoproterozoic igneous rocks. Some Paleoproterozoic metamorphic rocks could lie beneath the westernmost part of the map area (Sims, 1990), and some of the basal section of the Lamotte Sandstone could be as old as Neoproterozoic. Figure 4 shows a stratigraphic column for these rocks; see Lowell and others (2010) and the published geologic maps of the 7.5-minute quadrangles listed in table 1 for detailed descriptions of stratigraphic units.

The Proterozoic-Paleozoic contact is highly irregular, and locally exhibits paleo-relief of as much as 1,600 feet (ft) (500 meters (m)) over relatively short distances (see cross sections), resulting in protrusions of basement rocks into the Paleozoic section. The study area has been subaerially exposed from as far back as the Cretaceous to the present, and during this period a relatively thick cover of residual and colluvial material was developed extensively on the Paleozoic sediments.

Paleoproterozoic Rocks

Paleoproterozoic metamorphic rocks may occur in the subsurface in the westernmost part of the map area (Sims, 1990), but this is unconfirmed by drill-hole data. Sims (1990) ascribed these metamorphic rocks to the North American Paleoproterozoic crust that formed during the Central Plains orogen from ~1,800 to 1,600 Ma (mega-annum) (Sims and Peterman, 1986).

Mesoproterozoic Rocks

Mesoproterozoic Silicic Rocks

The Mesoproterozoic basement rocks consist principally of an older suite (~1.47 Ga) (giga-annum) of plutonic and volcanic rocks, and a younger suite (~1.38 Ga) of silicic, epizonal plutonic rocks (Sims, 1990; Van Schmus and others, 1996). A cluster of more than 50 knobs of the older suite protrude through the Paleozoic section and crop out in the Current River basin; elsewhere, the older suite does not crop out and is known only from subsurface data. A subcrop map of the Proterozoic basement beneath the map area can be found in Lowell and others (2010, fig. 8.7). Detailed discussions on the geology and geochemistry of the outcropping Mesoproterozoic rocks can be found in Lowell and others (2010), Lowell and others (2005), Harrison and others (2002), Orndorff and Harrison (2001), Lowell and Harrison (2001), Harrison and others (2000), McDowell and Harrison (2000), and Orndorff and others (1999).

An important feature of the Mesoproterozoic basement within the map area is the Eminence caldera, first described by Kisvarsanyi (1977, 1984). The approximate limit of location of the caldera is shown in figure 3. Caldera fill consists of ignimbrites and lavas that are divisible into an upper sequence and a lower sequence. Lower sequence volcanic rocks, commonly exhibiting dips of 65 degrees (°) to 90° that likely reflect caldera collapse, have a probable thickness of 7 to 8 km and a volume of at least 360 km^3. These rocks are overlain with angular unconformity by post-collapse, subhorizontal effusive rocks of the upper sequence that have a thickness of about 300 m. The unconformity is marked by an air-fall tuff at the base of the upper sequence, called the tuff of Mule Mountain. Lower sequence caldera-collapse rocks have been dated at 1,480 ± 42 Ma (Van Schmus and others, 1996) and post-collapse rocks have been dated at 1,470 ± 2.7 Ma (Harrison and others, 2000). The strike of rotated lower sequence caldera-collapse rocks displays a strong northwest trend (Lowell and others, 2010; Harrison and others, 2002; Orndorff and Harrison, 2001; Lowell and Harrison, 2001; Harrison and others, 2000); McDowell and Harrison, 2000; and Orndorff and others, 1999), which has been interpreted as indicating an inherent northwest-trending fabric in the basement. This fabric influenced caldera formation in a transtensional tectonic setting created by a left step in a left-lateral strike-slip fault system (Harrison and others, 2000; Lowell and others, 2010). From petrographic studies conducted elsewhere in southeastern Missouri, foliation-parallel left-lateral, northwest-trending ductile shear has been postulated for Mesoproterozoic-age basement rocks (Lowell and Clendenin, 2003; Lowell and others, 1995; Diehl and others, 1995). A genetic link between magma emplacement and transtensional step-overs in strike-slip faulting has been long established in the literature (Hutton and others, 1990; Schmidt and others, 1990; Glazner, 1991; Tikoff and Teyssier, 1991; and Román-Berdiel and others, 1997).

Mesoproterozoic Volcanic Ridge Beneath Hurricane Creek

Deep drilling in the Low Wassie quadrangle (see appendix 1) in the vicinity of Hurricane Creek in Shannon and Oregon Counties has delineated a northwest-trending ridge on the Proterozoic-Paleozoic unconformity that is underlain by Mesoproterozoic volcanic rocks (fig. 5; cross section *B–B′*). This buried feature closely coincides with a geophysical magnetic anomaly identified by Spector (1982) and is indicated in figure 3. Deep drill-hole data further indicate that the buried Hurricane Creek volcanic ridge is separated from volcanic rocks within the Eminence caldera by plutonic rocks of Mesoproterozoic age. The Hurricane Creek ridge is offset dextrally by the northeast-striking Wilderness-Handy fault zone from another topographic high on the unconformity, which is also underlain by volcanic rocks (Spector, 1982). Although the attitudes of volcanic fabric of these rocks are unknown, the similarity between the trend of the ridge and the volcanic fabric observed in outcropping volcanic rocks in the Eminence caldera strongly suggests that the volcanic rocks beneath Hurricane Creek have a steeply dipping, northwest-trending fabric. We further hypothesize that the buried Hurricane Creek volcanic rocks represent a distinct Mesoproterozoic volcanic center. An alternative hypothesis would be that the volcanic ridge is an outlier of the larger Eminence caldera, which either was eroded deep into its co-genetic plutonic equivalent or was intruded by younger, ~3.8-Ga plutonic rocks.

Mesoproterozoic Mafic Plutonic Rocks

The magnetic signature of mafic plutonic rocks that underlie the Eleven Point River basin (see cross section *B–B′*) in the northwestern corner of Oregon County, in T. 25 N., R. 6 W., creates a distinctive anomaly on the magnetic field map (fig. 3, white circle). This anomaly was drilled in 1968 to 1970 by the American Zinc Co. as part of their exploration program for nickel, copper, and cobalt deposits. They drilled three holes, which encountered rocks of olivine gabbro, uralitic gabbro, and norite composition (Kisvarsanyi, 1975). Van Schmus and others (1996) reported an age of approximately 1,500 Ma for these rocks, which is similar to ages of most mafic plutons elsewhere in Missouri. From inspection of drill cores of mafic plutons in Missouri, Kisvarsanyi (1974, 1988) described these bodies as differentiated layered intrusions that are typically intruded by granitic material and that contain disseminations of pyrrhotite, magnetite, pentlandite, and chalcopyrite. Van Schmus and others (1996) concluded that the mafic plutons are probably contemporaneous with the 1,470±40-Ma silicic igneous rocks, and that the magma source for the body beneath the Eleven Point River basin was probably Mesoproterozoic depleted mantle and perhaps juvenile subcontinental lithosphere.

Proterozoic-Paleozoic Unconformity

The unconformity between Proterozoic basement rocks and the overlying Paleozoic section is an erosional surface that represents more than 800 million years. During this long period of nondeposition, the supercontinent of Rodinia, which included the North America craton, was initially assembled between ~1,340 and 1,000 Ma. Basement rocks within the map area would have been within a few hundred kilometers of the orogenic front composing the southern margin of the North American plate (see Thomas, 2006). Therefore, we assume that some of the faulting observed in outcropping Mesoproterozoic sections is probably associated with large-scale plate tectonic movements during this period.

Along the unconformity, volcanic rocks that were deposited at the Earth’s surface now lie at the same elevations as coeval plutonic rocks that cooled at depths in excess of 5,000 to 6,000 ft (about 1.5 to 2 km), thus indicating substantial pre-Paleozoic deformation, localized uplift, and subsequent erosion.

Cambrian and Ordovician Geologic History

A renewed depositional record of geologic history in the map area began during the breakup of Rodinia, which lasted from about 760 Ma to about 530 Ma (see Thomas, 2006), when syntectonic marine sediments were laid down beneath an epicontinental sea that occupied most of Midcontinent North America. The floor of a major crustal rift, which ultimately failed and became known as the Reelfoot rift, lies only 60 km to the southeast of the map area (see Hildenbrand and Hendricks, 1995). In the southeastern part of the map area subsurface, the Cambrian succession (the Bonneterre and Davis Formations of the Elvins Group) exhibits thickness variations and facies transitions that were controlled by paleotopography along the northeast-trending structural fabric of the raised shoulder of the Reelfoot rift (Palmer, 1989; He and others, 1997; Seeger and Palmer, 1998). This produced a complicated pattern of Late Cambrian sediment distribution varying from (1) very deep depositional basin facies centered over the floor of the Reelfoot rift, to (2) carbonate shelf facies along the uplifted rift shoulder and in the vicinity of paleotopographic Mesoproterozoic basement highs, and (3) relatively shallow intrashelf basin facies in more foreland areas (Seeger and Palmer, 1998). In the map area, the transition from intrashelf facies, called the central Missouri basin by Seeger and Palmer (1998), to rift-shoulder carbonates is present in the Davis Formation across the Wilderness-Handy fault zone (see Lowell and others, 2010). Paleotopographic variations along the uplifted rift shoulder, from narrow and discontinuous to wide and continuous, also contributed to variations in sediment type in the adjacent intrashelf basins, from limestone dominated (typical of the Bonneterre Formation) to shale dominated (typical of the Davis Formation), respectively (Seeger and Palmer, 1998).

Although it failed along the Reelfoot rift, continental separation succeeded in opening a major continent-splitting ocean basin off the southern margin of the North American craton (Laurentia), approximately 200 km to the south of the map area. Sedimentation in the tectonically quiescent central Missouri basin and Reelfoot rift for the most part infilled and smoothed out the paleotopography, except where directly adjacent to steep-sided basement highs, which persisted as islands.

For the remainder of recorded geologic time in the map area, represented by the uppermost Cambrian and the Ordovician section, continental-shelf carbonate deposition persisted on the trailing edge of Laurentia. During this time, conditions including increasing eustatic levels, increasing distance from major terrestrial sediment sources located far to the north on the Canadian Shield, and a tropical to subtropical latitudinal position, all were conducive to deposition of relatively shallow-water carbonate sediments (Repetski and others, 1998). Dolomite, formed by both primary-diagenetic and secondary-alteration processes, is the dominant lithology in the uppermost Cambrian and Lower Ordovician interval

(Potosi Dolomite, Eminence Dolomite, Gasconade Dolomite, Roubidoux Formation, Jefferson City Dolomite, and Cotter Dolomite) (Repetski and others, 1998). Varying mixtures of medium- to thin-bedded sandstones are intercalated within the Paleozoic section in and above the uppermost Eminence Dolomite (see Description of Map Units and Lowell and others (2010)).

Rocks exposed in the field area have been near the Earth's surface since at least Mesozoic time, and an undetermined amount of erosion has taken place. The color alteration index (CAI) of conodonts reported from the Lower Ordovician rocks of the southern Ozarks of Missouri is 1 to 1.5, indicating only low levels of long-term post-burial heating that range from <50 to about 90 degrees Celsius (°C; Repetski and others, 1998; Lowell and others, 2010). Based on an average geothermal gradient, this suggests that the total burial thickness of sediments lying over these conodonts has never exceeded about 5,000 to 9,000 ft (1,500–2,700 m) (Epstein and others, 1977).

At several upland locations in the field area, localized occurrences of insoluble residuum of Mississippian-age rocks indicate that late Paleozoic marine strata once covered the region. None of the material at these locations is in place. Residuum consists of jumbled chert blocks that are scattered across the crests and slopes of hills, indicative of let-down residual blocks. The strewn chert fields do not consistently lie upon the highest hills in a given area, and their distribution in ellipsoidal patches that vary from a few tens of meters to a few hundred meters across suggests deposition in paleosink-holes (Bridge, 1930). Collected fossils consist of bryozoan fragments and crinoid columnals. More rarely, brachiopod molds were recovered, and one mold of a trilobite was found in the Birch Tree quadrangle. The brachiopod material was sent to Dr. John Carter (Carnegie Museum of Natural History, Pittsburgh) and the trilobite specimen was sent to Dr. David Brezinski (Maryland Geological Survey, Baltimore) for identification; their faunal identifications are presented in table 2.

Table 2. Biostratigraphic determinations for Mississippian chert collections from the Current River drainage basin, Missouri.

[Analyses conducted in 1998 by Dr. John Carter, Carnegie Museum of Natural History, Pittsburgh, and by Dr. David Brezinski, Maryland Geological Survey, Baltimore]

Taxon	Locality[1]	Probable source unit or age
	Brachiopoda	
Avonia minnewankensis or *A. williamsana*	B, BT, W	Burlington or Keokuk Limestones
Avonia sp.	E	Osagean
Brachythris sp.	B, BT, W	Not age diagnostic
Cyrtina sp.?	E	Burlington Limestone
Cleiothyridina sp. (large species)	B, BT, W	Osagean
Eumetria sp.	E	Burlington Limestone
Echinoconchus alternatus	B, BT, W	Keokuk Limestone
Girtyella sp.	E	Not age diagnostic
Punctospirifer sp. (narrow species)	E	Not age diagnostic
Punctospirifer sp.	B, BT, W, E	Mississippian
Pustula sp.	B, BT, W	Burlington Limestone
Rhynchopora sp.	B, BT, W	Carboniferous or Permian
Schellwienella sp. (large species)	E	Burlington Limestone
Setigerites setigerus	B, BT, W	Keokuk Limestone or younger
Spirifer cf. *S. grimesi* or *S. logani*	B, BT, W	Osagean
Tomiproductus sp.	B, BT, W	Keokuk Limestone
Torynifer sp.	B, BT, W	Burlington or Keokuk Limestones
	Arthropoda	
Breviphillipsia semiteretis	BT	Chouteau Limestone-Reeds Spring Formation-Pierson Limestone

[1]B, Bartlett quadrangle; BT, Birch Tree quadrangle; E, Exchange quadrangle; W, Winona quadrangle. Where B, BT, and W are listed together, the collections have not yet been reported separately by locality.

Based on faunal collections of chert residuum, at least two distinctly different ages appear to be represented. The older fauna is indicated by the single trilobite mold of *Breviphillipsia semiteretis* Hessler (1963). Based on the Mississippian stratigraphic nomenclature of Weller and others (1948), Hessler (1963, 1965) described this fauna as occurring in the late Kinderhookian Chouteau Limestone, the early Osagean Reeds Springs Formation, the middle Osagean St. Joe Limestone Member of the Boone Formation, and the middle Osagean Burlington Limestone. This fauna also occurs in the Nunn Member of the early Osagean Lake Valley Limestone of New Mexico. Brezinski's (2000) study of the Lake Valley Limestone of New Mexico, now known to range from Osagean to earliest Meramecian age, shows that *Breviphillipsia semiteretis* occurs in three of the six named members: the basal Andrecito and the successive Alamogordo and Nunn Members. These three members range from early to middle Osagean in age.

Because none of the brachiopod specimens suggest the presence of any rocks older than Osagean, and because most Kinderhookian-age units have little chert, it seems most likely that the trilobite-bearing chert came from either the Pierson Limestone or the Reeds Spring Formation of early Osagean age or their equivalents. This age is compatible with the brachiopod-bearing blocks from the Exchange quadrangle that yield large species of *Schellwienella* and *Eumetria*, *Punctospirifer*, and *Cyrtina?* This assemblage is typical of the Burlington Limestone (Osagean), which is time equivalent to the Pierson Limestone and Reeds Spring Formation but not to the overlying Keokuk Limestone (see Thompson, 1986).

The younger faunal horizon is indicated by brachiopods that are characteristic of the Keokuk Limestone or higher strata in the region.*Setigerites setigerus* occurs no lower than the Keokuk, *Tomiproductus* does not occur below the Keokuk except in the Cordilleran region, and *Echinoconchus alternatus* is most likely from the Keokuk. Therefore, at least two chert-rich Osagean formations were once present across the central Salem Plateau but have since been stripped away except for remnant residual cherts. None of the fossils collected suggests the former presence of any units other than ones of Osagean age.

Surficial Geology

Surficial deposits in the field area include alluvium, terrace deposits, residuum, colluvium, and minor loess. Overall, surficial deposits are estimated to cover more than 95 percent of the drainage basins; residuum is the greatest surficial deposit volumetrically, and in many areas is more than 100 ft (30 m) thick. Surficial deposits are not shown on the 1:100,000-scale geologic map but are depicted on the 1:24,000-scale geologic maps produced for this study (see table 1).

Karst Geology

The southeastern margin of the Ozark Plateaus that includes the map area is one of the most karstified regions in the United States. Karst development is characterized by well-developed and integrated underground drainage systems, long segments of losing and disappearing streams, long segments of gaining streams, hundreds of caves, thousands of sinkholes, and dozens of major springs, some of which are world class. The three major waterways in the study area, the Current River, its tributary the Jacks Fork, and the Eleven Point River (fig. 2*A*), are renowned for having the highest number of first-order-magnitude springs in the United States. Hundreds of second- and third-order-magnitude springs also occur along the rivers and their minor tributaries. There is strong correlation between the flow magnitudes of springs in the Current and Eleven Point River basins and the lengths of the interconnected cave networks that serve as groundwater conduits. Detailed discussions of Big, Round, and Alley Springs can be found in Lowell and others (2010).

A better understanding of the hydrogeology of the karst system is gained by groundwater dye-trace studies, which help define subsurface recharge areas (subsurface drainage basins) for spring discharge; however, such studies are limited as they are incapable of revealing actual flow paths. Dye-trace studies for major springs in the map area (Aley and Aley, 1987; Imes and Kleeschulte, 1995) show crossing trace paths, long distance of travel, overlapping subsurface drainages, and nonequivalent surface and subsurface drainage basins. Additional complexity in the hydrologic system also is revealed by the highly irregular regional groundwater surface and the distribution of losing and gaining streams (Gann and others, 1976).

Despite this complexity, our fieldwork recognized some of the major geologic controls on the development of karst features, particularly caves and springs, that are of both primary and secondary origin. Primary geologic controls that influence water flow and rock dissolution for cave or conduit formation include sedimentary features inherent from deposition and diagenesis; the major controlling features include bedding-plane partings, vertical variations of depositional facies within the Paleozoic section, and topographic relief on the unconformity between the basement (confining unit) and the overlying Paleozoic section. Virtually all caves are developed parallel or subparallel to bedding planes, and their vertical advances are almost strictly the result of physical stoping. Cave mapping for this project in the Current and Eleven Point River basins further identified an overall branchwork morphology of cave passages, similar to that identified by Dom and Wicks (2003) for approximately 72 percent of all caves in the Salem Plateau. Palmer (1991) showed that branching cave systems are indicative of bedding control, whereas curvilinear passages of branchwork morphology are controlled by bedding-plane-parting porosity. The Ozark caves are known to be concentrated at several discrete stratigraphic horizons:one level in the upper part of the Eminence Dolomite and one in the upper part of the Gasconade Dolomite.

Secondary geologic controls are largely restricted to dissolution-enhancing ground preparation created by fault movement in the Paleozoic section. This is particularly true for paleo-karst associated with the Wilderness-Handy fault zone (see Lowell and others, 2010, Stop 11 discussion). In rocks exposed at the surface, mostly the Eminence Dolomite and overlying section, jointing appears to play a subordinate role in karst development. This is probably because joints in the Current and Eleven Point River basins typically are not throughgoing, instead breaking only a single or at the most a few bedding horizons, and thus not developing vertically connected conduits capable of significant water flow. The joint fabric in the Derby-Doerun Dolomite and older rocks is not known, largely due to their subsurface occurrence. The joint fabric in the overlying Potosi Dolomite is only poorly known.

Progressive downcutting by the larger surface streams in the study area has lowered the elevation of the water table and stranded many caves, especially in the Current River basin, at levels well above the present groundwater surface. Some of these caves have immense rooms and channels indicative of large volumes of water flow. These stranded caves are comparable in scale to known present-day spring conduits such as Alley Spring (see Lowell and others, 2010), and they serve as ancient analogues to the conduits that exist in the shallow subsurface of the Ozarks today.

More than 700 caves are known in the field area, of which 79 were studied to gain understanding of the geologic controls on the development of groundwater conduits along the southeastern margin of the Ozark Plateaus. Geologic mapping of 19 of these caves collected information on the stratigraphy, passage orientations, fractures, and passage morphology (Šebela and others, 1999; Orndorff and others, 2001). In addition, maps of 60 other caves, produced by the Cave Research Foundation, were examined for information on passage orientation and morphology (for example, see Missouri Speleological Survey, 1977, 1982a,b, 1984).

Sinkholes

Combining geologic mapping and geographic information system (GIS) analysis, Orndorff and others (2000) concluded that several geologic, physiographic, and hydrogeologic parameters are related to sinkhole development. Most of the sinkholes in the study area occur in the Roubidoux Formation and Jefferson City Dolomite, the two formations of the Paleozoic section that contain more numerous sandstone beds and that have the greatest aerial extent in the mapped area. Regionally, these two units also form the upper surfaces of high plateaus.

Weary and Orndorff (2001) discussed how simple stratigraphic analysis of sinkhole occurrence can be misleading. For example, sinkholes shown on geologic maps as occurring in the Roubidoux Formation actually develop by collapse or subsidence into dissolution voids in the uppermost part of the Gasconade Dolomite. Therefore, the morphology of sinkholes is related to dissolution of dolostone directly beneath the sandstone beds (Orndorff and others, 2006). Many of the sinkholes observed in the field area are bedrock-collapse sinkholes formed by collapse of sandstone beds into large dissolution voids in subjacent dolomite beds. These sinkholes are characterized by very steep to vertical sides and are commonly rimmed by intact sandstone beds or slabby sandstone float blocks. This is in contrast to most karst areas and sinkhole plains, where cover-collapse sinkholes (sinkholes in the soil mantle characterized by more gentle slopes and rarely involving bedrock collapse) predominate. Sinkholes in the study area that are located away from the major river valleys in upland areas of the Salem Plateau, as well as sinkholes elsewhere in Missouri, tend to be of the cover-collapse type due to the thick residuum and soil overlying the bedrock.

Structural Geology

Sedimentary strata in the map area are generally subhorizontal to gently dipping, with gentle, open folds developed in compressional (or transpressional) domains near faults and in subsidence features related to large karstic voids. For most of the area, bedding dips of less than 2° are predominant, with the regional directional trend toward the south. Small, subtle folds, both anticlines and synclines, were observed at various locations in the map area, particularly along reaches of the larger rivers where continuous rock exposure occurs. These folds were generally too small to portray at map scale. A few larger folds, apparent via map pattern, are indicated by symbols on the map.

At many localities Paleozoic strata locally dip radially away from topographic highs on the Mesoproterozoic rock surface as a result of differential compaction and (or) non-horizontal primary deposition. Dip angles as steep as 38° have been reported in these strata within the study area (Harrison and others, 2002).

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 stata, 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) (see figure 3 and cross sections). By Early Pennsylvanian time, this elongated uplift, known as the Pascola arch, had grown to the southeast and extended to the Reelfoot rift and beyond to the Nashville dome (Grohskopf, 1955). The crest of the Pascola arch had as much as 7,900 ft (2,400 m) of uplift (Marcher and Stearns, 1962) where it crossed the Reelfoot rift, effectively cutting off sediment flow out the southern end of the Illinois basin (Kolata and Nelson, 1990).

Northeast-Trending Faults

The Wilderness-Handy fault zone is the longest, most continuous northeast-trending structure in the map area and appears to exert significant influence on groundwater flow (see Hydrogeology section below and Lowell and others (2010)). This fault zone, only a few kilometers in width, consists of parallel to braided fault strands that have been mapped at 1:24,000 scale between the Current River at Van Buren, Mo., and Horseshoe Bend on the Eleven Point River near Greer, Mo. (fig. 2*B*). The fault zone is inferred to extend on strike from the Eleven Point River to Thayer, Mo. (fig. 2*B*), where a northeast-trending fault zone mapped by Hedden (1968) is interpreted as its continuation. Reconnaissance mapping between the Eleven Point River and Thayer found a paucity of outcrops and no reliable structural data, and little subsurface drill-hole data available for this area.

Drill-hole data available from a segment of the fault zone near Van Buren indicate that the Cambrian section within the Wilderness-Handy fault zone is more intensely faulted than the exposed Ordovician section (for details see Harrison and McDowell, 2003; Lowell and others, 2010). In both the Thayer and Van Buren areas, where exposures are relatively good and detailed mapping exists, northeast-striking faults of the Wilderness-Handy fault zone appear to cut northwest-trending faults, suggesting that northeast-trending faults have experienced more recent movement. This is contrary to the relationship shown by Clendenin and others (1989) that showed the northwest-striking faults cutting those with a northeast trend. The Wilderness-Handy fault zone is assumed to cut the northwest-trending Teresita fault, but poor exposures in the intersectional area prevent us from having actual evidence.

In addition to the Wilderness-Handy fault zone, numerous other northeast-trending faults are portrayed on the geologic map. In the southern one-third of the map area, faults of this trend are thought to occur in areas of very poor to nonexistent bedrock exposure on the upland plateau area where, except for the Grand Gulf fault, they are inferred from drill-hole and aeromagnetic data. The Grand Gulf fault is exposed in walls of a collapsed cave system at Grand Gulf State Park, about 10 km west-northwest of Thayer. Extension of this fault along strike from this locality is tentative. In the northeast-central region of the map area, several northeast-trending faults were identified near the cluster of exposed Mesoproterozoic basement protrusions. Detailed 7.5-minute quadrangle mapping around the basement protrusions shows that these faults have offset the Mesoproterozoic rocks much more than the Paleozoic stratigraphy (Orndorff and others, 1999; McDowell and Harrison, 2000; Harrison and others, 2002). Several of these structures are associated with linear magnetic anomalies interpreted as Mesoproterozoic shear zones (Harrison and others, 2002). Kinematic indicators associated with two of these northeast-striking shear zones, Denning Hollow and Mud Spring Hollow, suggest that left-lateral strike-slip faulting during the Proterozoic (Harrison and others, 2002) was followed by re-activation at undetermined times.

Northwest-Trending Faults

The dominant trend of faults in the field area, both mapped and inferred, is northwesterly. A structural cross-sectional transect (*A–A′*) from the southwest-central part of the map area to the northeast corner encounters at least three zones of faulting (fig. 3): (1) the central Missouri tectonic zone of Kisvarsanyi (1984), considered by her as a crustal-scale zone of deformation in the basement fabric; (2) faults related to the Eminence caldera discussed previously; and (3) the Ellington fault zone, which is interpreted by Clendenin and others (1989) as a long-lived zone of crustal-scale deformation. These faults are likely related to the Bolivar-Mansfield fault system, which McCracken (1971) envisioned as extending across the entire southwest corner of Missouri from the Kansas border into Arkansas. All of these structures are thought to continue southeastward to and beneath the Mississippi embayment.

The Alice Mine fault is tentatively mapped along a prominent magnetic linear anomaly trending about N. 60º W. in the extreme southwest corner of the map area. From exposures located a few kilometers to the west of the map area, the Alice Mine fault is described by Kidwell (1946) as an elongated collapse structure striking approximately N. 70º W. to N. 80º W. that has about 18 ft (5.5 m) of down-to-the south displacement. McCracken (1971) suggests that this structure is a highly brecciated strike-slip fault.

The West Plains-Thayer fault zone, which represents the southeastward continuation of the Bolivar-Mansfield fault system, is relatively well-exposed to the west of the map area, where it deforms rocks as young as Pennsylvanian (see McCracken, 1971; Middendorf and others, 1991). In the West Plains area (fig. 2*B*), the existence of the West Plains-Thayer fault zone is based on differences in elevations of stratigraphic contacts in drill holes (see Missouri Department of Resources (2012) online well database at *http://www.dnr.mo.gov/env/wrc/logmain/index.html*) and the trace is considered approximately located. The West Plains-Thayer fault zone is better exposed in the Thayer area, where it was mapped by Hedden (1968). Northwest of the Thayer area, this fault zone is portrayed as a single strand, although it likely comprises multiple complex, braided to en echelon fault strands that are similar to those mapped in the Thayer area and along the Bolivar-Mansfield fault system (Middendorf and others, 1991).

The central Missouri tectonic zone of Kisvarsanyi (1981, 1984) extends from the Midcontinent Rift system in Nebraska to the Mississippi embayment in southeastern Missouri. This tectonic zone is associated spatially with a geophysical anomaly called the Missouri gravity low (see Lowell and others (2010) and Harrison and Schultz (2002) for discussions on the Missouri gravity low). The central Missouri tectonic zone traverses the entire map area from northwest to southeast and is represented on the magnetic survey map (fig. 3) as a belt having an overall magnetic-low signature and bounding linear anomalies. Two northwest-striking faults, the Teresita and Houston faults, which cut the Paleozoic section, are thought to represent re-activation of basement structures along the central Missouri tectonic zone.

The Teresita fault appears to be a continuous structure across the entire map area and is spatially associated with a linear trough in the regional groundwater surface (see text below and Lowell and others (2010) for further discussion). The portrayal of the Teresita fault in the southeast corner of the field area is based on unpublished geologic mapping in files of the Missouri Geological Survey in Rolla. In the western part of the map area the location of the Teresita fault is constrained by drill-hole data and the fault is considered approximately located. On cross sections *A–A′* and *B–B′* the Teresita fault is interpreted as the southwestern boundary of the central Missouri tectonic zone. The fault appears to scissor along strike, so that along its eastern extent (east of the trace of cross section *A–A′*) strata are downthrown to the southwest, while along its western extent strata are downthrown commonly to the northeast. In the south-central part of the study area, where the Teresita fault crosses the Eleven Point River, stratigraphic offset of the Gasconade Dolomite-Roubidoux Formation contact across the fault is minor (Weary, 2008b). A down-to-the northeast, northwest-trending fault has been mapped on-strike with the Teresita fault in the adjacent Springfield 1°× 2° quadrangle to the west of the map area (Middendorf and others, 1991). Because of its long strike length, relatively minor vertical offset, and scissoring nature, the Teresita fault is interpreted to be a strike-slip structure.

The Houston fault disrupts bedding within the Gasconade Dolomite in a roadcut along U.S. Route 63 at the northern outskirts of Houston, Mo., near the northwestern corner of the study area (fig. 2*B*). From here, along strike to the northwest in the map area, the Houston fault is a down-to-the southwest structure that juxtaposes Gasconade Dolomite against the Roubidoux Formation. Still farther to the northwest, a down-to-the-southwest fault mapped by Middendorf and others (1991) in the adjacent Springfield 1°× 2° quadrangle is considered to be a continuation of the Houston fault. Southeast of the town of Houston, the Houston fault is approximately located based on subsurface drill-hole data, as well as on both reconnaissance and detailed mapping, for a distance of about 66 km before it either dies out within the Ordovician section or its stratigraphic offset is so minor that it becomes untraceable at the surface. The geophysical survey conducted by Spector (1982) indicates that the Houston fault trend continues southeastward in the Mesoproterozoic basement to as far as the Wilderness-Handy fault. Spector’s (1982) data also suggest that after a right-lateral offset across the Wilderness-Handy fault, the Houston fault trend in the Mesoproterozoic basement continues yet farther to the southeast.

The Houston fault marks the northeastern boundary of the central Missouri tectonic zone, as it is the apparent boundary between differing Mesoproterozoic units (such as Y2g and Y1g on cross section *A–A′*, and Y1v and Y1g on cross section *B–B′*). The Precambrian basement map of Sims (1990) suggests between 30 and 100 km of left-lateral offset of the contact between Paleoproterozoic metamorphic rocks and Mesoproterozoic igneous rocks across the central Missouri tectonic zone (see figure 8.7 of Lowell and others, 2010). Drill-hole and aeromagnetic data suggest a possible 20 km of left-lateral offset of Mesoproterozoic volcanic rocks across the Houston fault in the subsurface of the central part of the map area.

In the upper part of the Jacks Fork drainage, three relatively short north- to northwest-trending faults (the Fly Blow Hollow, Buck Hollow, and Belew Hollow faults) have been mapped between the Teresita and Houston faults. These three faults merge toward the southeast where they either terminate within the Ordovician section or the observed stratigraphic offset becomes insufficient to map. A prominent linear magnetic anomaly (fig. 3) projects several kilometers farther to the southeast from the fault terminations, suggesting that the faulting may continue in the Mesoproterozoic basement in that direction. This projection also coincides with a linear stretch of the South Fork of Hurricane Creek, and main stem Hurricane Creek drainages, suggesting a possible structural control.

With orientations that are parallel to or en echelon with the structural trend of the Houston fault is a discontinuous linear series of individual faults called, from northwest to southeast, the Low Wassie, Evans Hollow, and Eastwood faults. This structural trend is cut by at least four northeast-trending strands of the Wilderness-Handy fault zone (see 7.5-minute geologic maps for more details on these faults). The structural trend was interpreted as a regional strike-slip fault by Clendenin and others (1989), who referred to it as the Shannon County fault. Horizontal slickenside striations observed in drill-hole samples of the Cambrian part of the section along the Low Wassie fault provide further evidence of Paleozoic strike-slip movement for this structure (Orndorff and Harrison, 2001).

In the northwest corner of the study area our Hartshorn and Sutton Creek-Ink faults were originally mapped in reconnaissance by Satterfield (1976) and called, respectively, the Arthur Creek and Oscars faults. The Big Creek fault was identified during our detailed mapping in the Montauk quadrangle. Westward continuations of the Hartshorn and Sutton Creek-Ink faults have been mapped on the adjacent Springfield 1º× 2º quadrangle (Middendorf and others, 1991). Our mapping has extended the Hartshorn and Sutton Creek-Ink faults eastward into the western part of the Eminence caldera (fig. 3). Both of these faults display reversals in stratigraphic offset, or scissoring, suggesting a strike-slip component to their movement.

The Gladden Creek fault was mapped in the Cedargrove quadrangle in the north-central part of the map area (Weary, 2008a). The fault extends to the northwest into the adjacent Montauk quadrangle where identifiable offset along it diminishes, making it unmappable (D.J. Weary, USGS, unpub. data, 2013). The Gladden Creek fault is inferred to extend to the southeast from the Cedargrove quadrangle into the northern part of the Eminence caldera, based on drill-hole and aeromagnetic data (fig. 3). The fault displays scissoring, suggesting that it is a strike-slip fault.

The Ellington fault zone is a strike-slip system that exhibits left-lateral movement (Clendenin and others, 1989; Taylor, 1983). This fault zone is well known from underground exposures in the Sweetwater Mine (see below for discussion) and from drilling in the vicinity of Ellington, Mo. (fig. 2*B*) (McCracken, 1971). Reconnaissance mapping of this study extends the Ellington fault zone beyond the northern edge of the map area (see Stop 3 in Lowell and others, 2010). Within the Sweetwater Mine orebody, parts of the Ellington fault zone are mineralized. This relationship aided Clendenin and Duane (1990) in their interpretation that northwest-trending fault zones in southeastern and southern Missouri (including the Ellington and Low Wassie-Evans Hollow-Eastwood faults) provided pathways for mineralizing Mississippi Valley-type base-metal fluids.

The Bunker fault, located in the northeastern part of the map area, is inferred both from drill-hole data and from a prominent linear magnetic anomaly (fig. 3). Drill holes located in and around the town of Bunker (fig. 2*B*) indicate that the Bunker fault is a down-to-the-northeast structure that juxtaposes the Roubidoux Formation against the Gasconade Dolomite. The Bunker fault, as inferred from the aeromagnetic data, is a linear anomaly that appears to merge with the Ellington fault zone near the eastern edge of the map area.

The Webb Creek fault is a northwest-striking structure near the eastern edge of the study area that is inferred from drill-hole data. These data indicate an area of uplift exists between the Webb Creek fault and the Ellington fault zone; an anomalous outcrop of Mesoproterozoic granite (unit Y1g) located between these two faults also implies structural uplift. The north-trending Pine Valley Creek fault, inferred from anomalies in the aeromagnetic data, provides a structural link between the Webb Creek fault and the Ellington fault zone and forms the western side of the uplift. The uplift area is rhomb-shaped if the eastern edge of the map area is considered its eastern side. A possible explanation for the uplifted area is that it is in a restraining bend created by a right step in the left-lateral Ellington fault zone.

A small segment of the Black fault, located in the northeast corner of the map area, was delineated in reconnaissance mapping by Middendorf in the Centerville quadrangle (1979). This fault bounds the southern edge of the St. Francois igneous terrane (Clendenin and others, 1989) and is believed to be a strike-slip structure that exhibits a left-lateral sense of motion. Rocks to the north of the fault exhibit upward vertical offset relative to rocks to the south.

Seismicity

Seismicity in the map area has been sporadic, relatively widespread, historically of low magnitudes (Hadley and Devine, 1974; Nuttli and Brill, 1981; Dewey and others, 1989), and typically only locally felt. Recorded epicenters from the most recent earthquakes, for the years 1964 through 2003, are plotted on the geologic map (Missouri data may be accessed via search tools at the USGS Earthquake Hazards Program online databases, *http://earthquake.usgs.gov/earthquakes/states/?region=Missouri*; and also at the University of Memphis, Center for Earthquake Research and Information, *http://www.ceri.memphis.edu/seismic/*). Magnitudes of these earthquakes range from 2.5 to 5.1 on the Richter scale and reported depth ranges are shallow (0–12 km below the surface).

The few focal-mechanism solutions that have been obtained for earthquake events near the study area indicate that the regional compressional stress field in the central United States is oriented east-northeast (Zoback and Zoback, 1991; Zoback, 1992). Hermann and Nguyen (1992) corrected and verified previously published focal mechanism solutions using waveform modeling of broadband data in complement with regional seismic-network data.

Mississippi Valley-Type Base-Metal Occurrences

The two southernmost active mines in the Viburnum Trend exploiting Mississippi Valley-type (MVT) base-metal mineralization are the Fletcher Mine and the Sweetwater Mine, both located within the map area (fig. 2*A*). These mines are currently owned and operated by the Doe Run Co. Both operations are located in the upper Black River drainage basin; however, the underground workings of the Sweetwater Mine are located within the subsurface recharge area for springs that feed the Current River (Feder and Barks, 1972; Maxwell, 1974; Aley and Aley, 1987).

Fletcher Mine

The discovery hole for the Fletcher Mine, located in sec. 13, T. 32 N., R. 2 W., was drilled in 1958; shaft excavation began in 1964, and milling operations began in early 1967 (Paarlberg and Evans, 1975). Ore principally occurs as disseminations and stratabound bands in beds of laminated siltstone and oolitic grainstone, the latter having algal characteristics, within the upper Bonneterre Formation, but some ore also occurs in brecciated parts of the overlying Davis Formation of the Elvins Group (Paarlberg and Evans, 1977). Two ore bodies are mined at Fletcher: one that is draped over the axis of a north-trending Precambrian basement protrusion, and another that occurs directly over a pinchout of the Lamotte Sandstone on the west flank of the same protrusion (Paarlberg and Evans, 1975, 1977).

Sweetwater Mine

The Sweetwater Mine (see cross section *A–A′*) is the southernmost mine in the Viburnum Trend; it has also been known as the Ozark Lead mine, the Frank R. Milliken Mine, and the Adair Creek Mine (it is labeled Adair Creek Mine on the geologic map). The occurrence of MVT economic mineralization at this location was discovered in 1962 and mine production commenced in 1968 (Mouat and Clendenin, 1975). The orebody consists of several ore shoots that occur throughout the Bonneterre Formation comprising multiple stratabound horizons of dominantly digitate algal boundstones and oolitic grainstones, and is in proximity to a series of northwest-trending basement protrusions (Mouat and Clendenin, 1975, 1977). Two differing deformational processes contributed to ground preparation for mineralization: (1) multiple complex episodes of sediment gravity-sliding away from the basement protrusions, with associated solution collapse (Larsen and others, 1979) and (2) transtensional dilation in a left-lateral shear couple (Taylor, 1983). Given the similar timing with deformation in the nearby Reelfoot rift, the gravity slides could well have been seismic in origin.

The Sweetwater ore deposit overlies the location of local basement protrusions that are situated primarily on the upthrown side of a high-angle reverse-fault strand of the northwest-trending Ellington fault zone (Mouat and Clendenin, 1977; Paarlberg and Evans, 1977). As discussed previously, the Ellington fault zone is a left-lateral, strike-slip system. Because parts of the Ellington fault zone are mineralized within the orebody, Clendenin and Duane (1990) concluded that northwest-trending fault zones in southeastern and southern Missouri provided pathways for mineralizing MVT fluids. The Sweetwater and Suses Branch faults, both major strands of the Ellington fault zone, partition the Sweetwater deposit into three orebodies (B. Walker, Sweetwater Mine geologist, oral commun., 1996). Base-metal mineralization between the Sweetwater and Suses Branch faults occurs in northeast-trending en echelon ore shoots (Taylor, 1983), a geometry that is consistent with right-lateral horizontal strain along a conjugate Reidel shear related to the left-lateral motion of the Ellington fault zone (see schematic plan view above the Ellington fault zone on cross section *A–A′*). In workings of the Sweetwater Mine, exposures of the Ellington fault zone exhibit multiple episodes of pre- and post-ore emplacement strike-slip faulting (Taylor, 1983; Clendenin and others, 1989).

Within the Sweetwater Mine, the Sweetwater fault acts as an aquitard (B. Walker, Sweetwater Mine geologist, oral commun., 1996). Vertical movement has offset the Davis Formation-Bonneterre Formation contact by approximately 100 ft (30 m) across the fault. Dewatering of the uppermost bed of the Bonneterre Formation in the hanging wall produced no change in hydrologic conditions in the uppermost bed of the Bonneterre Formation in the footwall, nor do mine workings “make water” (release excess water) from the fault zone itself when they crosscut it (B. Walker, Sweetwater Mine geologist, oral commun., 1996).

Mississippi Valley-type base-metal deposits are known to occur beneath the drainage basin of Blair Creek (see cross section *A–A′*), which is a tributary of the Current River (Kisvarsanyi, 1977). These occurrences were drilled in the 1960s and the results are proprietary.

In an area located several kilometers north of Greer Spring, numerous drill holes encountered trace to large amounts of base-metal mineralization, principally within the Bonneterre Formation. Lesser mineralization was encountered within other units. The most significant mineralization found to date occurs within the Bonneterre Formation beneath the small drainages of Becky Hollow, Mine Hollow, McCormack Hollow, and Threemile Hollow in secs. 2, 3, 10, 11, 14, 15, and 22, T. 25 N., R. 4 W., in the Greer and Piedmont Hollow 7.5-minute quadrangles. These drainages flow a short distance (3–5 km) into the Eleven Point River. Table 3 summarizes the high-grade metal occurrences encountered.

Table 3. Summary of high-grade base-metal mineralization encountered in drill holes in the Bonneterre Formation several kilometers north of Greer Spring, Mo.

[Drill-hole locations are shown on the geologic map within the outlined area marked “Area of figures 6 and 7” and are listed in appendix 1]

Drill-hole number	Thickness recovered, in feet	Metal concentration in recovered interval, in percent	
		Lead	Zinc
801-129	1.0	26.5	1.2
801-148	1.0	11.0	2.9
84W40	6.2	35.9	12.2
86W4	4.0	75.4	25.6
86W6	18.4	66.1	11.2

Audio-Magnetotelluric (AMT) Survey

In an effort to better understand the anomalous mineral occurrences in the area north of Greer Spring, in the vicinity of the above-mentioned drill holes, audio-magnetotelluric (AMT) soundings were made to determine variations in the electrical resistivity of the earth with depth. AMT sounding uses natural-source, multi-frequency electromagnetic signals from lightning or other atmospheric disturbances as an energy source (Cagniard, 1953; Dmitriev and Berdichevsky, 1979; Wait, 1962). AMT soundings consist of electric and magnetic field measurements taken over a four-decade range of frequencies from 10 to 100,000 Hertz (Hz). The resultant distribution of currents induced in the earth is dependent on the electrical resistivity and magnetic permeability of the earth and the frequency measured. Since low-frequency signals penetrate to greater depths than high-frequency signals, measurements of the electromagnetic response at several frequencies contain information on the variation of resistivity at depth. Data from these sounding traverses are inverted and stitched together to form depth profiles that are oriented at various angles to the buried geologic structures. AMT tensor soundings collected by Herbert A. Pierce (USGS) during the spring of 2001 in the proposed prospecting-permit-application area (see figure 2*A* for location) were recorded using a Geometrics EH-4 system. No vertical magnetic field (Hz) data were recorded because the system is limited to four channels (E_x, E_y, H_x, and H_y). Initially about 2,000 frequencies were collected and then reduced to approximately 40 frequencies (10 per decade) for each of the two (X and Y) directions from 10 to 100,000 Hz. The magnetic field sensors, electric field sensors, buffers, and pre-amplifiers for both systems, including a 60-Hz notch filter to reduce interference from electric power lines, were manufactured by Electromagnetic Instruments, Inc. (EMI), now Schlumberger EMI Technology Center.

In our AMT survey, the Geometrics EH-4 receiver employed a two-stage coefficient-of-coherence cutoff filter that first removed any signals having a coefficient of coherence less than 0.3, then removed any signals having coefficients of coherence less than 0.5 in the second stage. Signal amplitudes were monitored, and any that saturated the receiver amplifiers were rejected. Time series that had more than seven sensor or instrument saturations were also rejected. Assessments were made of the sounding locations before and after data collection. Sites were chosen so that stations were more than 100 m away from power lines. Background electric and magnetic fields were monitored prior to recordings, and stations were moved if the static fields were above 200 millivolts (mV) on the electric lines or above 150 nanoteslas (nT) on the magnetic coils. Two-dimensional invariant inversions of the collected data were completed using a uniform half-space starting with 100 ohm-meters. They are presented in map form and as electrical sections or profiles (figs. 6 and 7, respectively), discussed below. Calculated values of phase-sensitive skew indicate that two-dimensionality is a good assumption for most frequencies. Generally all frequency decades, 100,000 Hz to 10 Hz, have skews less than 0.25.

Inverted data from 24 AMT soundings collected in the vicinity of high-grade base-metal mineralization were combined into a map (fig. 6) and two vertical depth profiles (figs. 7*A* and *B*). The map view, which is at an elevation of 300 m below mean sea level, shows an area of relatively low resistivity coincident with four out of the five drill holes containing anomalously high values of lead and zinc mineralization (table 3). The low resistivities suggest that the mineralization is related to measurable lower resistivity values. Drill holes 801-148, 84W40, 86W4, and 86W6 are within the low-resistivity area on the map; although drill hole 801-129 also has high values of mineralization, it is located outside and north of the 2001 AMT survey grid. Figure 7 shows the east- and northeast-oriented two-dimensional electrical profiles. The low resistivity values calculated by the finite-difference two-dimensional modeling of the electrical soundings are shown as blue areas.

On the east-oriented invariant electric traverse profile (fig. 7*A*) the low-resistivity area outside of the measured mineralization appears to extend nearly to the surface, possibly indicating alteration and increased permeability related to the mineralizing process. The northeast-oriented invariant electric traverse profile (fig. 7*B*) does not have low resistivity values that continuously approach the surface.

The processed AMT data appear to convincingly delineate the volume of lead/zinc mineralization in the area north of Greer Spring. Electrical sections and map images of the resistivity below and near the area of base-metal mineralization recovered the depths and lateral extent of the known mineralized area. The extent of mineralization to the north of the main cluster of discovery drill holes, indicated by a single drill hole (801-129), was outside the spread of AMT sounding sites, so limits to the mineralized body to the north could not be estimated. Additional AMT soundings to the north would probably better define the extent of this deposit.

Hydrogeology

Geohydrologic units for the Ozark Plateaus physiographic province, which encompasses the map area, have been established as the Ozark Plateaus geohydrologic system (Gann and others, 1976; Imes, 1989; Imes and Smith, 1990; Imes, 1990a,b; Kleeschulte, 2001). This vast system extends throughout southern Missouri, northern Arkansas, and eastern parts of Oklahoma and Kansas. The Ozark Plateaus geohydrologic system consists of four major geohydrologic units, which in ascending order include the basement confining unit, the St. Francois aquifer, the St. Francois confining unit, and the Ozark aquifer (see figure 4) (Gann and others, 1976; Imes, 1989; Imes and Smith, 1990; Imes, 1990a,b; Kleeschulte, 2001). The basement confining unit comprises the Mesoproterozoic volcanic and plutonic basement rocks of the St. Francois terrane and Paleoproterozoic metamorphic rocks (Imes, 1989). These dense basement rocks are largely highly impermeable, except along faults and fracture zones where small water yields are possible (Imes, 1989). The St. Francois aquifer comprises Upper Cambrian strata that disconformably overlie the basement confining unit and conformably underlie the St. Francois confining unit (Imes, 1990a). In the map area, the St. Francois aquifer consists of a basal conglomerate of the Lamotte Sandstone that exists on top of the major Proterozoic-Paleozoic unconformity, the remainder of the Lamotte Sandstone, and the Bonneterre Formation. From drill-hole data, the basal conglomerate of the Lamotte appears to be ubiquitous, although it is generally very thin (<20 ft) (6 m). The Lamotte Sandstone generally thickens toward the west in the study area, although it is known to be absent adjacent to or over many basement highs. Bounding the top of the St. Francois aquifer is the St. Francois confining unit, which is composed of the Cambrian Elvins Group. The Elvins Group is subdivided into the Davis Formation and overlying Derby-Doerun Dolomite (usage of Missouri Geological Survey, 1979). West of the Wilderness-Handy fault zone, these stratigraphic units contain beds of shale, shaly mudstone, and thinly bedded, dense, fine-grained dolomites, which analyses have shown are nonporous (primary porosity) and very impermeable (Kleeschulte and Seeger, 2000, 2001). No studies have been undertaken to evaluate the secondary porosity of these rocks. East of the Wilderness-Handy fault zone, these formations comprise more porous shallow-water carbonate facies, including digitate and planar algal bioherms, and as discussed previously, breccias associated with the shoulder of the Cambrian Reelfoot rift. In effect, to the east of the Wilderness-Handy fault zone, only an unconfined aquifer exists from the basement confining unit to the surface. See Lowell and others (2010, Stop 11) for additional discussion of the Wilderness-Handy fault zone and its influence on groundwater flow.

From the top of the St. Francois confining unit to the topographic surface is the Ozark aquifer (Imes, 1990a). In the map area it comprises, in ascending order, the Potosi, Eminence, and Gasconade Dolomites, the Roubidoux Formation, and the Jefferson City and Cotter Dolomites. The Ozark aquifer is unconfined and serves as the principal domestic water source for most of southeastern Missouri, except in the St. Francois Mountains, where near-surface stratigraphic units of the St. Francois aquifer are commonly tapped.

A hydrologic study of the Viburnum Trend mining district by Kleeschulte (2001) encompassed the northeastern part of the map area, including the area around the Sweetwater Mine, but did not extend to the Current River. The contoured potentiometric surface drawn by Kleeschulte (2001) shows a deep, southwest-inclined trough beneath Big Creek, which is a tributary to the Current River. In a more regional hydrologic study of south-central Missouri, Gann and others (1976) produced a slightly different potentiometric surface that depicted a relatively deep and narrow, southerly inclined groundwater trough beneath Logan Creek, with groundwater flow toward Blue Spring. Although Kleeschulte (2001) and Gann and others (1976) differ in exact locations of their potentiometric troughs, they clearly demonstrate that groundwater flow occurs from the southern part of the Viburnum Trend, in the Black River drainage basin (Sweetwater Mine area), and rapidly moves to the southwest toward the Current River. A study by Duchrow and others (1980) demonstrated that particulate material introduced into the Logan Creek surface drainage from three tailings-pond breaches in 1977 and 1978 made their way into the Current River alluvial system via Blue Spring. Dye traces further indicate that the underground workings of the Sweetwater Mine are within the recharge area for springs along the Current River, particularly Blue Spring (Kleeschulte, 2001).

Dye-tracing studies conducted for springs southwest of the Current River (Aley, 1978; Aley and Aley, 1987; Kleeschulte, 2000; Imes and Kleeschulte, 1995; Imes and others, 2007) indicate that groundwater flow is commonly interconnected beneath surface drainage divides and is much more complicated than surface flow. For example, some groundwater dye-traces recovered at Big Spring originated more than 50 mi (80 km) away to the southwest and crossed beneath the entire Eleven Point River surface basin (fig. 2*A*) (Imes and Kleeschulte, 1995; Kleeschulte (2000). Measured in a direct line, these distant traces, as well as shorter traces, pass through the proposed prospecting-permit-application area in the flow path to Big Spring (Imes and Kleeschulte, 1995). The inconsistent pattern of crossing flow paths (see Imes and

Kleeschulte, 1995) is best explained by including an overriding karst control on groundwater flow. When the pattern of losing streams is added into consideration (see Imes and Kleeschulte, 1995), it is very clear that there is little consistency between surface-water flow and groundwater flow; once again, this is best explained by incorporating an overriding karst control over the regional hydrology.

To check for geologic controls on groundwater flow, particularly in areas of mapped fault structures, a potentiometric groundwater surface map of the Ozark aquifer was created (fig. 8) from water-table data provided by the USGS Missouri Water Science Center in Rolla (Imes and others, 2007). Water levels from more than 300 wells, all measured during the same low-water- flow season (fall 2000), were contoured by hand. Contouring followed strict rules of interpolation between control points only, independent of all geology. Our contour data shows gross similar trends to that generated by Imes and Kleeschulte (1995) and Imes and others (2007); however, there are differences in detail due to differences in contouring methods used and to the fact that our contouring is more regional in coverage.

Our contoured groundwater map (fig. 8) exhibits an irregular, undulating surface, consisting of an alternating series of northwest-trending subparallel troughs and ridges that are interrupted by a northeast-trending, elongated groundwater high that closely coincides with the Wilderness-Handy fault zone and its associated regional subsurface stratigraphic changes. These changes are related to the uplifted shoulder of the Reelfoot rift to the southeast of the map area, as discussed previously in the "Cambrian and Ordovician geologic history" section. Northwest of and adjacent to the elongated groundwater high are two prominent closed groundwater depressions that are connected by a trough in the water table. One depression is associated with the confluence of the Eleven Point River and both Spring and Hurricane Creeks and the other with the Pike Creek basin south of Fremont, about 9 mi (14 km) west-southwest of Big Spring. A similar trough is apparent in the potentiometric surface of Imes and Kleeschulte (1995), who first emphasized the necessity of groundwater flow through this trough in order to explain movement of dye traces to Big Spring. The potentiometric surface is also discussed in more detail in Lowell and others (2010).

Description of Map Units

Paleozoic Sedimentary Rocks

Ocjc **Cotter Dolomite and Jefferson City Dolomite, undivided (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-bedded 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 difficult to differentiate from the Cotter Dolomite without good exposure of the contact. Since exposures of either formation are rare in the study area, these units are undifferentiated. The Jefferson City and Cotter Dolomites are sparsely fossiliferous, but have yielded trilobites and conodonts as reported by Repetski and others (1998). These formations each have an average thickness of about 200 ft (61 m) in Missouri (Thompson, 1995). Typically considerably less than the full 400-ft (122-m) thickness of these combined units is exposed in the Current River and Eleven Point River basins. Areas underlain by the Cotter Dolomite are probably restricted to the southern and western uplands in the map area

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)

Og **Gasconade Dolomite (Lower Ordovician)**—Dolomite, chert, sandstone, and orthoquartzite. Formation can be divided into three informal units (fig. 4), 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 (0.6–3 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

Ꞓe **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- to 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

Ꞓp **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 ranges from about 50 to 575 ft (15–175 m) thick in the Current River basin

Elvins Group (Upper Cambrian)—Consists of the Derby-Doerun Dolomite (usage of Missouri Geological Survey, 1979) and the Davis Formation

Ꞓdd **Derby-Doerun Dolomite (usage of Missouri Geological Survey, 1979) (Upper Cambrian)**—Dolomite, siltstone, and shale. Dolomite is buff to light gray, fine to medium grained, thin to medium bedded, argillaceous and silty, and contains minor amounts of chert. Siltstone and shale are thin bedded and interbedded with dolomite. Lower part of unit is silty and glauconitic. Thickness averages about 150 ft (46 m) but ranges up to about 354 ft (108 m)

Ꞓd **Davis Formation (Upper Cambrian)**—Shown in cross sections only. Shale, siltstone, sandstone, dolomite, and limestone conglomerate. Locally hydrothermally dolomitized to “white rock” that is indistinguishable from the overlying Derby-Doerun Dolomite (usage of Missouri Geological Survey, 1979). Thickness averages about 170 ft (52 m) but ranges up to 322 ft (98 m)

Ꞓb **Bonneterre Formation (Upper Cambrian)**—Shown in cross sections only. Interbedded dolomite, shale, limestone, and siltstone. Dolomite is light gray, fine to medium grained, medium bedded, locally glauconitic and argillaceous; lower part locally contains small igneous rock fragments where it was deposited directly over Mesoproterozoic basement rocks or near basement knobs. A shale interval 2 to 6 ft (0.6–1.8 m) thick occurs in upper part of unit, and is commonly referred to as the “False Davis.” Limestone is brownish gray to pink, thin bedded, and fine grained. Siltstone is light to dark gray, laminated, and quartzose. Thickness about 564 ft (172 m)

Ꞓl **Lamotte Sandstone (Upper Cambrian, Lower Cambrian?, and Neoproterozoic?)**—Shown in cross sections only. Sandstone and conglomerate. Unit dominantly consists of light-gray to brown, medium-grained, moderately to well-sorted quartzose sandstone. Coarse-grained basal conglomerate beds are common and consist of igneous detritus shed from knobs of Mesoproterozoic volcanic rocks. Clasts range in size up to boulders, several feet (1 m) in diameter. The exact age of basal conglomerate beds is poorly constrained and may be in part Lower Cambrian and (or) Neoproterozoic. Thickness ranges from zero at pinchouts against Mesoproterozoic knobs to about 330 ft (100 m)

Mesoproterozoic Intrusive Rocks

Y2g **Granite of Y2mg province of Sims (1990) and Graniteville-type granite of Kisvarsanyi (1981)**—Shown in cross sections only. Mesozonal granite. Van Schmus and others (1996) reported a uranium-lead (U-Pb) age of 1,323 ± 6 Ma for this unit from an exploratory drill hole in Shannon County (see cross section *A–A'*) in the map area and a U-Pb age of 1,376 ± 4 Ma from a drill hole immediately south of the map area in Arkansas

Y1gb **Gabbro of Sims (1990)**—Shown in cross section *B–B'* only. YXgb gabbro unit of Sims (1990). Analyses by Van Schmus and others (1996) indicate a U-Pb age of ~1,500 Ma

Y1g **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. Outcrops are known from two areas in the map area, the Ellington 7.5-minute quadrangle (sec. 27, T. 29 N., R. 1 E.) and the Big Spring 7.5-minute 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 in 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).

Y1gp **Granite porphyry of Kisvarsanyi and Kisvarsanyi (1990)**—Shown in cross section *A–A'* only. Interpreted as a ring dike of the Eminence caldera by Kisvarsanyi and Kisvarsanyi (1990). Thickness of the ring dike is exaggerated in cross section *A–A'* because the section cuts the granite body obliquely

Mesoproterozoic Volcanic Rocks

Y1v **Volcanic rocks, undifferentiated**—Shown in cross sections only

Upper Sequence of Mesoproterozoic Volcanic Rocks

Yr **Rhyolite, undifferentiated**—Exposed in a few small areas in the northeast corner of the study area, northeast of the Black fault

Yscr **Rhyolite of Storys Creek**—Alkali rhyolite named for a single exposure east of Storys Creek, in sec. 15, T. 29 N., R. 4 W. Rock is aphanophyric, with only 3 percent phenocrysts of alkali feldspar. Matrix texture is of the snowflake type and lacks both spherulites and lithophysal cavities. Fresh rock is medium pinkish gray. Thickness unknown

Yrm **Rhyolite of Russell Mountain**—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 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 by rotation during caldera collapse (Harrison and others, 2000). Relation to the tuff 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)

Yvc **Volcaniclastic conglomerate, breccia, and sandstone**—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 observed only on southern side of Coot Mountain, in secs. 22 and 23, T. 29 N., R. 3 W., in the Eminence and Powder Mill Ferry 7.5-minute quadrangles (Orndorff and others, 1999; McDowell and Harrison, 2000). Contacts with other units not exposed

Ysc **Rhyolite of Sutton Creek—**Lava(?) of alkali rhyolite to rhyolite; massive and 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 the Current River in an unnamed knob 1.6 km upstream from the confluence with the Jacks Fork River. Thickness unknown

Ysi **Rhyolite of Shut-In Mountain**—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 fraction 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)

Ysm **Rhyolite of Stegall Mountain**—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 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 200 ft (61 m)

Ymm **Tuff of Mule Mountain**—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 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)

Lower Sequence of Mesoproterozoic Volcanic Rocks

Yltm **Tuff of Little Thorny Mountain**—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 (1,000 m)

Ycu **Upper Coot Mountain unit**—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)

Ycl **Lower Coot Mountain unit**—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 the 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 the 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, 2.0 km east of Eminence

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Appendix 1. Summary of Drill-Hole Data for the Study Area

Appendix 1. Summary of drill-hole data for the study area.

[Compiled from Kisvarsanyi (1975) and U.S. Bureau of Land Management (BLM) paper files. These data are not available as part of the Missouri Department of Natural Resources, Division of Geology and Land Survey well database (*http://www.dnr.mo.gov/env/wrc/logmain/index.html*) that is maintained by the Water Resources Center. Column headings: QUADRANGLE, name of USGS 7.5-minute quadrangle; DRILL HOLE, drill-hole identifier shown on map; LOCATION, section location, or better, in the Public Land Survey System; UTM_NORTH, northing in meters, Universal Transverse Mercator projection, NAD 83, Zone 15 North; UTM_EAST, easting in meters, Universal Transverse Mercator projection, NAD 83, Zone 15 North; COLLAR_ELE, collar elevation, in feet above mean sea level. Reported elevation of contacts in well, in feet above mean sea level: OR_OG, Roubidoux Formation/Gasconade Dolomite; OG_CE, Gasconade Dolomite/Eminence Dolomite; CE_CP, Eminence Dolomite/Potosi Dolomite]

QUADRANGLE	DRILL HOLE	LOCATION	UTM_NORTH	UTM_EAST	COLLAR_ELE	OR_OG	OG_CE	CE_CP
Bardley	CF-1	SE1/4SE1/4 sec. 17, T. 24 N., R. 1 W.	4067110	670717	728	—	—	—
Bartlett	BT-2	SE1/4NE1/4 sec. 1, T. 27 N., R. 5 W.	4100496	638923	1,040	—	—	—
Birch Tree	801-163	SE1/4NW1/4 sec. 34, T. 27 N., R. 4 W.	4092638	644352	942	—	—	—
Bunker	HA-3	SW1/4SE1/4 sec. 5, T. 31 N., R. 2 W.	4141028	660790	1,262	—	—	842
Bunker	HA-13	NE1/4NE1/4 sec. 8, T. 31 N., R. 2 W.	4140290	661104	1,220	—	—	839
Bunker	HA-23	NW1/4 sec. 6, T. 32 N., R. 2 W.	4141578	659220	1,290	—	—	790
Bunker	HA-24	SW1/4SW1/4 sec. 1, T. 31 N., R. 3 W.	4140903	656786	1,040	—	—	860
Bunker	HA-25	SE1/4NW1/4 sec. 11, T. 31 N., R. 3 W.	4139945	655515	1,290	—	—	895
Bunker	HA-29	NE1/4NW1/4 sec. 18, T. 31 N., R. 2 W.	4138642	658812	1,270	—	—	920
Corridon	BF-8	SE1/4NE1/4 sec. 18, T. 32 N., R. 1 W.	4148545	669209	1,265	—	—	995
Corridon	BF-11-119-577	NE1/4NW1/4 sec. 7, T. 32 N., R. 1 W.	4150222	668531	1,245	—	—	—
Corridon	BF-116	NE1/4SW1/4 sec. 18, T. 32 N., R. 1 W.	4148003	668461	1,207	—	—	—
Corridon	BF-120	SE1/4NW1/4 sec. 7, T. 32 N., R. 1 W.	4149906	668442	1,150	—	—	—
Corridon	60W100	SE1/4SE1/4 sec. 31, T. 32 N., R. 1 W.	4142991	669410	1,080	—	—	—
Corridon	60W112	SE1/4NE1/4 sec. 31, T. 32 N., R. 1 W.	4143727	669118	1,180	—	—	—
Corridon	60W155	NW1/4NE1/4 sec. 31, T. 32 N., R. 1 W.	4144184	668910	1,004	—	—	—
Corridon	579	SW1/4NE1/4 sec. 19, T. 32 N., R. 1 W.	4146989	668818	1,163	—	—	—
Corridon	584	SW1/4NE1/4 sec. 7, T. 32 N., R. 1 W.	4149916	668735	1,069	—	—	—
Fremont	PK-21	SW1/4NE1/4 sec. 33, T. 26 N., R. 2 W.	4082750	662452	925	—	—	—
Fremont	PK-26	SE1/4NW1/4 sec. 1, T. 26 N., R. 3 W.	4090820	657248	970	—	—	—
Fremont	PK-32	NW1/4SE1/4 sec. 7, T. 26 N., R. 2 W.	4088909	659322	875	—	—	—
Fremont	PK-34	NW1/4NE1/4 sec. 32, T. 26 N., R. 2 W.	4083013	660875	910	—	—	—

[Continued—CP_CDD, Potosi Dolomite/Derby-Doerun Dolomite (Derby-Doerun Dolomite is usage of Missouri Geological Survey, 1979); CDD_CD, Derby-Doerun Dolomite/Davis Formation; CD_CB, Davis Formation/Bonneterre Formation; CB_CL, Bonneterre Formation/Lamotte Sandstone; CD_YV, Davis Formation/Mesoproterozoic volcanic rocks; CB_YV, Bonneterre Formation/ Mesoproterozoic volcanic rocks; CB_YG, Bonneterre Formation / Mesoproterozoic plutonic rocks; CL_YV, Lamotte Sandstone/ Mesoproterozoic volcanic rocks; CL_YG, Lamotte Sandstone/ Mesoproterozoic plutonic rocks. BOTTOM_ELE, elevation of bottom of drill hole, in feet above mean sea level. "?" indicates value is unknown; "—" indicates no data]

CP_CDD	CDD_CD	CD_CB	CB_CL	CD_YV	CB_YV	CB_YG	CL_YV	CL_YG	BOTTOM_ELE	DRILL HOLE
–860	—	—	–1,774	—	—	—	—	—	–1,885	CF-1
–393	–518	–781	–1,150	—	—	—	–1,455	—	–1,580	BT-2
–371	–515	–721	–1,084	—	—	—	—	—	–1,084	801-163
401	332	84	–174	—	—	—	—	—	–364	HA-3
390	283	123	–202	—	—	—	—	—	–214	HA-13
390	285	116	–217	—	—	—	—	—	–218	HA-23
440	328	161	–165	—	—	—	—	—	–170	HA-24
491	379	195	–132	—	—	—	—	—	–139	HA-25
460	345	161	–177	—	—	—	—	—	–182	HA-29
575	486	327	—	—	72	—	—	—	61	BF-8
520	435	288	26	—	—	—	—	—	–4	BF-11-119-577
545	452	306	2	—	—	—	—	—	1	BF-116
589	501	359	86	—	—	—	—	—	81	BF-120
308	144	–152	—	—	—	—	—	—	–182	60W100
315	162	–123	—	—	—	—	—	—	–206	60W112
—	176	–144	—	—	—	—	—	—	–192	60W155
—	436	286	–13	—	—	—	—	—	–34	579
—	—	303	15	—	—	—	—	—	10	584
—	—	–805	—	—	—	—	—	—	–1,222	PK-21
—	–571	–673	–1,150	—	—	—	—	—	–1,158	PK-26
–477	–639	–834	–1,234	—	—	—	—	—	–1,239	PK-32
—	—	–661	–1,174	—	—	—	–1,178	—	–1,180	PK-34

Appendix 1. Summary of drill-hole data for the study area.—Continued

[Compiled from Kisvarsanyi (1975) and U.S. Bureau of Land Management (BLM) paper files. These data are not available as part of the Missouri Department of Natural Resources, Division of Geology and Land Survey well database (*http://www.dnr.mo.gov/env/wrc/logmain/index.html*) that is maintained by the Water Resources Center. Column headings: QUADRANGLE, name of USGS 7.5-minute quadrangle; DRILL HOLE, drill-hole identifier shown on map; LOCATION, section location, or better, in the Public Land Survey System; UTM_NORTH, northing in meters, Universal Transverse Mercator projection, NAD 83, Zone 15 North; UTM_EAST, easting in meters, Universal Transverse Mercator projection, NAD 83, Zone 15 North; COLLAR_ELE, collar elevation, in feet above mean sea level. Reported elevation of contacts in well, in feet above mean sea level: OR_OG, Roubidoux Formation/Gasconade Dolomite; OG_CE, Gasconade Dolomite/Eminence Dolomite; CE_CP, Eminence Dolomite/Potosi Dolomite]

QUADRANGLE	DRILL HOLE	LOCATION	UTM_NORTH	UTM_EAST	COLLAR_ELE	OR_OG	OG_CE	CE_CP
Fremont	PK-40	NW1/4SE1/4 sec. 2, T. 26 N., R. 3 W.	4090683	655995	975	—	—	—
Fremont	SF-1	NE1/4NE1/4 sec. 28, T. 26 N., R. 2 W.	4084866	663163	975	—	—	—
Fremont	SF-2	NW1/4SE1/4 sec. 27, T. 26 N., R. 2 W.	4084159	664112	910	—	—	—
Fremont	SF-28	SW1/4SE1/4 sec. 6, T. 26 N., R. 2 W.	4089942	659417	720	—	—	—
Fremont	SJ76W05	NW1/4NE1/4 sec. 11, T. 26 N., R. 2 W.	4089722	665822	631	—	—	—
Fremont	SJ77W02	SW1/4NE1/4 sec. 32, T. 27 N., R. 2 W.	4092563	661010	761	—	—	—
Fremont	SJ77W05	SW1/4SE1/4 sec. 23, T. 27 N., R. 3 W.	4095016	656130	808	—	—	—
Fremont	SJ77W06	NE1/4SW1/4 sec. 21, T. 27 N., R. 2 W.	4095220	662007	731	—	—	—
Fremont	SJ82W19	SE1/4SW1/4 sec. 23, T. 26 N., R. 3 W.	4085266	655875	790	—	—	—
Fremont	801-13	NW1/4SE1/4 sec. 20, T. 26 N., R. 2 W.	4085452	660901	905	—	—	—
Fremont	801-18	NW1/4NW1/4 sec. 32, T. 27 N., R. 2 W.	4092727	660276	780	—	—	—
Fremont	801-22AD	SE1/4NW1/4 sec. 30, T. 26 N., R. 2 W.	4084337	658889	980	—	—	—
Fremont	801-24	SE1/4SW1/4 sec. 29, T. 27 N., R. 2 W.	4093371	660643	730	—	—	—
Fremont	801-52AF	SE1/4SW1/4 sec. 30, T. 26 N., R. 2 W.	4083781	658853	990	—	—	—
Fremont	801-55	SW1/4NW1/4 sec. 36, T. 26 N., R. 3 W.	4083063	657132	795	—	—	—
Fremont	801-89	SE1/4SW1/4 sec. 30, T. 26 N., R. 2 W.	4083494	658976	1,000	—	—	—
Fremont	801-90	SE1/4NW1/4 sec. 31, T. 26 N., R. 2 W.	4082958	658853	970	—	—	—
Fremont	801-91	NE1/4NW1/4 sec. 31, T. 26 N., R. 2 W.	4083217	658877	980	—	—	—
Fremont	801-92	NE1/4SW1/4 sec. 31, T. 26 N., R. 2 W.	4082549	658867	990	—	—	—
Fremont	76W7	NW1/4SE1/4 sec. 9, T. 26 N., R. 2 W.	4088886	662506	760	—	470	140
Greer	801-15	SW1/4SE1/4 sec. 4, T. 25 N., R. 3 W.	4080525	652777	635	—	—	—
Greer	801-16	SE1/4NW1/4 sec. 18, T. 25 N., R. 3 W.	4077850	649271	905	—	—	—

[Continued—CP_CDD, Potosi Dolomite/Derby-Doerun Dolomite (Derby-Doerun Dolomite is usage of Missouri Geological Survey, 1979); CDD_CD, Derby-Doerun Dolomite/Davis Formation; CD_CB, Davis Formation/Bonneterre Formation; CB_CL, Bonneterre Formation/Lamotte Sandstone; CD_YV, Davis Formation/Mesoproterozoic volcanic rocks; CB_YV, Bonneterre Formation/ Mesoproterozoic volcanic rocks; CB_YG, Bonneterre Formation / Mesoproterozoic plutonic rocks; CL_YV, Lamotte Sandstone/ Mesoproterozoic volcanic rocks; CL_YG, Lamotte Sandstone/ Mesoproterozoic plutonic rocks. BOTTOM_ELE, elevation of bottom of drill hole, in feet above mean sea level. “?” indicates value is unknown; “—” indicates no data]

CP_CDD	CDD_CD	CD_CB	CB_CL	CD_YV	CB_YV	CB_YG	CL_YV	CL_YG	BOTTOM_ELE	DRILL HOLE
—	–842	–902	–1,175	—	—	—	—	—	–1,185	PK-40
—	–648	–771	–1,256	—	—	—	—	—	–1,325	SF-1
–548	–692	–834	–1,280	—	—	—	—	—	–1,312	SF-2
—	–667	–762	—	—	—	—	—	—	–1,212	SF-28
—	–665	–882	–1,180	—	—	—	—	—	–1,317	SJ76W05
—	–750	–799	—	—	—	—	—	—	–1,045	SJ77W02
—	–701	–742	–1,070	—	—	—	—	—	–1,104	SJ77W05
—	–621	–768	–1,135	—	—	—	—	—	–1,155	SJ77W06
—	–580	–756	–1,175	—	—	—	—	—	–1,458	SJ82W19
—	–515	–771	–1,163	—	—	—	—	—	–1,165	801-13
—	—	–738	–1,160	—	—	—	—	—	–1,183	801-18
–368	–465	–725	–1,124	—	—	—	—	—	–1,167	801-22AD
—	—	–729	–1,126	—	—	—	—	—	–1,137	801-24
–469	–535	–730	–1,198	—	—	—	—	—	–1,210	801-52AF
—	–512	–692	–1,136	—	—	—	—	—	–1,152	801-55
–471	–539	–765	—	—	—	—	—	—	–1,165	801-89
–507	–577	–813	–1,213	—	—	—	—	—	–1,248	801-90
–474	–545	–776	–1,175	—	—	—	–1,189	—	–1,193	801-91
–512	–598	–846	–1,224	—	—	—	—	—	–1,233	801-92
–398	–476	–576	–1,117	—	—	—	—	—	–1,155	76W7
–600	–659	–897	–1,334	—	—	—	—	—	—	801-15
–620	–682	–907	–1,334	—	—	—	—	—	—	801-16

Appendix 1. Summary of drill-hole data for the study area.—Continued

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QUADRANGLE	DRILL HOLE	LOCATION	UTM_NORTH	UTM_EAST	COLLAR_ELE	OR_OG	OG_CE	CE_CP
Greer	801-17	SW1/4NE1/4 sec. 21, T. 25 N., R. 3 W.	4076347	652644	590	—	—	—
Greer	801-51	SW1/4NE1/4 sec. 5, T. 25 N., R. 3 W.	4081147	651253	840	—	—	—
Greer	801-54-BK	SE1/4SW1/4 sec. 5, T. 25 N., R. 3 W.	4080459	650746	920	—	—	—
Greer	801-56	SW1/4SW1/4 sec. 12, T. 25 N., R. 4 W.	4078923	647041	920	—	—	—
Greer	801-57	NE1/4NW1/4 sec. 2, T. 25 N., R. 4 W.	4081524	645781	980	—	—	—
Greer	801-65-BC	SE1/4NW1/4 sec. 2, T. 25 N., R. 3 W.	4081278	655613	950	—	—	—
Greer	801-70	NE1/4SW1/4 sec. 15, T. 25 N., R. 3 W.	4077796	653861	640	—	—	—
Greer	801-85	NE1/4NW1/4, sec. 2, T. 25 N., R. 3 W.	4081544	655357	920	—	—	—
Greer	801-86	NE1/4NW1/4 sec. 21, T. 25 N., R. 3 W.	4076954	652151	790	—	—	—
Greer	801-87	SE1/4SW1/4 sec. 13, T. 25 N., R. 4 W.	4077409	647490	890	—	—	—
Greer	801-93	NE1/4SW1/4 sec. 24, T. 25 N., R. 4 W.	4075904	647531	580	—	—	—
Greer	801-94	SW1/4NE1/4 sec. 4, T. 25 N., R. 3 W.	4081215	652643	640	—	—	—
Greer	801-95	NE1/4SE1/4 sec. 9, T. 25 N., R. 3 W.	4079307	653080	830	—	—	—
Greer	801-106	SW1/4NE1/4 sec. 3, T. 25 N., R. 4 W.	4081232	644814	986	—	—	—
Greer	801-114	SE1/4SE1/4 sec. 19, T. 25 N., R. 3 W.	4075517	649926	925	—	—	—
Greer	801-117	NW1/4NW1/4 sec. 2, T. 25 N., R. 4 W.	4081534	645507	979	—	—	—
Greer	801-118	SE1/4NE1/4 sec. 3, T. 25 N., R. 4 W.	4081203	645240	960	—	—	—
Greer	801-119	NW1/4NW1/4 sec. 1, T. 25 N., R. 4 W.	4081589	647049	960	—	—	—
Greer	801-120	SE1/4SE1/4 sec. 12, T. 25 N., R. 4 W.	4079003	648254	920	—	—	—
Greer	801-122	SW1/4SE1/4 sec. 2, T. 25 N., R. 4 W.	4080589	646232	930	—	—	—
Greer	801-123	SW1/4NE1/4 sec. 6, T. 25 N., R. 3 W.	4081281	649434	935	—	—	–272
Greer	801-128	SE1/4NW1/4 sec. 12, T. 25 N., R. 4 W.	4079786	647637	940	—	—	—

[Continued—CP_CDD, Potosi Dolomite/Derby-Doerun Dolomite (Derby-Doerun Dolomite is usage of Missouri Geological Survey, 1979); CDD_CD, Derby-Doerun Dolomite/Davis Formation; CD_CB, Davis Formation/Bonneterre Formation; CB_CL, Bonneterre Formation/Lamotte Sandstone; CD_YV, Davis Formation/Mesoproterozoic volcanic rocks; CB_YV, Bonneterre Formation/ Mesoproterozoic volcanic rocks; CB_YG, Bonneterre Formation / Mesoproterozoic plutonic rocks; CL_YV, Lamotte Sandstone/ Mesoproterozoic volcanic rocks; CL_YG, Lamotte Sandstone/ Mesoproterozoic plutonic rocks. BOTTOM_ELE, elevation of bottom of drill hole, in feet above mean sea level. "?" indicates value is unknown; "—" indicates no data]

CP_CDD	CDD_CD	CD_CB	CB_CL	CD_YV	CB_YV	CB_YG	CL_YV	CL_YG	BOTTOM_ELE	DRILL HOLE
—	–581	–831	–1,334	—	—	—	—	—	—	801-17
–590	–652	–906	–1,388	—	—	—	—	—	–1,345	801-51
–550	–614	–899	–1,328	—	—	—	—	—	–1,347	801-54-BK
–531	–594	–877	–1,313	—	—	—	—	—	—	801-56
–507	–571	–864	–1,247	—	—	—	—	—	—	801-57
–547	–612	–849	–1,290	—	—	—	—	—	–1,307	801-65-BC
–519	–585	–823	–1,261	—	—	—	—	—	–1,286	801-70
–642	–701	–905	–1,342	—	—	—	—	—	–1,365	801-85
–623	–698	–908	–1,353	—	—	—	—	—	—	801-86
–606	–663	–932	–1,340	—	—	—	—	—	–1,358	801-87
–613	–710	–931	–1,368	—	—	—	—	—	–1,382	801-93
–639	–706	–919	–1,346	—	—	—	—	—	–1,362	801-94
–675	–753	–949	–1,387	—	—	—	—	—	–1,391	801-95
–547	–646	–855	–1,277	—	—	—	—	—	—	801-106
–639	–683	–949	–1,379	—	—	—	—	—	–1,403	801-114
–553	–647	–861	–1,261	—	—	—	—	—	—	801-117
–561	–673	–871	–1,286	—	—	—	—	—	—	801-118
–586	–653	–877	–1,286	—	—	—	—	—	–1,298	801-119
–608	–678	–902	–1,327	—	—	—	—	—	–1,348	801-120
–593	–703	–895	–1,312	—	—	—	—	—	—	801-122
–584	–682	–889	–1,314	—	—	—	—	—	–1,328	801-123
–604	–685	–899	–1,326	—	—	—	—	—	—	801-128

Appendix 1. Summary of drill-hole data for the study area.—Continued

[Compiled from Kisvarsanyi (1975) and U.S. Bureau of Land Management (BLM) paper files. These data are not available as part of the Missouri Department of Natural Resources, Division of Geology and Land Survey well database (*http://www.dnr.mo.gov/env/wrc/logmain/index.html*) that is maintained by the Water Resources Center. Column headings: QUADRANGLE, name of USGS 7.5-minute quadrangle; DRILL HOLE, drill-hole identifier shown on map; LOCATION, section location, or better, in the Public Land Survey System; UTM_NORTH, northing in meters, Universal Transverse Mercator projection, NAD 83, Zone 15 North; UTM_EAST, easting in meters, Universal Transverse Mercator projection, NAD 83, Zone 15 North; COLLAR_ELE, collar elevation, in feet above mean sea level. Reported elevation of contacts in well, in feet above mean sea level: OR_OG, Roubidoux Formation/Gasconade Dolomite; OG_CE, Gasconade Dolomite/Eminence Dolomite; CE_CP, Eminence Dolomite/Potosi Dolomite]

QUADRANGLE	DRILL HOLE	LOCATION	UTM_NORTH	UTM_EAST	COLLAR_ELE	OR_OG	OG_CE	CE_CP
Greer	801-129	SW1/4SW1/4 sec. 2, T. 25 N., R. 4 W.	4080401	645446	855	—	—	—
Greer	801-131	NW1/4NE1/4 sec. 11, T. 25 N., R. 4 W.	4079926	646381	890	—	—	—
Greer	801-148	NW1/4SW1/4 sec. 11, T. 25 N., R. 4 W.	4079218	645607	920	—	—	—
Greer	801-149	SW1/4SE1/4 sec. 3, T. 25 N., R. 4 W.	4080327	644853	910	—	—	—
Greer	801-156	SE1/4SE1/4 sec. 14, T. 25 N., R. 4 W.	4077174	646547	845	—	—	—
Greer	801-158	SE1/4SW1/4 sec. 11, T. 25 N., R. 4 W.	4078789	646067	927	—	—	—
Greer	82W3	NW1/4NW1/4 sec. 6, T. 25 N., R. 3 W.	4081570	648628	960	—	—	—
Greer	83W25	NW1/4NE1/4 sec. 2, T. 24 N., R. 3 W.	4071621	655673	860	—	—	—
Greer	84W40	SE1/4SE1/4 sec. 10, T. 25 N., R. 4 W.	4078893	645281	905	—	—	—
Greer	84W44	NE1/4SW1/4 sec. 2, T. 24 N., R. 3 W.	4070766	655279	805	—	—	—
Greer	85W9	NW1/4SE1/4 sec. 14, T. 25 N., R. 4 W.	4077702	646180	912	—	—	—
Greer	85W11	NW1/4NE1/4 sec. 14, T. 25 N., R. 4 W.	4078380	646129	919	—	—	—
Greer	85W15	NE1/4SE1/4 sec. 14, T. 25 N., R. 4 W.	4077645	646510	887	—	—	—
Greer	85W31	NE1/4SE1/4 sec. 14, T. 25 N., R. 4 W.	4077822	646886	644	—	—	—
Greer	86W2	NW1/4SE1/4 sec. 14, T. 25 N., R. 4 W.	4077673	646362	874	—	—	—
Greer	86W4	SW1/4SW1/4 sec. 11, T. 25 N., R. 4 W.	4078811	645479	873	—	—	—
Greer	86W6	SW1/4SW1/4 sec. 11, T. 25 N., R. 4 W.	4078723	645356	851	—	—	—
Greer	88W4	SE1/4SE1/4 sec. 24, T. 25 N., R. 4 W.	4075793	648473	920	—	—	—
Greer	88W5	SE1/4SE1/4, sec. 24, T. 25 N., R. 4 W.	4075505	648175	870	—	—	—
Greer	88W6	SW1/4NE1/4, sec. 14, T. 25 N., R. 4 W.	4078035	646167	910	—	—	—
Greer	89W1	SW1/4SW1/4 sec. 24, T. 25 N., R. 4 W.	4075612	647123	551	—	—	—
Handy	81W29	NW1/4SW1/4 sec. 7, T. 24 N., R. 1 W.	4068822	667872	760	—	—	—

[Continued—CP_CDD, Potosi Dolomite/Derby-Doerun Dolomite (Derby-Doerun Dolomite is usage of Missouri Geological Survey, 1979); CDD_CD, Derby-Doerun Dolomite/Davis Formation; CD_CB, Davis Formation/Bonneterre Formation; CB_CL, Bonneterre Formation/Lamotte Sandstone; CD_YV, Davis Formation/Mesoproterozoic volcanic rocks; CB_YV, Bonneterre Formation/ Mesoproterozoic volcanic rocks; CB_YG, Bonneterre Formation / Mesoproterozoic plutonic rocks; CL_YV, Lamotte Sandstone/ Mesoproterozoic volcanic rocks; CL_YG, Lamotte Sandstone/ Mesoproterozoic plutonic rocks. BOTTOM_ELE, elevation of bottom of drill hole, in feet above mean sea level. “?” indicates value is unknown; “—” indicates no data]

CP_CDD	CDD_CD	CD_CB	CB_CL	CD_YV	CB_YV	CB_YG	CL_YV	CL_YG	BOTTOM_ELE	DRILL HOLE
–549	–647	–848	–1,272	—	—	—	—	—	—	801-129
–591	–665	–884	–1,310	—	—	—	—	—	—	801-131
–608	–696	–899	–1,318	—	—	—	—	—	—	801-148
–578	–664	–864	–1,284	—	—	—	—	—	—	801-149
–576	–666	–879	–1,301	—	—	—	—	—	–1,327	801-156
–615	–683	–889	–1,319	—	—	—	—	—	—	801-158
–568	–659	–891	–1,312	—	—	—	—	—	–1,330	82W3
–684	–823	–1,077	–1,539	—	—	—	—	—	–1,546	83W25
—	–658	–890	–1,296	—	—	—	—	—	–1,322	84W40
—	–796	–1,049	–1,516	—	—	—	—	—	–1,532	84W44
—	–640	–914	–1,338	—	—	—	—	—	–1,354	85W9
—	–621	–936	–1,305	—	—	—	—	—	–1,318	85W11
—	–620	–913	–1,301	—	—	—	—	—	–1,310	85W15
—	–627	–932	–1,307	—	—	—	—	—	–1,314	85W31
–573	–661	–928	—	—	—	—	—	—	–1,306	86W2
—	–653	–920	–1,316	—	—	—	—	—	–1,324	86W4
—	–879	–921	–1,303	—	—	—	—	—	–1,315	86W6
–617	–730	–1,041	—	—	—	—	—	—	–1,396	88W4
–596	–651	–964	–1,361	—	—	—	—	—	–1,375	88W5
–590	–608	–927	–1,293	—	—	—	—	—	–1,311	88W6
—	–699	–979	–1,370	—	—	—	—	—	–1,384	89W1
—	–1,006	–1,216	–1,736	—	—	—	—	—	–1,780	81W29

Appendix 1. Summary of drill-hole data for the study area.—Continued

[Compiled from Kisvarsanyi (1975) and U.S. Bureau of Land Management (BLM) paper files. These data are not available as part of the Missouri Department of Natural Resources, Division of Geology and Land Survey well database (*http://www.dnr.mo.gov/env/wrc/logmain/index.html*) that is maintained by the Water Resources Center. Column headings: QUADRANGLE, name of USGS 7.5-minute quadrangle; DRILL HOLE, drill-hole identifier shown on map; LOCATION, section location, or better, in the Public Land Survey System; UTM_NORTH, northing in meters, Universal Transverse Mercator projection, NAD 83, Zone 15 North; UTM_EAST, easting in meters, Universal Transverse Mercator projection, NAD 83, Zone 15 North; COLLAR_ELE, collar elevation, in feet above mean sea level. Reported elevation of contacts in well, in feet above mean sea level: OR_OG, Roubidoux Formation/Gasconade Dolomite; OG_CE, Gasconade Dolomite/Eminence Dolomite; CE_CP, Eminence Dolomite/Potosi Dolomite]

QUADRANGLE	DRILL HOLE	LOCATION	UTM_NORTH	UTM_EAST	COLLAR_ELE	OR_OG	OG_CE	CE_CP
Handy	76W3	SE1/4NW1/4 sec. 13, T. 25 N., R. 1 W.	4077855	676726	484	—	—	–236
Handy	62W82	NE1/4SW1/4 sec. 5, T. 25 N., R. 1 W.	4080778	670230	600	—	—	—
Handy	312-A	SW1/4NW1/4 sec. 30, T. 25 N., R. 1 W.	4074729	668021	890	—	—	—
Jam Up Cave	MOSH-100	Sec. 7, T. 27 N., R. 5 W.	4098605	630027	?	—	—	—
Loggers Lake	HA-31	SE1/4NW1/4 sec. 4, T. 31 N., R. 3 W.	4141639	652510	1,210	—	—	845
Loggers Lake	HA-33	SW1/4SE1/4 sec. 5, T. 31 N., R. 3 W.	4140905	650931	1,170	—	—	710
Loggers Lake	HA-34	NW1/4NW1/4 sec. 4, T. 31 N., R. 3 W.	4142420	651840	1,000	—	—	—
Loggers Lake	HA-35	NW1/4NW1/4 sec. 12, T. 32 N., R. 4 W.	4150184	647488	1,210	—	—	930
Loggers Lake	HA-36	SE1/4NW1/4 sec. 4, T. 31 N., R. 3 W.	4141769	652247	1,100	—	—	1,065
Loggers Lake	HA-37	NE1/4NE1/4 sec. 4, T. 31 N., R. 3 W.	4142324	653324	1,150	—	—	965
Low Wassie	PK-9	SW1/4SW1/4 sec. 25, T. 27 N., R. 4 W.	4093501	646930	1,020	—	—	—
Low Wassie	PK-10	SW1/4NW1/4 sec. 12, T. 26 N., R. 4 W.	4089527	647057	1,000	—	—	—
Low Wassie	PK-13	SE1/4SE1/4 sec. 35, T. 27 N., R. 4 W.	4091567	646761	1,025	—	—	—
Low Wassie	PK-14	SW1/4NE1/4 sec. 9, T. 26 N., R. 3 W.	4089428	652941	1,005	—	—	—
Low Wassie	PK-15	NE1/4SE1/4 sec. 12, T. 26 N., R. 4 W.	4088885	648407	950	—	—	—
Low Wassie	PK-17	SE1/4SW1/4 sec. 12, T. 26 N., R. 4 W.	4088720	647585	990	—	—	—
Low Wassie	PK-18	NE1/4NW1/4 sec. 11, T. 26 N., R. 4 W.	4089841	645830	960	—	—	—
Low Wassie	PK-19	SE1/4NW1/4 sec. 28, T. 26 N., R. 3 W.	4084672	652533	925	—	—	—
Low Wassie	PK-20	SE1/4SW1/4 sec. 26, T. 26 N., R. 3 W.	4083833	655652	760	—	—	—
Low Wassie	PK-22	SE1/4SE1/4 sec. 11, T. 26 N., R. 4 W.	4088642	646798	935	—	—	—
Low Wassie	PK-23	SE1/4SW1/4 sec. 11, T. 26 N., R. 4 W.	4088700	645741	1,000	—	—	—
Low Wassie	PK-27	SW1/4SE1/4 sec. 35, T. 27 N., R. 4 W.	4091851	646086	1,000	—	—	—

[Continued—CP_CDD, Potosi Dolomite/Derby-Doerun Dolomite (Derby-Doerun Dolomite is usage of Missouri Geological Survey, 1979); CDD_CD, Derby-Doerun Dolomite/Davis Formation; CD_CB, Davis Formation/Bonneterre Formation; CB_CL, Bonneterre Formation/Lamotte Sandstone; CD_YV, Davis Formation/Mesoproterozoic volcanic rocks; CB_YV, Bonneterre Formation/ Mesoproterozoic volcanic rocks; CB_YG, Bonneterre Formation / Mesoproterozoic plutonic rocks; CL_YV, Lamotte Sandstone/ Mesoproterozoic volcanic rocks; CL_YG, Lamotte Sandstone/ Mesoproterozoic plutonic rocks. BOTTOM_ELE, elevation of bottom of drill hole, in feet above mean sea level. "?" indicates value is unknown; "—" indicates no data]

CP_CDD	CDD_CD	CD_CB	CB_CL	CD_YV	CB_YV	CB_YG	CL_YV	CL_YG	BOTTOM_ELE	DRILL HOLE
–796	–1,182	–1,206	–1,607	—	—	—	—	—	–1,683	76W3
—	–1,015	–1,071	–1,453	—	—	—	—	—	–1,988	62W82
–733	–1,001	–1,299	–1,705	—	—	—	—	—	–1,752	312-A
—	—	—	—	—	—	?	—	—	?	MOSH-100
510	465	335	—	—	—	43	—	—	38	HA-31
305	203	21	–307	—	—	—	—	—	–355	HA-33
575	449	275	–58	—	—	—	—	—	–69	HA-34
497	387	203	–120	—	—	—	—	—	–175	HA-35
650	539	374	—	—	—	136	—	—	97	HA-36
563	447	276	–51	—	—	—	—	—	–135	HA-37
—	—	–693	–1,085	—	—	—	—	—	–1,104	PK-9
—	–378	–581	—	—	—	—	—	—	–879	PK-10
—	—	–689	–1,045	—	—	—	—	—	–1,092	PK-13
—	–514	–715	–1,154	—	—	—	—	—	–1,159	PK-14
—	–502	–697	–1,097	—	—	—	—	—	–1,190	PK-15
—	–396	–596	–920	—	—	—	—	—	–924	PK-17
—	–327	–525	–647	—	—	—	—	—	–647	PK-18
—	–560	–751	–1,185	—	—	—	—	—	–1,199	PK-19
—	–553	–715	–1,195	—	—	—	—	—	–1,255	PK-20
–377	–470	–682	–1,074	—	—	—	—	—	–1,085	PK-22
–347	–488	–732	–1,112	—	—	—	—	—	–1,160	PK-23
–318	–509	–710	–1,095	—	—	—	—	—	–1,109	PK-27

Appendix 1. Summary of drill-hole data for the study area.—Continued

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QUADRANGLE	DRILL HOLE	LOCATION	UTM_NORTH	UTM_EAST	COLLAR_ELE	OR_OG	OG_CE	CE_CP
Low Wassie	PK-29	NW1/4NE1/4 sec. 28, T. 26 N., R. 3 W.	4085096	653006	1,016	—	—	—
Low Wassie	PK-30	NW1/4SW1/4 sec. 36, T. 27 N., R. 4 W.	4092156	647053	1,065	—	—	—
Low Wassie	PK-31	SW1/4NW1/4 sec. 6, T. 26 N., R. 3 W.	4090926	648732	990	—	—	—
Low Wassie	PK-33	NE1/4NE1/4 sec. 28, T. 26 N., R. 3 W.	4084820	653105	950	—	—	—
Low Wassie	PK-38	NE1/4SE1/4 sec. 29, T. 26 N., R. 3 W.	4084080	651771	875	—	—	—
Low Wassie	PK-41	NE1/4NE1/4 sec. 12, T. 26 N., R. 4 W.	4089691	648271	955	—	—	—
Low Wassie	PK-42	SE1/4NE1/4 sec. 12, T. 26 N., R. 4 W.	4089403	648082	915	—	—	—
Low Wassie	PK-43	SW1/4SW1/4 sec. 25, T. 27 N., R. 4 W.	4093267	646938	1,025	—	—	—
Low Wassie	PK-44	NW1/4SW1/4 sec. 25, T. 27 N., R. 4 W.	4093662	646946	1,010	—	—	—
Low Wassie	PK-46	SE1/4SW1/4 sec. 12, T. 26 N., R. 4 W.	4088404	647555	990	—	—	—
Low Wassie	SF-6	SE1/4SE1/4 sec. 34, T. 27 N., R. 3 W.	4092012	654969	985	—	—	—
Low Wassie	76W20	SW1/4NE1/4 sec. 22, T. 27 N., R. 3 W.	4095876	654316	951	—	—	—
Low Wassie	77W11	SW1/4NW1/4 sec. 21, T. 27 N., R. 3 W.	4095933	652237	901	—	—	—
Low Wassie	79W03	SW1/4NW1/4 sec. 34, T. 27 N., R. 3 W.	4092563	653706	871	—	—	—
Low Wassie	79W05	SW1/4NW1/4 sec. 35, T. 26 N., R. 3 W.	4082928	655265	706	—	—	—
Low Wassie	82W21	SW1/4SW1/4 sec. 22, T. 26 N., R. 3 W.	4085285	653623	970	—	—	—
Low Wassie	82W25	SW1/4NW1/4 sec. 22, T. 26 N., R. 3 W.	4086207	653776	965	—	—	—
Low Wassie	82W27	SE1/4NW1/4 sec. 29, T. 26 N., R. 3 W.	4084475	650916	890	—	—	—
Low Wassie	83W14	NW1/4SW1/4 sec. 22, T. 26 N., R. 3 W.	4085771	653628	985	—	465	95
Low Wassie	83W15	SE1/4SW1/4 sec. 22, T. 26 N., R. 3 W.	4085326	654138	785	—	—	—
Low Wassie	766-002	NW1/4SE1/4 sec. 6, T. 26 N., R. 3 W.	4090674	649499	1,022	—	—	—
Low Wassie	801-002	NW1/4SW1/4 sec. 33, T. 27 N., R. 3 W.	4092111	652133	1,006	—	—	—

[Continued—CP_CDD, Potosi Dolomite/Derby-Doerun Dolomite (Derby-Doerun Dolomite is usage of Missouri Geological Survey, 1979); CDD_CD, Derby-Doerun Dolomite/Davis Formation; CD_CB, Davis Formation/Bonneterre Formation; CB_CL, Bonneterre Formation/Lamotte Sandstone; CD_YV, Davis Formation/Mesoproterozoic volcanic rocks; CB_YV, Bonneterre Formation/ Mesoproterozoic volcanic rocks; CB_YG, Bonneterre Formation / Mesoproterozoic plutonic rocks; CL_YV, Lamotte Sandstone/ Mesoproterozoic volcanic rocks; CL_YG, Lamotte Sandstone/ Mesoproterozoic plutonic rocks. BOTTOM_ELE, elevation of bottom of drill hole, in feet above mean sea level. "?" indicates value is unknown; "—" indicates no data]

CP_CDD	CDD_CD	CD_CB	CB_CL	CD_YV	CB_YV	CB_YG	CL_YV	CL_YG	BOTTOM_ELE	DRILL HOLE
—	—	–504	–603	—	—	—	—	—	–640	PK-29
—	—	–677	–1,083	—	—	—	—	—	–1,096	PK-30
–392	–552	–711	–1,110	—	—	—	—	—	–1,124	PK-31
—	–398	–590	–798	—	—	—	—	—	–810	PK-33
—	–629	–845	–1,259	—	—	—	—	—	–1,297	PK-38
—	—	–675	–1,095	—	—	—	—	—	–1,119	PK-41
—	–497	–573	–1,075	—	—	—	—	—	–1,089	PK-42
—	–517	–709	–1,051	—	—	—	—	—	–1,108	PK-43
—	–540	–694	–1,033	—	—	—	—	—	–1,125	PK-44
—	–422	–625	—	—	–1,028	—	—	—	–1,045	PK-46
–428	–577	–730	–1,145	—	—	—	—	—	–1,176	SF-6
–304	–493	–636	–956	—	—	—	—	—	—	76W20
–442	–545	–763	–1,066	—	—	—	—	—	—	77W11
–494	–545	–859	–1,187	—	—	—	—	—	—	79W03
–566	–624	–947	–1,324	—	—	—	—	—	—	79W05
—	—	–487	—	—	–558	—	—	—	–558	82W21
—	–575	–778	–1,187	—	—	—	—	—	–1,206	82W25
–285	–605	–805	–1,233	—	—	—	—	—	–1,265	82W27
–297	–357	–497	—	—	–563	—	—	—	–565	83W14
–349	–488	–668	–1,107	—	—	—	–1,161	—	–1,176	83W15
–403	–473	–685	–1,090	—	—	—	—	—	—	766-002
–439	–489	–730	–1,125	—	—	—	—	—	—	801-002

Appendix 1. Summary of drill-hole data for the study area.—Continued

[Compiled from Kisvarsanyi (1975) and U.S. Bureau of Land Management (BLM) paper files. These data are not available as part of the Missouri Department of Natural Resources, Division of Geology and Land Survey well database (*http://www.dnr.mo.gov/env/wrc/logmain/index.html*) that is maintained by the Water Resources Center. Column headings: QUADRANGLE, name of USGS 7.5-minute quadrangle; DRILL HOLE, drill-hole identifier shown on map; LOCATION, section location, or better, in the Public Land Survey System; UTM_NORTH, northing in meters, Universal Transverse Mercator projection, NAD 83, Zone 15 North; UTM_EAST, easting in meters, Universal Transverse Mercator projection, NAD 83, Zone 15 North; COLLAR_ELE, collar elevation, in feet above mean sea level. Reported elevation of contacts in well, in feet above mean sea level: OR_OG, Roubidoux Formation/Gasconade Dolomite; OG_CE, Gasconade Dolomite/Eminence Dolomite; CE_CP, Eminence Dolomite/Potosi Dolomite]

QUADRANGLE	DRILL HOLE	LOCATION	UTM_NORTH	UTM_EAST	COLLAR_ELE	OR_OG	OG_CE	CE_CP
Low Wassie	801-003	NW1/4SE1/4 sec. 7, T. 26 N., R. 3 W.	4089070	649707	886	—	—	—
Low Wassie	801-005	NE1/4NE1/4 sec. 26, T. 26 N., R. 4 W.	4085005	646847	820	—	—	—
Low Wassie	801-009	SW1/4SE1/4 sec. 3, T. 26 N., R. 4 W.	4090222	644733	895	—	—	—
Low Wassie	801-011	SE1/4SE1/4 sec. 18, T. 26 N., R. 3 W.	4087120	650081	895	—	—	—
Low Wassie	801-19-W	SW1/4SW1/4 sec. 16, T. 26 N., R. 3 W.	4086811	651978	950	—	—	—
Low Wassie	801-20	NW1/4SE1/4 sec. 20, T. 26 N., R. 3 W.	4085659	651369	920	—	—	—
Low Wassie	801-21-AB	NE1/4SE1/4 sec. 21, T. 26 N., R. 3 W.	4085898	653459	975	—	—	—
Low Wassie	801-25-O	NE1/4NW1/4 sec. 17, T. 26 N., R. 3 W.	4088350	650826	940	—	—	—
Low Wassie	801-27-E	NW1/4NW1/4 sec. 14, T. 26 N., R. 4 W.	4088293	645630	990	—	—	—
Low Wassie	801-28-H	NE1/4NW1/4 sec. 13, T. 26 N., R. 4 W.	4088153	647477	985	—	—	—
Low Wassie	801-29-O	NW1/4NE1/4 sec. 19, T. 26 N., R. 3 W.	4086503	649489	920	—	—	—
Low Wassie	801-30-P	NW1/4SW1/4 sec. 19, T. 26 N., R. 3 W.	4085766	648563	880	—	—	—
Low Wassie	801-31-BW	NE1/4NE1/4 sec. 35, T. 26 N., R. 4 W.	4083191	646679	920	—	—	—
Low Wassie	801-32-N	NE1/4NW1/4 sec. 17, T. 26 N., R. 3 W.	4088058	650797	920	—	—	—
Low Wassie	801-33-1	SW1/4NE1/4 sec. 7, T. 26 N., R. 3 W.	4089428	649509	880	—	—	—
Low Wassie	801-34-X	SW1/4SW1/4 sec. 16, T. 26 N., R. 3 W.	4087025	651941	930	—	—	—
Low Wassie	801-35-R	NW1/4NE1/4 sec. 19, T. 26 N., R. 3 W.	4086589	649694	880	—	—	—
Low Wassie	801-36-V	NE1/4NE1/4 sec. 20, T. 26 N., R. 3 W.	4086540	651768	970	—	—	—
Low Wassie	801-37-U	NE1/4NE1/4 sec. 20, T. 26 N., R. 3 W.	4086367	651509	1,035	—	—	—
Low Wassie	801-38	SW1/4NW1/4 sec. 17, T. 26 N., R. 3 W.	4087778	650649	920	—	—	—
Low Wassie	801-39-L	NW1/4SW1/4 sec. 17, T. 26 N., R. 3 W.	4087552	650336	830	—	—	—
Low Wassie	801-40-AA	NE1/4SE1/4 sec. 21, T. 26 N., R. 3 W.	4085622	653471	980	—	—	—

[Continued—CP_CDD, Potosi Dolomite/Derby-Doerun Dolomite (Derby-Doerun Dolomite is usage of Missouri Geological Survey, 1979); CDD_CD, Derby-Doerun Dolomite/Davis Formation; CD_CB, Davis Formation/Bonneterre Formation; CB_CL, Bonneterre Formation/Lamotte Sandstone; CD_YV, Davis Formation/Mesoproterozoic volcanic rocks; CB_YV, Bonneterre Formation/ Mesoproterozoic volcanic rocks; CB_YG, Bonneterre Formation / Mesoproterozoic plutonic rocks; CL_YV, Lamotte Sandstone/ Mesoproterozoic volcanic rocks; CL_YG, Lamotte Sandstone/ Mesoproterozoic plutonic rocks. BOTTOM_ELE, elevation of bottom of drill hole, in feet above mean sea level. "?" indicates value is unknown; "—" indicates no data]

CP_CDD	CDD_CD	CD_CB	CB_CL	CD_YV	CB_YV	CB_YG	CL_YV	CL_YG	BOTTOM_ELE	DRILL HOLE
–398	–459	–677	–1,081	—	—	—	—	—	—	801-003
–525	–610	–802	–1,229	—	—	—	—	—	—	801-005
–487	–530	–740	–1,114	—	—	—	—	—	—	801-009
–335	–396	–587	—	—	—	—	—	—	—	801-011
–420	–477	–732	–1,113	—	—	—	—	—	–1,130	801-19-W
–426	–511	–705	—	—	–1,101	—	—	—	–1,106	801-20
–409	–467	–713	–1,110	—	—	—	–1,130	—	–1,136	801-21-AB
–411	–474	–686	–1,106	—	—	—	—	—	–1,108	801-25-O
–406	–526	–728	–1,116	—	—	—	—	—	–1,146	801-27-E
–445	–507	–714	–1,062	—	—	—	—	—	–1,070	801-28-H
–507	–574	–778	–1,153	—	—	—	—	—	–1,182	801-29-O
–486	–574	–782	–1,208	—	—	—	—	—	–1,215	801-30-P
–545	–622	–844	–1,260	—	—	—	—	—	–1,270	801-31-BW
–451	–485	–699	–1,111	—	—	—	—	—	–1,113	801-32-N
–407	–485	–690	–1,059	—	—	—	—	—	–1,097	801-33-1
–443	–481	–701	–1,182	—	—	—	—	—	–1,186	801-34-X
–456	–503	–716	–1,129	—	—	—	—	—	–1,140	801-35-R
–402	–427	–641	—	—	–1,010	—	—	—	–1,012	801-36-V
–379	–445	–650	—	—	–1,050	—	—	—	–1,055	801-37-U
–409	–483	–700	–1,137	—	—	—	—	—	–1,157	801-38
–362	–425	–631	–991	—	—	—	—	—	–1,002	801-39-L
–327	–385	–645	—	—	–934	—	—	—	–965	801-40-AA

Appendix 1. Summary of drill-hole data for the study area.—Continued

[Compiled from Kisvarsanyi (1975) and U.S. Bureau of Land Management (BLM) paper files. These data are not available as part of the Missouri Department of Natural Resources, Division of Geology and Land Survey well database (*http://www.dnr.mo.gov/env/wrc/logmain/index.html*) that is maintained by the Water Resources Center. Column headings: QUADRANGLE, name of USGS 7.5-minute quadrangle; DRILL HOLE, drill-hole identifier shown on map; LOCATION, section location, or better, in the Public Land Survey System; UTM_NORTH, northing in meters, Universal Transverse Mercator projection, NAD 83, Zone 15 North; UTM_EAST, easting in meters, Universal Transverse Mercator projection, NAD 83, Zone 15 North; COLLAR_ELE, collar elevation, in feet above mean sea level. Reported elevation of contacts in well, in feet above mean sea level: OR_OG, Roubidoux Formation/Gasconade Dolomite; OG_CE, Gasconade Dolomite/Eminence Dolomite; CE_CP, Eminence Dolomite/Potosi Dolomite]

QUADRANGLE	DRILL HOLE	LOCATION	UTM_NORTH	UTM_EAST	COLLAR_ELE	OR_OG	OG_CE	CE_CP
Low Wassie	801-41-Y	NW1/4SW1/4 sec. 16, T. 26 N., R. 3 W.	4087313	652179	960	—	—	—
Low Wassie	801-43-BA	SW1/4SE1/4 sec. 20, T. 26 N., R. 3 W.	4085330	651398	905	—	—	—
Low Wassie	801-44-T	SW1/4NE1/4 sec. 20, T. 26 N., R. 3 W.	4085989	651472	970	—	—	—
Low Wassie	801-45-G	NW1/4NW1/4 sec. 13, T. 26 N., R. 4 W.	4088248	647011	940	—	—	—
Low Wassie	801-46-F	NE1/4NE1/4 sec. 14, T. 26 N., R. 4 W.	4088157	646596	840	—	—	—
Low Wassie	801-48	SW1/4SE1/4 sec. 15, T. 26 N., R. 4 W.	4087058	644864	890	—	—	—
Low Wassie	801-49-J	NW1/4NE1/4 sec. 32, T. 27 N., R. 3 W.	4093098	651188	1,030	—	335	–75
Low Wassie	801-50-Z	SE1/4SE1/4 sec. 21, T. 26 N., R. 3 W.	4085466	653212	960	—	—	—
Low Wassie	801-58	NE1/4NE1/4 sec. 35, T. 26 N., R. 4 W.	4083387	646848	920	—	—	—
Low Wassie	801-59	SE1/4SW1/4 sec. 2, T. 26 N., R. 4 W.	4090016	645716	985	—	—	—
Low Wassie	801-60	SE1/4SE1/4 sec. 7, T. 26 N., R. 3 W.	4088745	650126	865	—	—	—
Low Wassie	801-61	SE1/4SE1/4 sec. 7, T. 26 N., R. 3 W.	4088432	649978	855	—	—	—
Low Wassie	801-63	NE1/4NE1/4 sec. 13, T. 26 N., R. 4 W.	4088153	648423	980	—	—	—
Low Wassie	801-66	SW1/4SW1/4 sec. 13, T. 26 N., R. 4 W.	4087243	647123	915	—	—	—
Low Wassie	801-67	NW1/4SW1/4 sec. 13, T. 26 N., R. 4 W.	4087313	647074	945	—	—	—
Low Wassie	801-68	NE1/4NE1/4 sec. 15, T. 26 N., R. 4 W.	4088161	644955	900	—	—	—
Low Wassie	801-69-CP	NW1/4SW1/4 sec. 19, T. 26 N., R. 3 W.	4085746	648682	885	—	—	—
Low Wassie	801-71	NW1/4NW1/4 sec. 17, T. 26 N., R. 3 W.	4087906	650661	930	—	—	—
Low Wassie	801-72	NE1/4NW1/4 sec. 17, T. 26 N., R. 3 W.	4088124	650822	930	—	—	—
Low Wassie	801-74	SE1/4NW1/4 sec. 19, T. 26 N., R. 3 W.	4086038	649003	900	—	—	—
Low Wassie	801-75	SE1/4NW1/4 sec. 19, T. 26 N., R. 3 W.	4086110	649212	830	—	—	—
Low Wassie	801-76	NE1/4NE1/4 sec. 27, T. 27 N., R. 4 W.	4094466	645112	1,090	—	—	—

[Continued—CP_CDD, Potosi Dolomite/Derby-Doerun Dolomite (Derby-Doerun Dolomite is usage of Missouri Geological Survey, 1979); CDD_CD, Derby-Doerun Dolomite/Davis Formation; CD_CB, Davis Formation/Bonneterre Formation; CB_CL, Bonneterre Formation/Lamotte Sandstone; CD_YV, Davis Formation/Mesoproterozoic volcanic rocks; CB_YV, Bonneterre Formation/ Mesoproterozoic volcanic rocks; CB_YG, Bonneterre Formation / Mesoproterozoic plutonic rocks; CL_YV, Lamotte Sandstone/ Mesoproterozoic volcanic rocks; CL_YG, Lamotte Sandstone/ Mesoproterozoic plutonic rocks. BOTTOM_ELE, elevation of bottom of drill hole, in feet above mean sea level. "?" indicates value is unknown; "—" indicates no data]

CP_CDD	CDD_CD	CD_CB	CB_CL	CD_YV	CB_YV	CB_YG	CL_YV	CL_YG	BOTTOM_ELE	DRILL HOLE
–458	–512	–725	–1,138	—		—	—	—	–1,160	801-41-Y
–463	–560	–762	–1,181	—		—	—	—	–1,201	801-43-BA
–327	–390	–578	—	—	–768	—	—	—	–814	801-44-T
–418	–487	–711	–1,059	—	—	—	—	—	–1,067	801-45-G
–454	–525	–737	–1,097	—	—	—	—	—	–1,127	801-46-F
–447	–578	–772	–1,122	—	—	—	—	—	–1,148	801-48
–425	–480	–682	–1,069	—	—	—	—	—	–1,107	801-49-J
–395	–460	–663	–1,090	—	—	—	—	—	–1,112	801-50-Z
–568	–650	–852	–1,268	—	—	—	—	—	–1,275	801-58
–332	–405	–642	–972	—	—	—	—	—	—	801-59
–432	–495	–685	–1,087	—	—	—	—	—	—	801-60
–429	–501	–694	–1,116	—	—	—	—	—	—	801-61
–368	–435	–652	—	—	–951	—	—	—	–992	801-63
–515	–586	–806	–1,205	—	—	—	—	—	–1,222	801-66
–472	–584	–783	–1,191	—	—	—	—	—	–1,103	801-67
–475	–552	–739	–1,133	—	—	—	—	—	–1,162	801-68
–497	–585	–790	–1,210	—	—	—	—	—	–1,232	801-69-CP
–424	–497	–703	–1,168	—	—	—	—	—	–1,170	801-71
–428	–500	–698	–1,123	—	—	—	—	—	–1,138	801-72
–493	–580	–782	–1,198	—	—	—	—	—	–1,208	801-74
–464	–549	–757	–1,171	—	—	—	—	—	–1,184	801-75
–448	–557	–715	–1,052	—	—	—	—	—	–1,062	801-76

Appendix 1. Summary of drill-hole data for the study area.—Continued

[Compiled from Kisvarsanyi (1975) and U.S. Bureau of Land Management (BLM) paper files. These data are not available as part of the Missouri Department of Natural Resources, Division of Geology and Land Survey well database (*http://www.dnr.mo.gov/env/wrc/logmain/index.html*) that is maintained by the Water Resources Center. Column headings: QUADRANGLE, name of USGS 7.5-minute quadrangle; DRILL HOLE, drill-hole identifier shown on map; LOCATION, section location, or better, in the Public Land Survey System; UTM_NORTH, northing in meters, Universal Transverse Mercator projection, NAD 83, Zone 15 North; UTM_EAST, easting in meters, Universal Transverse Mercator projection, NAD 83, Zone 15 North; COLLAR_ELE, collar elevation, in feet above mean sea level. Reported elevation of contacts in well, in feet above mean sea level: OR_OG, Roubidoux Formation/Gasconade Dolomite; OG_CE, Gasconade Dolomite/Eminence Dolomite; CE_CP, Eminence Dolomite/Potosi Dolomite]

QUADRANGLE	DRILL HOLE	LOCATION	UTM_NORTH	UTM_EAST	COLLAR_ELE	OR_OG	OG_CE	CE_CP
Low Wassie	801-77	SE1/4NW1/4 sec. 13, T. 26 N., R. 4 W.	4087927	647128	985	—	—	—
Low Wassie	801-78	SW1/4NW1/4 sec. 13, T. 26 N., R. 4 W.	4087495	647007	940	—	—	—
Low Wassie	801-79	NE1/4NE1/4 sec. 13, T. 26 N., R. 4 W.	4088155	648181	950	—	—	—
Low Wassie	801-80	SE1/4NW1/4 sec. 13, T. 26 N., R. 4 W.	4087918	647456	975	—	—	—
Low Wassie	801-81	NE1/4NW1/4 sec. 13, T. 26 N., R. 4 W.	4088069	647628	960	—	—	—
Low Wassie	801-82	NE1/4NW1/4 sec. 13, T. 26 N., R. 4 W.	4088164	647326	955	—	—	—
Low Wassie	801-83	NW1/4NW1/4 sec. 13, T. 26 N., R. 4 W.	4088190	647214	920	—	—	—
Low Wassie	801-84	NW1/4NE1/4 sec. 13, T. 26 N., R. 4 W.	4088138	647879	920	—	—	—
Low Wassie	801-88	NW1/4SW1/4 sec. 8, T. 26 N., R. 3 W.	4088846	650425	870	—	—	—
Low Wassie	801-96	NW1/4SE1/4 sec. 24, T. 26 N., R. 4 W.	4085531	647797	910	—	—	—
Low Wassie	801-97	SW1/4SE1/4 sec. 24, T. 26 N., R. 4 W.	4085212	647736	890	—	—	—
Low Wassie	801-98	NE1/4NW1/4 sec. 25, T. 26 N., R. 4 W.	4085000	647426	840	—	—	—
Low Wassie	801-99	NW1/4SW1/4 sec. 13, T. 26 N., R. 4 W.	4087275	647266	900	—	—	—
Low Wassie	801-100	NE1/4SW1/4 sec. 13, T. 26 N., R. 4 W.	4087538	647382	900	—	—	—
Low Wassie	801-101	SE1/4NW1/4 sec. 13, T. 26 N., R. 4 W.	4087789	647460	960	—	—	—
Low Wassie	801-102	NW1/4NE1/4 sec. 19, T. 26 N., R. 3 W.	4086377	649359	910	—	—	—
Low Wassie	801-103	NW1/4SW1/4 sec. 17, T. 26 N., R. 3 W.	4087530	650477	860	—	—	—
Low Wassie	801-104	NW1/4NE1/4 sec. 13, T. 26 N., R. 4 W.	4087905	647780	900	—	—	—
Low Wassie	801-107	NW1/4NE1/4 sec. 14, T. 26 N., R. 4 W.	4088181	646152	950	—	—	—
Low Wassie	801-108	NW1/4SW1/4 sec. 17, T. 26 N., R. 3 W.	4087470	650400	840	—	—	—
Low Wassie	801-109	SW1/4SE1/4 sec. 18, T. 26 N., R. 3 W.	4086981	650128	910	—	—	—
Low Wassie	801-110	SE1/4SE1/4 sec. 18, T. 26 N., R. 3 W.	4086800	649877	900	—	—	—

[Continued—CP_CDD, Potosi Dolomite/Derby-Doerun Dolomite (Derby-Doerun Dolomite is usage of Missouri Geological Survey, 1979); CDD_CD, Derby-Doerun Dolomite/Davis Formation; CD_CB, Davis Formation/Bonneterre Formation; CB_CL, Bonneterre Formation/Lamotte Sandstone; CD_YV, Davis Formation/Mesoproterozoic volcanic rocks; CB_YV, Bonneterre Formation/ Mesoproterozoic volcanic rocks; CB_YG, Bonneterre Formation / Mesoproterozoic plutonic rocks; CL_YV, Lamotte Sandstone/ Mesoproterozoic volcanic rocks; CL_YG, Lamotte Sandstone/ Mesoproterozoic plutonic rocks. BOTTOM_ELE, elevation of bottom of drill hole, in feet above mean sea level. "?" indicates value is unknown; "—" indicates no data]

CP_CDD	CDD_CD	CD_CB	CB_CL	CD_YV	CB_YV	CB_YG	CL_YV	CL_YG	BOTTOM_ELE	DRILL HOLE
–468	–537	–738	–1,080	—	—	—	—	—	–1,103	801-77
–502	–565	–778	–1,185	—	—	—	—	—	–1,195	801-78
–390	–451	–655	–1,051	—	—	—	—	—	–1,086	801-79
–475	–540	–738	–1,092	—	—	—	—	—	–1,103	801-80
–433	–507	–709	–1,107	—	—	—	—	—	–1,124	801-81
–419	–197	–700	–1,087	—	—	—	—	—	–1,103	801-82
–425	–489	–696	–1,048	—	—	—	—	—	–1,069	801-83
–431	–505	–713	–1,115	—	—	—	—	—	–1,133	801-84
–418	–481	–667	–1,077	—	—	—	—	—	–1,104	801-88
–519	–582	–785	–1,209	—	—	—	—	—	–1,218	801-96
–509	–596	–796	–1,214	—	—	—	—	—	–1,221	801-97
–545	–617	–830	–1,243	—	—	—	—	—	–1,256	801-98
–487	–546	–752	–1,170	—	—	—	—	—	–1,185	801-99
–481	–548	–745	–1,152	—	—	—	—	—	–1,173	801-100
–453	–528	–740	–1,145	—	—	—	—	—	–1,164	801-101
–480	–550	–739	–1,156	—	—	—	—	—	–1,178	801-102
–431	–496	–681	—	—	–985	—	—	—	–994	801-103
–434	–502	–708	–1,121	—	—	—	—	—	–1,158	801-104
–462	–549	–744	–1,156	—	—	—	—	—	–1,188	801-107
–381	–441	–633	—	—	–1,039	—	—	—	–1,042	801-108
–327	–402	–582	–821	—	—	—	–834	—	—	801-109
–396	–459	–650	–1,032	—	—	—	–1,042	—	—	801-110

Appendix 1. Summary of drill-hole data for the study area.—Continued

[Compiled from Kisvarsanyi (1975) and U.S. Bureau of Land Management (BLM) paper files. These data are not available as part of the Missouri Department of Natural Resources, Division of Geology and Land Survey well database (*http://www.dnr.mo.gov/env/wrc/logmain/index.html*) that is maintained by the Water Resources Center. Column headings: QUADRANGLE, name of USGS 7.5-minute quadrangle; DRILL HOLE, drill-hole identifier shown on map; LOCATION, section location, or better, in the Public Land Survey System; UTM_NORTH, northing in meters, Universal Transverse Mercator projection, NAD 83, Zone 15 North; UTM_EAST, easting in meters, Universal Transverse Mercator projection, NAD 83, Zone 15 North; COLLAR_ELE, collar elevation, in feet above mean sea level. Reported elevation of contacts in well, in feet above mean sea level: OR_OG, Roubidoux Formation/Gasconade Dolomite; OG_CE, Gasconade Dolomite/Eminence Dolomite; CE_CP, Eminence Dolomite/Potosi Dolomite]

QUADRANGLE	DRILL HOLE	LOCATION	UTM_NORTH	UTM_EAST	COLLAR_ELE	OR_OG	OG_CE	CE_CP
Low Wassie	801-111	NW1/4SW1/4 sec. 7, T. 26 N., R. 3 W.	4088859	648751	880	—	—	—
Low Wassie	801-112	SE1/4SW1/4 sec. 7, T. 26 N., R. 3 W.	4088406	649079	930	—	—	—
Low Wassie	801-115	NE1/4NW1/4 sec. 14, T. 26 N., R. 4 W.	4088244	645852	960	—	—	—
Low Wassie	801-116	NW1/4NE1/4 sec. 14, T. 26 N., R. 4 W.	4088177	646329	945	—	—	—
Low Wassie	801-121	NE1/4SW1/4 sec. 36, T. 26 N., R. 4 W.	4082406	647624	940	—	—	—
Low Wassie	801-124	SW1/4NE1/4 sec. 31, T. 26 N., R. 3 W.	4082890	649603	900	—	—	—
Low Wassie	801-125	SE1/4NE1/4 sec. 34, T. 27 N., R. 4 W.	4092687	645028	1,020	—	—	—
Low Wassie	801-126	NE1/4NE1/4 sec. 14, T. 26 N., R. 4 W.	4088242	646802	945	—	—	—
Low Wassie	801-127	NE1/4NW1/4 sec. 14, T. 26 N., R. 4 W.	4088242	645766	990	—	—	—
Low Wassie	801-132	SE1/4SW1/4 sec. 7, T. 26 N., R. 3 W.	4088888	649001	870	—	—	—
Low Wassie	801-135	SE1/4SE1/4 sec. 14, T. 26 N., R. 4 W.	4087054	646625	960	—	—	—
Low Wassie	801-136	NE1/4SW1/4 sec. 31, T. 26 N., R. 3 W.	4082333	649212	920	—	—	—
Low Wassie	801-137	SW1/4NE1/4 sec. 36, T. 26 N., R. 4 W.	4083082	647730	905	—	—	—
Low Wassie	801-138	SW1/4SW1/4 sec. 2, T. 26 N., R. 4 W.	4090046	645341	925	—	—	—
Low Wassie	801-142	SW1/4SE1/4 sec. 6, T. 26 N., R. 3 W.	4090167	649584	950	—	—	—
Low Wassie	801-143	NW1/4NW1/4 sec. 7, T. 26 N., R. 3 W.	4089860	648527	980	—	—	—
Low Wassie	801-144	NW1/4NE1/4 sec. 18, T. 26 N., R. 3 W.	4088256	649694	853	—	—	—
Low Wassie	801-145	NW1/4NE1/4 sec. 18, T. 26 N., R. 3 W.	4088289	649446	920	—	—	—
Low Wassie	801-146	SW1/4SE1/4 sec. 14, T. 26 N., R. 4 W.	4086864	646279	800	—	—	—
Low Wassie	801-147	SW1/4SW1/4 sec. 26, T. 26 N., R. 4 W.	4083565	645506	955	—	—	—
Low Wassie	801-155	NW1/4NW1/4 sec. 23, T. 26 N., R. 4 W.	4086495	645326	910	—	—	—
Low Wassie	801-157	NE1/4SE1/4 sec. 15, T. 26 N., R. 4 W.	4087506	644957	1,035	—	—	—

[Continued—CP_CDD, Potosi Dolomite/Derby-Doerun Dolomite (Derby-Doerun Dolomite is usage of Missouri Geological Survey, 1979); CDD_CD, Derby-Doerun Dolomite/Davis Formation; CD_CB, Davis Formation/Bonneterre Formation; CB_CL, Bonneterre Formation/Lamotte Sandstone; CD_YV, Davis Formation/Mesoproterozoic volcanic rocks; CB_YV, Bonneterre Formation/ Mesoproterozoic volcanic rocks; CB_YG, Bonneterre Formation / Mesoproterozoic plutonic rocks; CL_YV, Lamotte Sandstone/ Mesoproterozoic volcanic rocks; CL_YG, Lamotte Sandstone/ Mesoproterozoic plutonic rocks. BOTTOM_ELE, elevation of bottom of drill hole, in feet above mean sea level. "?" indicates value is unknown; "—" indicates no data]

CP_CDD	CDD_CD	CD_CB	CB_CL	CD_YV	CB_YV	CB_YG	CL_YV	CL_YG	BOTTOM_ELE	DRILL HOLE
–421	–482	–634	–1,060	—	—	—	—	—	—	801-111
–378	–434	–629	—	—	–948	—	—	—	—	801-112
–452	–535	–732	–1,132	—	—	—	—	—	–1,139	801-115
–448	–531	–729	–1,127	—	—	—	—	—	–1,155	801-116
–578	–675	–874	–1,299	—	—	—	—	—	–1,311	801-121
–585	–655	–871	—	—	—	—	—	—	—	801-124
–461	–535	–738	–1,116	—	—	—	—	—	–1,158	801-125
–451	–519	–720	–1,120	—	—	—	—	—	–1,133	801-126
–444	–532	–729	–1,129	—	—	—	—	—	–1,133	801-127
–413	–485	–686	–1,062	—	—	—	—	—	—	801-132
–496	–570	–768	–1,180	—	—	—	—	—	–1,200	801-135
–604	–677	–880	–1,308	—	—	—	—	—	—	801-136
–593	–663	–864	–1,281	—	—	—	—	—	–1,303	801-137
–415	–504	–708	–1,096	—	—	—	—	—	—	801-138
–440	–506	–702	–1,097	—	—	—	—	—	—	801-142
–408	–481	–678	–1,089	—	—	—	—	—	–1,108	801-143
–416	–485	–679	–1,095	—	—	—	—	—	—	801-144
–438	–504	–702	–1,120	—	—	—	—	—	—	801-145
–486	–554	–749	–1,150	—	—	—	—	—	–1,200	801-146
–551	–638	–852	–1,254	—	—	—	—	—	–1,261	801-147
–510	–590	–792	–1,195	—	—	—	—	—	–1,224	801-155
–472	–565	–757	–1,161	—	—	—	—	—	–1,193	801-157

Appendix 1. Summary of drill-hole data for the study area.—Continued

[Compiled from Kisvarsanyi (1975) and U.S. Bureau of Land Management (BLM) paper files. These data are not available as part of the Missouri Department of Natural Resources, Division of Geology and Land Survey well database (*http://www.dnr.mo.gov/env/wrc/logmain/index.html*) that is maintained by the Water Resources Center. Column headings: QUADRANGLE, name of USGS 7.5-minute quadrangle; DRILL HOLE, drill-hole identifier shown on map; LOCATION, section location, or better, in the Public Land Survey System; UTM_NORTH, northing in meters, Universal Transverse Mercator projection, NAD 83, Zone 15 North; UTM_EAST, easting in meters, Universal Transverse Mercator projection, NAD 83, Zone 15 North; COLLAR_ELE, collar elevation, in feet above mean sea level. Reported elevation of contacts in well, in feet above mean sea level: OR_OG, Roubidoux Formation/Gasconade Dolomite; OG_CE, Gasconade Dolomite/Eminence Dolomite; CE_CP, Eminence Dolomite/Potosi Dolomite]

QUADRANGLE	DRILL HOLE	LOCATION	UTM_NORTH	UTM_EAST	COLLAR_ELE	OR_OG	OG_CE	CE_CP
Low Wassie	801-166	NW1/4NE1/4 sec. 34, T. 27 N., R. 4 W.	4092813	644752	953	—	—	—
Midridge	AC-47	Sec. 18, T. 31 N., R. 2 W.	4137622	659164	1,200	—	—	895
Midridge	BLM-A-047523	NW1/4SW1/4 sec. 25, T. 31 N., R. 3 W.	4134901	656903	1,277	—	897	642
Midridge	CP-47	Sec. 20, T. 31 N., R. 2 W.	4137017	660260	1,236	—	—	901
Midridge	CP-48	Sec. 19, T. 31 N., R. 2 W.	4137145	659506	1,107	—	—	882
Midridge	CP-51	Sec. 20, T. 31 N., R. 2 W.	4136816	660555	1,232	—	—	922
Midridge	CP-52	Sec. 19, T. 31 N., R. 2 W.	4136378	659277	1,239	—	1,014	844
Midridge	CP-57	Sec. 19, T. 31 N., R. 2 W.	4137359	658951	1,177	—	—	902
Midridge	CP-58	Sec. 19, T. 31 N., R. 2 W.	4136797	659441	1,243	—	—	868
Midridge	CP-59	Sec. 20, T. 31 N., R. 2 W.	4136384	661356	1,197	—	—	957
Midridge	CP-63	Sec. 20, T. 31 N., R. 2 W.	4136548	660025	1,251	—	—	891
Midridge	CP-64	Sec. 20, T. 31 N., R. 2 W.	4136925	660744	1,184	—	—	954
Midridge	CP-65	Sec. 20, T. 31 N., R. 2 W.	4136923	660437	1,236	—	—	956
Midridge	CP-68	Sec. 20, T. 31 N., R. 2 W.	4136548	660808	1,174	—	—	944
Midridge	CP-72	Sec. 20, T. 31 N., R. 2 W.	4136961	660602	1,376	—	—	1,106
Midridge	CP-74	Sec. 19, T. 31 N., R. 2 W.	4137509	659933	1,133	—	—	863
Midridge	HA-15	NE1/4NE1/4 sec. 25, T. 31 N., R. 3 W.	4135722	658060	1,235	—	—	665
Midridge	HA-16	SE1/4SW1/4 sec. 30, T. 31 N., R. 2 W.	4134665	658857	1,160	—	840	620
Midridge	HA-17	SE1/4SE1/4 sec. 31, T. 32 N., R. 2 W.	4132956	659844	1,010	—	—	667
Midridge	HA-30	SW1/4SW1/4 sec. 35, T. 31 N., R. 3 W.	4132928	655142	1,190	1,010	—	698
Midridge	HA-32	NE1/4SE1/4 sec. 36, T. 31 N., R. 3 W.	4133307	658005	1,215	—	—	656
Piedmont Hollow	83W35	SW1/4SW1/4 sec. 3, T. 25 N., R. 4 W.	4080664	643885	735	—	—	–291

[Continued—CP_CDD, Potosi Dolomite/Derby-Doerun Dolomite (Derby-Doerun Dolomite is usage of Missouri Geological Survey, 1979); CDD_CD, Derby-Doerun Dolomite/Davis Formation; CD_CB, Davis Formation/Bonneterre Formation; CB_CL, Bonneterre Formation/Lamotte Sandstone; CD_YV, Davis Formation/Mesoproterozoic volcanic rocks; CB_YV, Bonneterre Formation/ Mesoproterozoic volcanic rocks; CB_YG, Bonneterre Formation / Mesoproterozoic plutonic rocks; CL_YV, Lamotte Sandstone/ Mesoproterozoic volcanic rocks; CL_YG, Lamotte Sandstone/ Mesoproterozoic plutonic rocks. BOTTOM_ELE, elevation of bottom of drill hole, in feet above mean sea level. “?” indicates value is unknown; “—” indicates no data]

CP_CDD	CDD_CD	CD_CB	CB_CL	CD_YV	CB_YV	CB_YG	CL_YV	CL_YG	BOTTOM_ELE	DRILL HOLE
–450	–530	–724	–1,098	—	—	—	—	—	–1,125	801-166
433	315	102	–175	—	—	—	—	—	–231	AC-47
205	109	–119	–386	—	—	—	—	—	–386	BLM-A-047523
450	345	106	–165	—	—	—	—	—	–225	CP-47
429	316	94	–180	—	—	—	—	—	–234	CP-48
482	381	153	–118	—	—	—	—	—	–170	CP-51
386	279	64	–221	—	—	—	—	—	–272	CP-52
446	338	121	–160	—	—	—	—	—	–209	CP-57
424	317	100	–181	—	—	—	—	—	–231	CP-58
498	395	159	–113	—	—	—	—	—	–159	CP-59
441	335	115	–158	—	—	—	—	—	–211	CP-63
508	406	192	–74	—	—	—	—	—	–87	CP-64
514	416	194	–60	—	—	—	—	–68	–72	CP-65
494	392	162	–109	—	—	—	—	—	–162	CP-68
659	559	338	34	—	—	—	—	—	0	CP-72
413	307	87	–190	—	—	—	—	—	–242	CP-74
215	109	–55	–375	—	—	—	—	—	–379	HA-15
211	98	–74	–396	—	—	—	—	—	–406	HA-16
217	104	–65	–387	—	—	—	—	—	–406	HA-17
238	103	–64	–371	—	—	—	—	—	–385	HA-30
206	54	–96	–401	—	—	—	—	—	–404	HA-32
–618	–866	–1,250	–1,252	—	—	—	—	—	–1,252	83W35

Appendix 1. Summary of drill-hole data for the study area.—Continued

[Compiled from Kisvarsanyi (1975) and U.S. Bureau of Land Management (BLM) paper files. These data are not available as part of the Missouri Department of Natural Resources, Division of Geology and Land Survey well database (*http://www.dnr.mo.gov/env/wrc/logmain/index.html*) that is maintained by the Water Resources Center. Column headings: QUADRANGLE, name of USGS 7.5-minute quadrangle; DRILL HOLE, drill-hole identifier shown on map; LOCATION, section location, or better, in the Public Land Survey System; UTM_NORTH, northing in meters, Universal Transverse Mercator projection, NAD 83, Zone 15 North; UTM_EAST, easting in meters, Universal Transverse Mercator projection, NAD 83, Zone 15 North; COLLAR_ELE, collar elevation, in feet above mean sea level. Reported elevation of contacts in well, in feet above mean sea level: OR_OG, Roubidoux Formation/Gasconade Dolomite; OG_CE, Gasconade Dolomite/Eminence Dolomite; CE_CP, Eminence Dolomite/Potosi Dolomite]

QUADRANGLE	DRILL HOLE	LOCATION	UTM_NORTH	UTM_EAST	COLLAR_ELE	OR_OG	OG_CE	CE_CP
Piedmont Hollow	82W7	NW1/4NW1/4 sec. 3, T. 25 N., R. 4 W.	4081503	643771	745	—	—	–521
Piedmont Hollow	83W22	NE1/4NW1/4 sec. 3, T. 25 N., R. 4 W.	4081749	644408	930	—	—	—
Stegall Mountain	801-001	Center sec. 14, T. 27 N., R. 3 W.	4097173	656006	900	—	—	—
Stegall Mountain	CT-6	NE1/4NW1/4 sec. 18, T. 27 N., R. 2 W.	4096442	659806	750	—	—	—
Stegall Mountain	CT-7	SW1/4SW1/4 sec. 7, T. 27 N., R. 2 W.	4098233	658856	829	—	—	—
The Sinks	HA-26	SE1/4SE1/4 sec. 15, T. 31 N., R. 3 W.	4137687	654704	1,210	—	—	1,060
The Sinks	HA-27	NE1/4NE1/4 sec. 21, T. 31 N., R. 3 W.	4137293	653206	910	—	—	865
The Sinks	HA-28	SW1/4 sec. 31, T. 31 N., R. 3 W.	4133095	649037	1,060	927	—	577
Van Buren North	PD-15-1	NE1/4SE1/4 sec. 15, T. 27 N., R. 1 W.	4097519	672564	706	—	—	—
Van Buren North	SH-12	SE1/4NW1/4 sec. 7, T. 28 N., R. 1 W.	4109114	668774	560	—	—	—
Van Buren North	SH-35	SW1/4NW1/4 sec. 14, T. 28 N., R. 1 W.	4108429	674564	580	—	—	—
Van Buren North	SH-4	NE1/4NW1/4 sec. 21, T. 28 N., R. 1 W.	4107269	672564	520	—	—	—
Van Buren North	CT-3	SE1/4NW1/4 sec. 33, T. 28 N., R. 1 W.	4102929	671786	510	—	—	255
Van Buren South	PK-16	SW1/4NE1/4 sec. 36, T. 26 N., R. 2 W.	4082725	667440	860	—	—	—
Van Buren South	SF-20	SW1/4SE1/4 sec. 1, T. 26 N., R. 2 W.	4090123	667281	800	—	—	–260
Van Buren South	SF-21	NE1/4NW1/4 sec. 4, T. 26 N., R. 1 W.	4091724	671846	620	—	—	–440
Van Buren South	SF-22	SW1/4SW1/4 sec. 3, T. 26 N., R. 1 W.	4090165	673037	840	—	—	–360
Van Buren South	SF-27	NW1/4SW1/4 sec. 11, T. 26 N., R. 1 W.	4089328	674773	955	—	—	–295
Van Buren South	SF-33	NW1/4SE1/4 sec. 10, T. 26 N., R. 1 W.	4089105	673772	900	—	—	–200
Van Buren South	SF-36	SE1/4NW1/4 sec. 10, T. 26 N., R. 1 W.	4089548	673441	885	—	—	–493
Van Buren South	VB-23	Center sec. 2, T. 26 N., R. 1 W.	4091200	675242	580	—	—	—
Van Buren South	VB-24	Center sec. 3, T. 26 N., R. 1 W.	4091054	673603	780	—	—	—

[Continued—CP_CDD, Potosi Dolomite/Derby-Doerun Dolomite (Derby-Doerun Dolomite is usage of Missouri Geological Survey, 1979); CDD_CD, Derby-Doerun Dolomite/Davis Formation; CD_CB, Davis Formation/Bonneterre Formation; CB_CL, Bonneterre Formation/Lamotte Sandstone; CD_YV, Davis Formation/Mesoproterozoic volcanic rocks; CB_YV, Bonneterre Formation/ Mesoproterozoic volcanic rocks; CB_YG, Bonneterre Formation / Mesoproterozoic plutonic rocks; CL_YV, Lamotte Sandstone/ Mesoproterozoic volcanic rocks; CL_YG, Lamotte Sandstone/ Mesoproterozoic plutonic rocks. BOTTOM_ELE, elevation of bottom of drill hole, in feet above mean sea level. “?” indicates value is unknown; “—” indicates no data]

CP_CDD	CDD_CD	CD_CB	CB_CL	CD_YV	CB_YV	CB_YG	CL_YV	CL_YG	BOTTOM_ELE	DRILL HOLE
—	–873	–1,215	–1,277	—	—	—	—	—	–1,277	82W7
–600	–863	–1,211	–1,252	—	—	—	—	—	–1,252	83W22
–271	–330	–526	—	—	–650	—	—	—	–655	801-001
—	—	—	—	—	—	—	—	–1,289	–1,292	CT-6
—	—	—	—	—	—	—	—	–716	–770	CT-7
—	—	—	—	—	—	—	—	—	560	HA-26
—	—	—	—	—	—	—	—	—	358	HA-27
157	45	–98	–402	—	—	—	—	—	–408	HA-28
–126	–299	–430	–630	—	—	—	—	–632	–658	PD-15-1
—	—	—	—	—	—	—	—	–908	–915	SH-12
—	—	—	—	—	—	—	—	–800	–804	SH-35
—	—	—	—	—	—	—	—	–838	–860	SH-4
–160	–330	–505	–795	—	—	—	—	—	–806	CT-3
—	—	–858	–1,305	—	—	—	—	—	–1,310	PK-16
–422	–539	–682	—	—	—	—	—	–1,134	–1,144	SF-20
–497	–599	–793	–1,287	—	—	—	—	—	–1,356	SF-21
–519	–634	–790	–1,320	—	—	—	—	—	–1,508	SF-22
–589	–779	–838	–1,349	—	—	—	—	—	–1,533	SF-27
–516	–737	–793	–1,305	—	—	—	—	—	–1,454	SF-33
–546	–729	–795	–1,298	—	—	—	—	—	–1,382	SF-36
–744	–845	–878	–1,291	—	—	—	—	–1,568	–1,575	VB-23
—	—	—	–1,271	—	—	—	—	—	–1,346	VB-24

Appendix 1. Summary of drill-hole data for the study area.—Continued

[Compiled from Kisvarsanyi (1975) and U.S. Bureau of Land Management (BLM) paper files. These data are not available as part of the Missouri Department of Natural Resources, Division of Geology and Land Survey well database (*http://www.dnr.mo.gov/env/wrc/logmain/index.html*) that is maintained by the Water Resources Center. Column headings: QUADRANGLE, name of USGS 7.5-minute quadrangle; DRILL HOLE, drill-hole identifier shown on map; LOCATION, section location, or better, in the Public Land Survey System; UTM_NORTH, northing in meters, Universal Transverse Mercator projection, NAD 83, Zone 15 North; UTM_EAST, easting in meters, Universal Transverse Mercator projection, NAD 83, Zone 15 North; COLLAR_ELE, collar elevation, in feet above mean sea level. Reported elevation of contacts in well, in feet above mean sea level: OR_OG, Roubidoux Formation/Gasconade Dolomite; OG_CE, Gasconade Dolomite/Eminence Dolomite; CE_CP, Eminence Dolomite/Potosi Dolomite]

QUADRANGLE	DRILL HOLE	LOCATION	UTM_NORTH	UTM_EAST	COLLAR_ELE	OR_OG	OG_CE	CE_CP
West Plains	215	SE1/4NW1/4 sec. 35, T. 24 N., R. 8 W.	4062889	605677	924	479	—	—
Wilderness	MOSS	Center SW1/4 sec. 22, T. 25 N., R. 2 W.	4075639	663515	?	—	—	—
Wilderness	801-007	NE1/4NE1/4 sec. 4, T. 25 N., R. 2 W.	4081346	663102	780	—	—	—
Wilderness	801-26-AL	SE1/4SW1/4 sec. 31, T. 26 N., R. 2 W.	4081990	658890	975	—	—	—
Wilderness	801-53-AK	NE1/4SW1/4 sec. 31, T. 26 N., R. 2 W.	4082247	658755	985	—	—	—
Wilderness	801-62-AY	SE1/4SE1/4 sec. 2, T. 25 N., R. 3 W.	4080317	656527	990	—	—	—
Wilderness	801-73	NE1/4NE1/4 sec. 12, T. 25 N., R. 3 W.	4080163	658205	990	—	—	—
Wilderness	801-105	NE1/4NW1/4 sec. 6, T. 25 N., R. 2 W.	4081753	658759	970	—	—	—
Wilderness	801-150	SE1/4SW1/4 sec. 31, T. 26 N., R. 2 W.	4081869	658775	975	—	—	—
Wilderness	88W3	SE1/4NW1/4 sec. 1, T. 24 N., R. 3 W.	4071091	656850	810	—	—	—
Wilderness	88W11	SW1/4SE1/4 sec. 1, T. 24 N., R. 3 W.	4070344	657090	760	—	—	—
Wilderness	89W22	SE1/4NE1/4 sec. 1, T. 24 N., R. 3 W.	4071331	657747	830	—	—	–522
Wilderness	90W3	SE1/4NW1/4 sec. 6, T. 24 N., R. 2 W.	4071061	658582	850	—	—	–146
Wilderness	111-A	SW1/4NW1/4 sec. 13, T. 25 N., R. 2 W.	4078631	666370	800	—	—	—
Wilderness	112-A	SE1/4SE1/4 sec. 11, T. 25 N., R. 2 W.	4078644	666427	680	—	—	—
Wilderness	112-B	NW1/4SW1/4 sec. 12, T. 25 N., R. 2 W.	4079289	666419	830	—	—	—
Wilderness	112-C	NW1/4NW1/4 sec. 12, T. 25 N., R. 2 W.	4079925	666447	845	—	—	—
Wilderness	112-D	SW1/4SW1/4 sec. 12, T. 25 N., R. 2 W.	4078868	666431	820	—	—	—
Wilderness	112-E	SW1/4NW1/4 sec. 12, T. 25 N., R. 2 W.	4079533	666447	700	—	—	—
Wilderness	112-G	SW1/4SW1/4 sec. 12, T. 25 N., R. 2 W.	4079031	666439	830	—	—	—
Wilderness	113-A	SW1/4SW1/4 sec. 1, T. 25 N., R. 2 W.	4080561	666447	865	—	—	—
Wilderness	122-A	NE1/4SE1/4 sec. 11, T. 25 N., R. 2 W.	4079121	666104	865	—	—	—

[Continued—CP_CDD, Potosi Dolomite/Derby-Doerun Dolomite (Derby-Doerun Dolomite is usage of Missouri Geological Survey, 1979); CDD_CD, Derby-Doerun Dolomite/Davis Formation; CD_CB, Davis Formation/Bonneterre Formation; CB_CL, Bonneterre Formation/Lamotte Sandstone; CD_YV, Davis Formation/Mesoproterozoic volcanic rocks; CB_YV, Bonneterre Formation/ Mesoproterozoic volcanic rocks; CB_YG, Bonneterre Formation / Mesoproterozoic plutonic rocks; CL_YV, Lamotte Sandstone/ Mesoproterozoic volcanic rocks; CL_YG, Lamotte Sandstone/ Mesoproterozoic plutonic rocks. BOTTOM_ELE, elevation of bottom of drill hole, in feet above mean sea level. "?" indicates value is unknown; "—" indicates no data]

CP_CDD	CDD_CD	CD_CB	CB_CL	CD_YV	CB_YV	CB_YG	CL_YV	CL_YG	BOTTOM_ELE	DRILL HOLE
—	—	—	—	—	—	—	—	—	419	215
—	—	—	—	—	—	—	–1,450	—	—	MOSS
—	–701	–920	–1,308	—	—	—	—	—	–1,345	801-007
–430	–494	–727	–939	—	—	—	—	—	–949	801-26-AL
–467	–517	–772	–1,162	—	—	—	—	—	–1,184	801-53-AK
–577	–647	–885	–1,326	—	—	—	—	—	–1,335	801-62-AY
–572	–643	–856	–1,353	—	—	—	—	—	–1,355	801-73
–497	–567	–784	–1,190	—	—	—	–1,223	—	–1,234	801-105
—	–484	–687		—	–885	—	—	—	–895	801-150
—	–878	–1,132	–1,574	—	—	—	—	—	–1,590	88W3
–871	–931	–1,239	–1,621	—	—	—	—	—	–1,640	88W11
–1,015	–1,153	–1,407		—	—	—	—	—	–1,760	89W22
–741	–841	–1,151	–1,599	—	—	—	—	—	–1,654	90W3
—	–758	–997	—	—	–1,173	—	—	—	–1,327	111-A
—	–728	–934	—	—	–1,173	—	—	—	–1,175	112-A
–577	–698	–903	—	—	–1,070	—	—	—	–1,075	112-B
—	–758	–967	—	—	—	—	—	—	–1,295	112-C
–580	–705	–923	—	—	–1,154	—	—	—	–1,158	112-D
—	–665	–864	—	—	–1,049	—	—	—	–1,051	112-E
–567	–706	–878	—	—	–1,149	—	—	—	–1,157	112-G
–578	–724	–919	—	—	–1,163	—	—	—	–1,165	113-A
–627	–772	–984	–1,325	—	—	—	—	—	–1,425	122-A

Appendix 1. Summary of drill-hole data for the study area.—Continued

[Compiled from Kisvarsanyi (1975) and U.S. Bureau of Land Management (BLM) paper files. These data are not available as part of the Missouri Department of Natural Resources, Division of Geology and Land Survey well database (*http://www.dnr.mo.gov/env/wrc/logmain/index.html*) that is maintained by the Water Resources Center. Column headings: QUADRANGLE, name of USGS 7.5-minute quadrangle; DRILL HOLE, drill-hole identifier shown on map; LOCATION, section location, or better, in the Public Land Survey System; UTM_NORTH, northing in meters, Universal Transverse Mercator projection, NAD 83, Zone 15 North; UTM_EAST, easting in meters, Universal Transverse Mercator projection, NAD 83, Zone 15 North; COLLAR_ELE, collar elevation, in feet above mean sea level. Reported elevation of contacts in well, in feet above mean sea level: OR_OG, Roubidoux Formation/Gasconade Dolomite; OG_CE, Gasconade Dolomite/Eminence Dolomite; CE_CP, Eminence Dolomite/Potosi Dolomite]

QUADRANGLE	DRILL HOLE	LOCATION	UTM_NORTH	UTM_EAST	COLLAR_ELE	OR_OG	OG_CE	CE_CP
Wilderness	STH-1	NE1/4SE1/4 sec. 26, T. 25 N., R. 2 W.	4074180	666263	920	—	—	—
Wilderness	STH-2	NE1/4NW1/4 sec. 25, T. 25 N., R. 2 W.	4075224	666843	910	—	—	—
Wilderness	81W15	NW1/4SW1/4 sec. 3, T. 24 N., R. 2 W.	4070881	663195	806	—	—	–54
Wilderness	164B	SE1/4SE1/4 sec. 31, T. 26 N., R. 2 W.	4082196	659597	940	—	—	—
Wilderness	164A	SW1/4SE1/4 sec. 31, T. 26 N., R. 2 W.	4082170	659265	930	—	—	—
Winona	PK-8	SW1/4 sec. 6, T. 27 N., R. 3 W.	4100376	648993	1,125	—	—	—
Winona	PK-12	SE1/4 sec. 1, T. 27 N., R. 4 W.	4100223	648068	1,110	—	—	—
Winona	PK-28	NE1/4 sec. 11, T. 27 N., R. 4 W.	4099442	646285	1,050	—	—	—
Winona	PK-35	NW1/4 sec. 7, T. 27 N., R. 3 W.	4099214	649116	995	—	—	—
Winona	SF-25	SE1/4 sec. 16, T. 27 N., R. 3 W.	4096434	652828	950	—	—	—
Winona	SJ77W03	SE1/4SW1/4 sec. 7, T. 27 N., R. 3 W.	4098424	649281	1,023	—	—	—
Winona	SJ77W08	SW1/4SW1/4 sec. 36, T. 28 N., R. 4 W.	4101491	647263	1,109	—	—	—
Winona	SJ81W09	SE1/4SE1/4 sec. 36, T. 28 N., R. 4 W.	4101513	648268	1,115	—	—	—
Winona	SJ83W06	NW1/4NW1/4 sec. 17, T. 27 N., R. 3 W.	4098039	650653	985	—	—	—
Winona	SJ83W09	SE1/4NE1/4 sec. 27, T. 28 N., R. 4 W.	4103756	645156	1,050	—	—	—
Winona	SJ83W44	SE1/4NW1/4 sec. 27, T. 28 N., R. 4 W.	4103773	644544	1,040	—	—	—
Winona	WN-21	NE1/4 sec. 7, T. 27 N., R. 3 W.	4099430	649636	1,080	—	—	—
Winona	WN-22	NW1/4 sec. 8, T. 27 N., R. 3 W.	4099558	650450	1,060	—	—	—
Winona	WN-23	NW1/4 sec. 8, T. 27 N., R. 3 W.	4098911	650750	1,065	—	—	—
Winona	27N3W8-1	SW1/4 sec. 8, T. 27 N., R. 3 W.	4098684	651074	1,055	—	645	342
Winona	27N3W8-2	SE1/4 sec. 8, T. 27 N., R. 3 W.	4098108	651880	918	—	643	326
Winona	27N3W17-1	NE1/4 sec. 17, T. 27 N., R. 3 W.	4097352	651177	921	—	591	251
Winona	27N4W1-1	SW1/4 sec. 1, T. 27 N., R. 4 W.	4100425	647686	1,070	—	655	333
Winona	SH-23	NE1/4NE1/4 sec. 22, T. 28 N., R. 4 W.	4105839	645270	871	—	—	—

[Continued—CP_CDD, Potosi Dolomite/Derby-Doerun Dolomite (Derby-Doerun Dolomite is usage of Missouri Geological Survey, 1979); CDD_CD, Derby-Doerun Dolomite/Davis Formation; CD_CB, Davis Formation/Bonneterre Formation; CB_CL, Bonneterre Formation/Lamotte Sandstone; CD_YV, Davis Formation/Mesoproterozoic volcanic rocks; CB_YV, Bonneterre Formation/ Mesoproterozoic volcanic rocks; CB_YG, Bonneterre Formation / Mesoproterozoic plutonic rocks; CL_YV, Lamotte Sandstone/ Mesoproterozoic volcanic rocks; CL_YG, Lamotte Sandstone/ Mesoproterozoic plutonic rocks. BOTTOM_ELE, elevation of bottom of drill hole, in feet above mean sea level. "?" indicates value is unknown; "—" indicates no data]

CP_CDD	CDD_CD	CD_CB	CB_CL	CD_YV	CB_YV	CB_YG	CL_YV	CL_YG	BOTTOM_ELE	DRILL HOLE
–857	–1,052	–1,204	–1,614	—	—	—	—	—	–1,667	STH-1
–867	–988	–1,184	–1,788	—	—	—	—	—	–1,831	STH-2
–842	–981	–1,129	—	—	—	—	—	—	–1,630	81W15
–434	–579	–737	–1,257	—	—	—	—	—	–1,419	164B
–447	–575	–734	–1,241	—	—	—	—	–1,311	–1,322	164A
—	—	–107	—	—	–131	—	—	—	–134	PK-8
—	—	–445	—	—	–855	—	—	—	–866	PK-12
—	—	–557	–950	—	—	—	—	—	–967	PK-28
—	—	–469	–915	—	—	—	—	—	–960	PK-35
—	–550	–606	–1,023	—	—	—	—	—	–1,054	SF-25
—	–414	–601	–830	—	—	—	—	—	—	SJ77W03
—	–281	–414	–648	—	—	—	–658	—	—	SJ77W08
—	–256	–422	—	—	—	—	—	—	—	SJ81W09
—	–447	–618	–904	—	—	—	–967	—	—	SJ83W06
—	–200	–350	–502	—	—	—	–541	—	–548	SJ83W09
—	–215	–457	–668	—	—	—	–714	—	–746	SJ83W44
—	—	–278	—	—	–467	—	—	—	–483	WN-21
—	—	–439	—	—	–777	—	—	—	–843	WN-22
–91	—	–448	–764	—	—	—	–782	—	–805	WN-23
–50	–355	—	—	–382	—	—	—	—	–423	27N3W8-1
–52	–400	–480	—	—	–639	—	—	—	–645	27N3W8-2
–194	–404	–491	–939	—	—	—	–989	—	–997	27N3W17-1
–113	–397	–472	–938	—	—	—	–996	—	–1,016	27N4W1-1
—	—	—	—	—	–613	—	—	—	–622	SH-23

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