GEOLOGIC MAP OF THE EMINENCE QUADRANGLE, SHANNON COUNTY, MISSOURI

By
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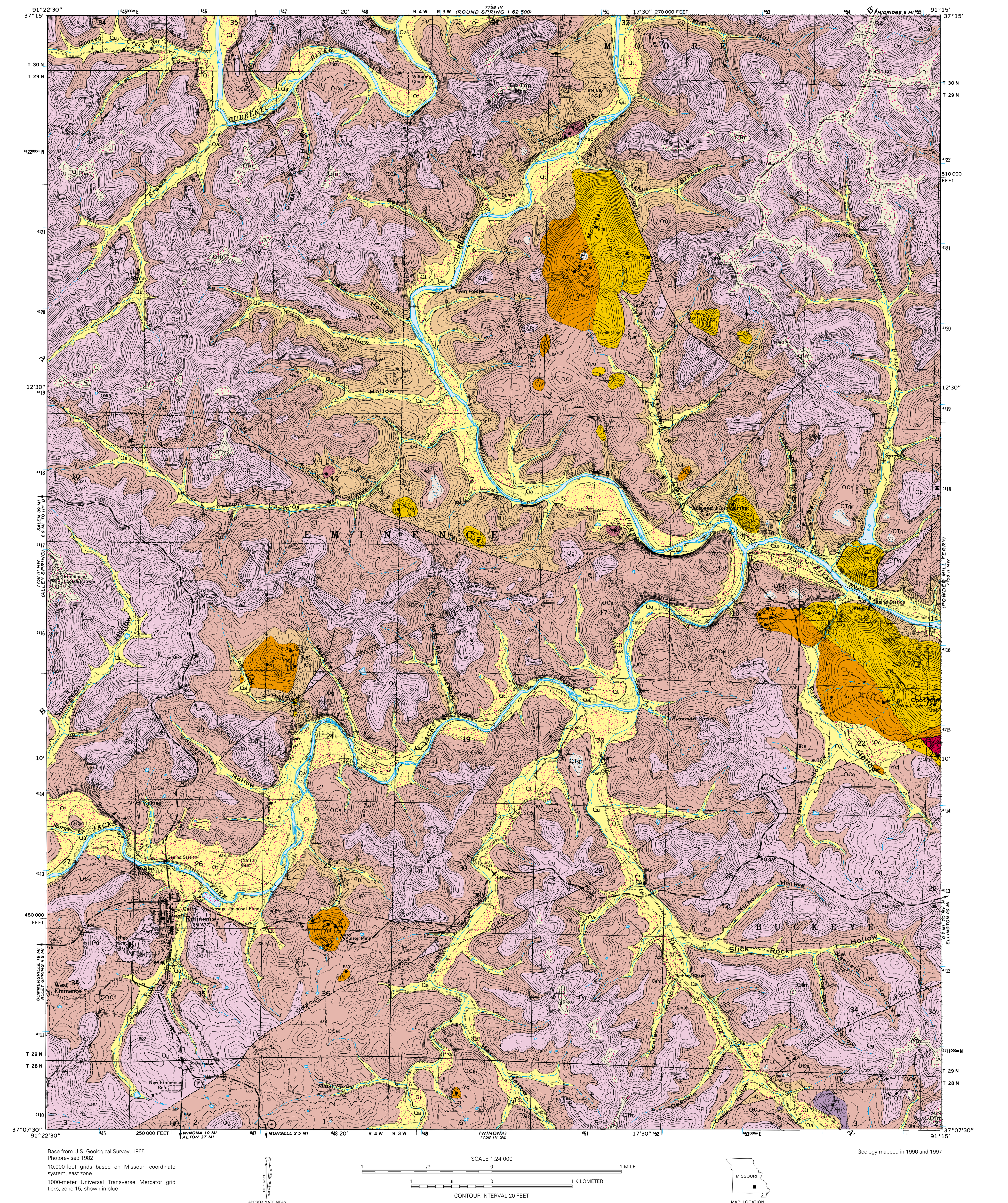

Table 1.—Summary of drillhole data for the Eminence quadrangle, Missouri.

[Elevations in feet; datum is mean sea level. All drillhole numbers are from Missouri Division of Geology and Land Survey file numbers. Og, Gasconade Dolomite; OЄe, Eminence Dolomite; Єp, Potosi Dolomite; Єdd, Derby-Doerun Dolomite; Єd, Davis Formation; Єb, Bonneterre Formation; Y, Middle Proterozoic rocks]

Drillhole no.	Location	Collar elevation, in feet	Contact elevation, in feet	Bottom elevation, in feet
8416	NW1/4NW1/4 sec. 35, T. 29 N., R. 4 W.	797	747 Og–OЄe	645
8417	NE1/4NE1/4 sec. 34, T. 29 N., R. 4 W.	828	No data to 603 603 OЄe	478
21235	NE1/4NE1/4 sec. 30, T. 29 N., R. 4 W.	640	370 OЄe–Єp 15 Єp–Єdd −135 Єdd–Єd −310 Єd–Єb −640 Єb–Y	−675
22309	NW1/4NW1/4 sec. 36, T. 29 N., R. 4 W.	706	No contacts; all OЄe	596
23821	NE1/4NE1/4 sec. 34, T. 29 N., R. 4 W.	818	763 Og–OЄe	538
26939	SE1/4NW1/4 sec. 14, T. 29 N., R. 4 W.	1,042	No data to 877 877 OЄe	742
27467	NW1/4SE1/4 sec. 20, T. 29 N., R. 3 W.	615	420 OЄe–Єp	365

Table 2.—Major-oxide analyses for Middle Proterozoic volcanic rocks.

[Sample locations shown on map. Whole-rock geochemistry provided by Actlabs, Inc., Wheat Ridge, Colorado. LOI, loss on ignition]

Sample no.	Location	Unit	SiO_2	Al_2O_3	Fe_2O_3	MnO	MgO	CaO	Na_2O	K_2O	TiO_2	P_2O_5	LOI	Total
E1	NW1/4NE1/4 sec. 22, T. 29 N., R. 3 W.	Ycl	69.81	12.69	5.03	0.02	0.06	0.15	0.11	10.23	0.57	0.12	0.48	99.27
E2	NW1/4NW1/4 sec. 23, T. 29 N., R. 3 W.	Ycu	77.74	10.86	3.09	.01	.14	.06	.15	7.26	.31	.3	.74	100.66
E3	SW1/4NW1/4 sec. 15, T. 29 N., R. 3 W.	Ycu	73.25	11.43	4.09	.03	.09	.12	.09	9.84	.37	.04	.67	100.02
E4	SW1/4NE1/4 sec. 16, T. 29 N., R. 3 W.	Ycl	68.35	12.76	5.48	.03	.09	.18	.1	10.0	.59	.15	.42	98.15
E5	NE1/4SE1/4 sec. 16, T. 29 N., R. 3 W.	Ycl	71.0	12.41	5.26	.04	.11	.16	.29	9.24	.64	.15	.57	99.87
E6	SW1/4SE1/4 sec. 8, T. 29 N., R. 3 W.	Ysc	83.19	8.54	1.12	.01	.03	<.01	.08	6.26	.1	.03	.46	99.82
E7	SE1/4NW1/4 sec. 3, T. 29 N., R. 3 W.	Ysi	77.64	10.17	1.83	.03	.03	.06	.22	8.22	.17	.03	.58	98.98
E8	SW1/4SE1/4 sec. 25, T. 29 N., R. 4 W.	Ycl	72.06	12.97	2.0	.02	.01	.13	1.3	9.32	.12	.05	.17	98.15
E9	SW1/4SE1/4 sec. 25, T. 29 N., R. 4 W.	Ycl	68.86	14.0	3.36	.04	.15	.18	.17	10.37	.31	.02	.71	98.17
E10	NW1/4NW1/4 sec. 24, T. 29 N., R. 4 W.	Ycu	67.70	14.51	2.66	.02	.01	.09	.14	12.58	.26	.05	.27	98.29
E11	SE1/4SE1/4 sec. 14, T. 29 N., R. 4 W.	Ycl	73.75	12.82	3.48	.07	.79	.37	4.53	2.86	.37	.08	.79	99.91
E12	SW1/4SW1/4 sec. 13, T. 29 N., R. 4 W.	Ycl	74.81	11.61	3.01	.05	.57	.3	4.17	2.54	.27	.05	.7	98.08
E13	SW1/4SW1/4 sec. 13, T. 29 N., R. 4 W.	Ycl	77.76	10.96	1.6	.01	.03	.03	.15	9.11	.24	.06	.29	100.24
E14	SW1/4SE1/4 sec. 7, T. 29 N., R. 3 W.	Ycu	73.86	10.96	3.2	.01	.07	.39	.49	8.35	.26	.05	.56	98.20
E15	SE1/4SE1/4 sec. 12, T. 29 N., R. 4 W.	Ycu	72.78	11.53	2.81	.01	.05	.45	.96	8.51	.23	.03	.67	98.03
E16	center sec. 12, T. 29 N., R. 4 W.	Ysc	74.08	11.61	2.37	.02	.09	.49	.12	10.28	.22	.03	.93	100.24
E17	NW1/4N1/2 sec. 5, T. 29 N., R. 3 W.	Ysc	71.02	12.48	4.8	.05	.12	.2	1.09	8.51	.37	.06	.91	99.61
E18	NW1/4N1/2 sec. 5, T. 29 N., R. 3 W.	Ysc	73.16	10.47	4.74	.02	.15	.39	.07	8.41	.41	.03	.9	98.75
E19	NW1/4N1/2 sec 5, T. 29 N., R. 3 W.	Ysc	72.2	12.0	3.22	.02	.1	.23	1.64	7.61	.24	.04	.57	97.87
E20	SE1/4SW1/4 sec. 25, T. 29 N., R. 4 W.	Ycl	75.54	10.85	3.11	.03	.04	.09	.18	8.65	.24	.02	.37	99.12
E21	SE1/4NW1/4 sec. 6, T. 28 N., R. 3 W.	Ycl	67.77	13.65	4.61	.04	.06	.11	.14	11.5	.35	.03	.39	98.65
E22	SE1/4NE1/4 sec. 16, T. 29 N., R. 3 W.	Ycl	67.66	12.82	5.45	.03	.09	.03	.1	10.09	.57	.1	.7	97.64
E23	NE1/4SE1/4 sec. 16, T. 29 N., R. 3 W.	Ycl	78.27	10.13	3.09	.04	.04	.03	.27	8.17	.31	.02	.35	100.72
E24	E1/2 sec. 5, T. 29 N., R. 3 W.	Ycu	75.15	11.6	3.28	.04	.05	.08	.22	9.45	.25	.04	.39	100.55
E25	E1/2 sec. 5, T. 29 N., R. 3 W.	Ycu	74.32	12.13	3.42	.04	.07	.03	.22	9.32	.29	.04	.67	100.55
E26	W1/2 sec. 5, T. 29 N., R. 3 W.	Ycu	75.16	11.22	3.96	.06	.19	.2	.62	7.54	.31	.03	.60	99.89
E27	W1/2 sec. 5, T. 29 N., R. 3 W.	Ycl	77.64	10.65	3.00	.04	.07	.03	.20	8.52	.26	.01	.45	100.87
E28	W1/2 sec 5, T. 29 N., R. 3 W.	Ycl	68.84	9.53	2.59	.04	.09	.13	.48	7.3	.24	.04	.42	89.70
E29	N1/2 sec. 36, T. 29 N., R. 4 W.	Ycl	73.87	12.41	2.84	.03	.05	.1	1.0	9.44	.28	.04	.3	100.36
E30	SW1/4NE1/4 sec. 36, T. 29 N., R. 4 W.	Ycl	76.88	10.96	3.15	.04	.08	.05	.60	8.05	.19	.04	.37	100.41
E31	NW1/4SE1/4 sec. 22, T. 29 N., R. 3 W.	Ycl	71.08	11.34	5.47	.03	.07	.30	.69	8.62	.53	.22	.47	98.82
E32	NW1/4SW1/4 sec. 23, T. 29 N., R. 3 W.	Ycu	73.71	11.71	3.0	.03	.04	.06	.27	9.46	.32	.05	.44	99.09
E33	NW1/4SW1/4 sec. 23, T. 29 N., R. 3 W.	Ycu	73.8	12.01	3.14	.02	.03	.02	.21	9.95	.26	.05	.3	99.79
E34	NE1/4NW1/4 sec. 15, T. 29 N., R. 3 W.	Ycu	71.56	12.13	4.94	.01	.08	.09	1.04	8.55	.41	.08	.74	99.63
E35	NE1/4SW1/4 sec. 9, T. 29 N., R. 3 W.	Ycu	72.48	12.40	5.36	.03	.13	.07	.66	8.83	.36	.03	.75	101.10

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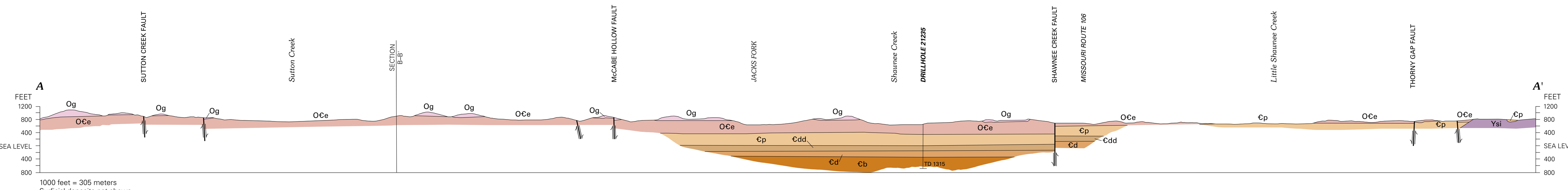
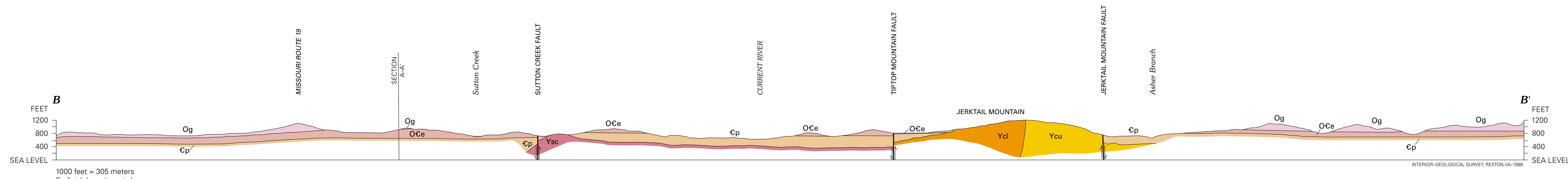
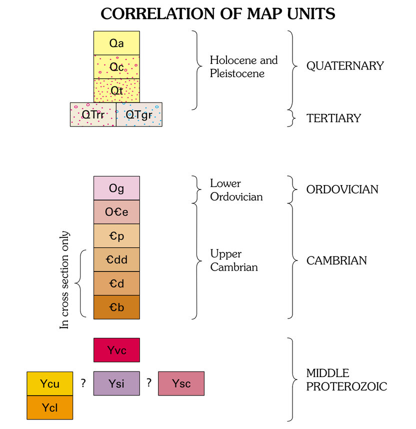




CORRELATION OF MAP UNITS



DESCRIPTION OF MAP UNITS

Qa **Alluvium (Holocene)**—Silt, sand, clay, and gravel derived from local bedrock. Gravel, angular to subrounded and mostly consisting of chert and sandstone. Forms flood plain and streambed deposits. Unit is as much as 30 ft thick along Current River and Jacks Fork

Qc **Colluvium of Coot Mountain (Holocene and Pleistocene)**—Boulders, cobbles, and pebbles of Middle Proterozoic volcanic rocks, poorly sorted, angular to subangular, formed by mass wasting. Occurs as thick deposit along southern side of Coot Mountain

Qt **Terrace deposits (Pleistocene?)**—Silt, sand, clay, and gravel. Gravel mostly composed of rounded cobbles of chert and sandstone. Deposits occur within and along sides of stream valleys and lie as much as 30 ft above mapped alluvium (Qa). One high-level terrace deposit was identified at about 790 ft elevation along Jacks Fork near Eminence. Unit probably as much as 30 ft thick

QTrr **Residuum derived from Roubidoux Formation (Quaternary and Tertiary)**—Red and reddish-orange sandy clay containing angular sandstone and chert cobbles and boulders as much as 4 ft in diameter. Sandstone cobbles and boulders, fine- to coarse-grained, poorly sorted, and contain symmetrical and asymmetrical ripple marks. Chert cobbles and boulders, light- to medium-gray consisting of banded, sandy, oolitic, and porcelaneous varieties. Occurs on hilltops and as colluvium on hillsides in areas where bedrock of the Roubidoux Formation has been deeply weathered and removed. Unit as much as 40 ft thick

QTgr **Residuum derived from Gasconade Dolomite (Quaternary and Tertiary)**—Brown and red clay containing angular blocks of white chert and masses of quartz druse. Chert blocks include porcelaneous, oolitic, and stromatolitic varieties. As much as 2 ft in diameter, averaging 0.5 ft. May include sandstone boulders or slabs derived from the basal Gunter Sandstone Member. Occurs on tops of hills and as colluvium on hillsides in areas where bedrock of the Gasconade Dolomite has been deeply weathered and removed. Unit as much as 40 ft thick

Og **Gasconade Dolomite (Lower Ordovician)**—Dolomite, chert, sandstone, and orthoquartzite. Formation is divided into an upper and middle unit and the Gunter Sandstone Member at base where completely exposed outside of Eminence quadrangle. In the Eminence quadrangle, only the middle unit and the Gunter Sandstone Member are exposed. Dolomite of middle unit, light- to very light gray, medium-bedded, medium- to coarse-grained, contains chert as nodules, stringers, and beds. Chert includes porcelaneous, oolitic, porous with druse, and stromatolitic varieties. Upper part of middle unit contains a persistent oolite bed. Dolomite of lower part of middle unit (Van Buren Formation of Bridge, 1930), light-gray to yellowish-gray, thin- to medium-bedded, fine- to medium-grained. Gunter Sandstone Member, light-gray to white sandstone, sandy dolomite, or orthoquartzite interbedded with light-gray to tan, fine-grained, thin-bedded dolomite. Thickness of the Gunter ranges from 10 to 20 ft. Maximum thickness of Gasconade Dolomite exposed in quadrangle is about 300 ft. Contact with underlying Eminence Dolomite is placed at base of lowest sandstone or sandy dolomite of the Gunter Sandstone Member. Contact is locally unconformable

OЄe **Eminence Dolomite (Lower Ordovician and Upper Cambrian)**—Dolomite and chert. Dolomite, light-gray, massive to thick-bedded, medium- to coarse-grained, weathers bluish gray or medium gray with a pitted surface, forms small knobs or pinnacles as outcrops. Fresh surfaces contain oxidized rust-colored mottles. Unit contains variable amounts of light-gray and white stringers and nodules of chert throughout; chert makes up less than 5 percent of formation. Thickness of unit is variable because of unconformity at base of overlying Gasconade Dolomite and thinning of unit near knobs of Middle Proterozoic rhyolite; thickness ranges from 80 to 270 ft, averaging 150 ft. Contact with underlying Potosi Dolomite is gradational and placed above the highest brown or drusy dolomite of the Potosi. Locally, unit unconformably overlies Middle Proterozoic volcanic rocks

Єp **Potosi Dolomite (Upper Cambrian)**—Dolomite and chert. Dolomite, light-brown, brown, and light-gray, massive to thick-bedded, fine- to medium-grained and contains quartz druse in vugs (locally extensive). Brown dolomite has fetid odor when freshly broken. Quartz druse developed as botryoidal masses of chalcedony with small quartz crystals coating surfaces. White to light-gray chert forms nodules and stringers. A bed, 1 to 3 ft thick, of rusty porous chert occurs near or at the contact with the overlying Eminence Dolomite. Exposed thickness as much as 200 ft; 355 ft thick in subsurface in southern part of quadrangle as shown in drillhole 21235 along Shawnee Creek. Averages about 400 ft thick in subsurface in nearby quadrangles. Unit unconformably overlies Middle Proterozoic volcanic rocks in outcrop

Єdd **Derby-Doerun Dolomite (usage of Missouri Geological Survey, 1979) (Upper Cambrian) (shown in cross section only)**—Dolomite, siltstone, and shale. Dolomite, buff to light-gray, thin- to medium-bedded, fine- to medium-grained, argillaceous and silty with minor amount of chert. Siltstone and shale, thin-bedded and interbedded with dolomite. Lower part of unit silty and glauconitic. Thickness 150 ft in drillhole 21235 along Shawnee Creek; averages about 200 ft in subsurface of nearby quadrangles

Єd **Davis Formation (Upper Cambrian) (shown in cross section only)**—Interbedded silty dolomite and green shale. Shale to dolomite ratio about 1:7 in drillhole 21235 along Shawnee Creek. Thickness 175 ft in drillhole 21235; average 175 ft thick in subsurface of nearby quadrangles

Єb **Bonneterre Formation (Upper Cambrian) (shown in cross section only)**—Interbedded dolomite, limestone, and siltstone. Dolomite, light-gray, medium-bedded, fine- to medium-grained, locally glauconitic and argillaceous, lower part locally contains small igneous rock fragments. Limestone, brownish-gray to pink, thin-bedded, fine-grained. Siltstone, light- to dark-gray, laminated, quartzose. Thickness 330 ft in drillhole 21235 along Shawnee Creek; averages 400 ft thick in subsurface of nearby quadrangles. Unconformably overlies Middle Proterozoic volcanic rocks

Yvc **Volcaniclastic conglomerate, breccia, and sandstone (Middle Proterozoic)**—Interbedded volcaniclastic conglomerate, breccia, and sandstone. Conglomerate consists of subrounded cobbles 3 to 5 in. in diameter and large pebbles of rhyolite of Sutton Creek (Ysc), upper unit of Coot Mountain (Ycu), and unidentified volcanic rocks. Matrix strongly altered, greenish, fine-grained volcaniclastic material. Conglomerate is overlain by strongly silicified volcanic breccia, possibly an autobrecciated flow, that consists of aphanitic pink rhyolite and quartz clasts in a quartz matrix. Sandstone is coarse to medium grained. Grains consist of quartz, lithics, and minor feldspar. Volcaniclastic unit only observed on southern side of Coot Mountain in secs. 22 and 23, T. 29 N., R. 3 W. Contacts with other units are not exposed

Ycu **Upper unit of Coot Mountain (Middle Proterozoic)**—Rhyolite to alkali rhyolite to alkali trachyte ash-flow tuff, densely welded, well-developed flow layering and eutaxitic texture; locally, flow layering poorly developed. Generally less than 10 percent phenocrysts of pink feldspar and sparse to no quartz; 4 to 10 percent disseminated magnetite throughout and locally contains disseminated fluorite. Common vapor-phase feldspar and quartz mineralization in pumice. Exposed at summit and along northeastern side of Coot Mountain and along eastern side of Jerktail Mountain. Approximately same as upper unit of Coot Mountain of Fisher (1969)

Ycl **Lower unit of Coot Mountain (Middle Proterozoic)**—Interbedded ash-flow tuff, air-fall tuff, and lava(?), dominantly ash-flow tuff. Ash-flow tuff, alkali rhyolite to alkali trachyte to trachyte to rhyolite, commonly massive and dense, weakly developed or no flow layering, although locally flow layering is moderately developed. Phenocrysts of 5 to 25 percent pink feldspar and no to sparse quartz in a dark-maroon matrix; 4 to 10 percent disseminated magnetite throughout. Commonly contains quartz veins and infilling of miarolitic cavities, locally spherulitic. Locally, a poorly to non-welded, pumice-rich, phenocryst-poor ash-flow tuff is interbedded in this interval. Ash-flow tuff approximately same as middle unit of Coot Mountain of Fisher (1969). Air-fall tuff, rhyolite, aphanitic, massive to thin-bedded, dark-maroon, locally silicified and contains disseminated pyrite. Petrographically consists of microlites less than 0.0004 in. in size and devitrified glass shards. Generally, all primary depositional features have been destroyed. Air-fall tuff approximately same as lower unit of Coot Mountain of Fisher (1969). Best exposed along southwestern side of Coot Mountain, western side of Jerktail Mountain, and on an unnamed knob exposed along State Highway 106, 1.25 mi east of Eminence

Ysc **Rhyolite of Sutton Creek (Middle Proterozoic)**—Lava(?), alkali rhyolite to rhyolite, massive, generally not flow layered although 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) aggregates (possibly xenoliths) of small pink feldspar phenocrysts in an apple-green matrix, which alter to yellowish white. Named for exposures 0.25 mi north of Sutton Creek in sec. 12, T. 29 N., R. 4 W. Also exposed along northwestern bank of Current River in knob 0.5 mi southeast of summit of Tip Top Mountain and along southern bank of Current River in unnamed knob 1 mi upstream from confluence with Jacks Fork

Ysi **Rhyolite of Shut-In Mountain (Middle Proterozoic)**—Lava, rhyolite, densely welded, approximately 10 to 15 percent white to pink feldspar and 5 percent anhedral quartz phenocrysts in a dense light-pink matrix; less than 5 percent disseminated magnetite. Poorly developed or no flow layering. Named for outcrops on Shut-In Mountain in northwestern part of Stegall Mountain quadrangle (southeast of Eminence quadrangle). Crops out as two unnamed small knobs in southeastern portion of quadrangle. Geochemical data for this unit in adjacent quadrangles indicate variable compositions other than rhyolite

EXPLANATION OF MAP SYMBOLS

Contact—Dashed where approximately located; dotted where concealed

Faults—Long-dashed where approximately located; short-dashed where inferred; dotted where concealed

Fault with probable oblique slip—Bar and ball on downthrown side; faults exposed in mines in nearby quadrangles have strike-slip displacement; however, strike-slip movements are not shown on this map because they cannot be documented in surface exposures

Reverse fault—R on upthrown side; arrow shows dip of fault plane

Fault with unknown direction of movement (in Middle Proterozoic rocks only)—Zone of tectonic brecciation and quartz alteration

Minor faults

Strike-slip fault—Arrows show direction of movement

Reactivated strike-slip fault—Arrows show direction of movement

Oblique-slip fault—Arrows show direction of movement; short arrow and number show rake of slickenside striations, measured on plane of fault

Normal fault—Direction and dip of fault plane are shown

PLANAR FEATURES

Strike and dip of beds—Symbols in Qa represent small bedrock outcrops in streambed

- 12 Inclined
- Horizontal

Strike and dip of flow-layered foliation

- 45 Inclined
- Vertical

Strike and dip of joints—Point of observation at intersection of multiple symbols. Apertures are narrow (less than 0.5 in), except where noted by w (wide, 2 to 8 in) and mw (moderately wide, 0.5 to 2 in)

Throughgoing, vertical
- Widely spaced (greater than 6 ft)
- Moderately spaced (2 to 6 ft)
- Closely spaced (less than 2 ft)

Throughgoing, inclined
- 75 Widely spaced (greater than 6 ft)
- 75 Moderately spaced (2 to 6 ft)
- 82 Closely spaced (less than 2 ft)

Non-throughgoing, vertical
- Widely spaced (greater than 6 ft)
- Moderately spaced (2 to 6 ft)
- Closely spaced (less than 2 ft)

Non-throughgoing, inclined
- 75 Widely spaced (greater than 6 ft)
- 75 Moderately spaced (2 to 6 ft)
- 75 Closely spaced (less than 2 ft)

OTHER FEATURES

k **Small sinkhole**

21235 **Drillhole**—Number refers to Missouri Division of Geology and Land Survey well records; see table 1 for summary of well data

Abandoned mine

Quarry

x **Prospect pit**

E1 **Sample locality for geochemistry of Middle Proterozoic rocks**—See table 2 for major-oxide analyses

DISCUSSION

INTRODUCTION

The Eminence 7.5-min quadrangle is on the Salem Plateau of the Ozark Plateaus province in Shannon County, south-central Missouri. As much as 1,000 ft of flat-lying to gently dipping Upper Cambrian and Lower Ordovician rocks, mostly dolomite, overlie Middle Proterozoic volcanic rocks that crop out in discrete knobs and mountains. The bedrock is overlain by unconsolidated residuum, colluvium, and alluvium. Karst features, such as small sinkholes and caves, have formed in the carbonate rocks; many streams are spring fed. The terrain is mountainous. Steep-sided hills range in elevation from 575 ft on the Current River at the eastern edge of the quadrangle to 1,256 ft at the crest of Coot Mountain, also on the eastern edge of the quadrangle. The area is mostly forested but contains some farmland and includes sections of the Ozark National Scenic Riverways (National Park Service) along the Current River and Jacks Fork and the Clow State Forest north of the town of Eminence.

Bridge (1930) mapped the Eminence quadrangle at a scale of 1:62,500, and Pratt and others (1992) mapped the Rolla 1° x 2° quadrangle at a scale of 1:250,000. Geologic mapping for this investigation was begun in the Spring of 1996 and was completed in the Summer of 1997.

STRATIGRAPHY

Middle Proterozoic volcanic rocks and Upper Cambrian and Lower Ordovician dolomite, sandstone, and chert crop out in the Eminence quadrangle. The Middle Proterozoic rocks are divided into five informal units, and the Cambrian and Ordovician rocks include, in ascending order, the Potosi Dolomite, the Eminence Dolomite, and the Gasconade Dolomite. The Cambrian and Ordovician rocks were deposited in a shallow sea containing islands of Middle Proterozoic rocks. In some places, the Cambrian and Ordovician rocks drape off these Middle Proterozoic knobs. Therefore, the Cambrian and Ordovician rocks are thin near the exposed knobs and more than 1,200 ft thick in a drillhole (table 1, hole no. 21235) along Shawnee Creek. In the Eminence quadrangle, only beds of the Potosi and Eminence Dolomites were observed in contact with the Middle Proterozoic volcanic rocks. Residual chert of the Gasconade Dolomite on the crest of Jerktail Mountain suggests that the Gasconade and overlying formations were deposited above the Middle Proterozoic rocks.

Middle Proterozoic Rocks

Middle Proterozoic volcanic rocks exposed in the Eminence area are a southwestern extension of the St. Francois Mountains of eastern Missouri and are some of the few exposures of Eastern Granite-Rhyolite terrane in the Midcontinent, U.S. (Van Schmus and others, 1993). Rb-Sr and U-Pb ages of about 1,500 to 1,450 Ma have been reported for the St. Francois Mountains (Bickford and Mose, 1975), and a U-Pb age of 1,473±15 Ma has been reported from granite from a corehole in the Round Spring quadrangle, northwest of the Eminence quadrangle (Bickford and others, 1981). The volcanic rocks in the Eminence area were first studied by Bridge (1930) who described them as Precambrian rhyolite porphyry. Although he mapped all of the igneous rocks as rhyolite porphyry, he recognized as many as five varieties of pyroclastic rocks and agglomerate. Fisher (1969) divided the rocks of Coot Mountain into lower, middle, and upper units on the basis of their lithologic characteristics and inferred their stratigraphic position on the basis of the dip of flow layering. Pratt and others (1979) mapped all of the volcanic rocks as alkali rhyolite and divided the rocks of Jerktail Mountain into three stratigraphic units.

In this study of the Eminence quadrangle, the Middle Proterozoic volcanic rocks were divided into five informal units: lower unit of Coot Mountain (Ycl), upper unit of Coot Mountain (Ycu), rhyolite of Shut-In Mountain (Ysi), rhyolite of Sutton Creek (Ysc), and volcaniclastic conglomerate, breccia, and sandstone (Yvc). The relative ages of these units are difficult to determine because of the probable interfingering of rock types, Precambrian and Paleozoic faulting, lack of contact exposures, near-vertical layering, and the isolated nature of exposures of Middle Proterozoic knobs. The largest exposures of Middle Proterozoic volcanic rocks are on Coot and Jerktail Mountains where several of these units were mapped. The lower unit of Coot Mountain (Ycl) is generally equivalent to the lower and middle units of Fisher (1969), and the upper unit of Coot Mountain (Ycu) is generally equivalent to the upper unit of Fisher (1969). The volcaniclastic conglomerate, breccia, and sandstone unit (Yvc) only was observed on Coot Mountain and is probably younger than the other volcanic rocks; clasts of rhyolite of Sutton Creek (Ysc) and the upper unit of Coot Mountain (Ycu) are included in the volcaniclastic unit.

Thirty-five samples of Middle Proterozoic volcanic rocks were analyzed for major oxides using the whole rock fusion-inductively coupled plasma emission spectrometry technique with 0.01 percent detection limits. Results are shown in table 2. The total alkali versus silica diagram (Le Maitre, 1984) shows that chemically the volcanic units in the Eminence quadrangle are mostly rhyolite and alkali rhyolite and lesser trachyte and alkali trachyte (fig. 1). K_2O is dominant with respect to Na_2O in all units except the air-fall tuff (samples E11 and E12) in the lower unit of Coot Mountain (Ycl).

Paleozoic Rocks

The oldest exposed Paleozoic unit is the Potosi Dolomite of Late Cambrian age. Its type area is Potosi, Washington County, eastern Missouri (Winslow, 1894). No type section was designated. It is a massive to thick-bedded, fine- to medium-grained dolomite characterized by quartz druse that fills vugs. In areas where the Potosi is highly weathered, drusy chert litters the ground surface. The Potosi also is characterized by brown dolomite that has a fetid odor when freshly broken. Brown dolomite is absent from other exposed units in this area. The basal contact of the Potosi with the Derby-Doerun Dolomite is not exposed in the Eminence quadrangle, therefore a total thickness for the unit is difficult to determine. However, the Potosi is 355 ft thick in the drillhole along Shawnee Creek. This is probably a maximum thickness as the unit thins near the Middle Proterozoic knobs. The Potosi grades into the overlying Eminence Dolomite through a sequence of interbedded brown dolomite and very light gray dolomite and the contact is placed at the top of the highest brown dolomite. This transition zone also contains a 1- to 3-ft-thick zone of porous chert that approximately marks the Potosi-Eminence contact. The interbedded dolomite sequence may indicate a lateral facies change near the Middle Proterozoic knobs.

The Eminence Dolomite was named by Ulrich (1911) for many exposures near Eminence. It is a massive to thick-bedded, medium- to coarse-grained, light-gray, somewhat cherty dolomite that typically weathers to pinnacles. The Eminence ranges from 80 to 270 ft thick. This range in thickness may be due to facies changes with the underlying Potosi Dolomite and the presence of an unconformity at the top of the formation. Conodonts recovered from the Eminence show that the Cambrian-Ordovician boundary occurs in the upper part of the formation (Kurtz, 1981; J.E. Repetski, written commun., 1997). Previously, the Cambrian-Ordovician boundary was placed at the Eminence-Gasconade contact (Bridge, 1930).

The Gasconade Dolomite was named by Nason (1892) for exposures along the Gasconade River in Laclede, Pulaski, and Phelps Counties, central Missouri. This is the highest bedrock unit exposed in the Eminence quadrangle. The basal 10 to 20 ft consists of interbedded sandstone, orthoquartzite, and thin-bedded dolomite and sandy dolomite named the Gunter Sandstone Member by Ball and Smith (1903) for exposures along the Niangua River at Gunter (now Hahatonka Springs), Camden County, central Missouri. Bridge speculated that an important unconformity exists at the base of the Gunter. Although an unconformity does occur below the lowest sandstone, conodont biostratigraphy suggests that it does not represent much time (J.E. Repetski, oral commun., 1997). Bridge (1930) used the name Van Buren Formation for medium-bedded cherty dolomite above the Gunter and below an oolite bed in the middle part of the Gasconade Dolomite. The Van Buren was defined by its faunal content and is no longer used. Pratt and others (1992) discussed a lower and upper part of the Gasconade Dolomite that is divided by a persistent cryptozoan chert located about 60 ft below the top of the Gasconade. The lower part includes the Gunter Sandstone Member and the rocks included in Bridge's Van Buren Formation. In the Eminence area, the cryptozoan chert does not crop out and cryptozoan-bearing float on ridge tops suggests that only the lower part of the Gasconade is exposed.

Bridge (1930) mapped the Roubidoux Formation on many ridge tops in the Eminence quadrangle. However, only residual sandstone blocks, as much as 4 ft in diameter, were observed in this study. This residual Roubidoux is a product of a higher part of the stratigraphic sequence let down by weathering to a lower stratigraphic level.

SURFICIAL GEOLOGY

Surficial deposits in the Eminence quadrangle include residuum, colluvium, terrace deposits, and alluvium. Although all areas underlain by carbonate rocks contain residuum, only those areas on ridge tops that have a distinctive residuum that can be related to a higher bedrock formation are included on this map. Residuum developed from leaching of dolomite by carbonic acid in ground water. Carbonate minerals were dissolved leaving poorly consolidated clay and sand containing fragments of chert, sandstone, and minor dolomite. The removal of carbonate materials also condensed the lithostratigraphic sequence. In many places, especially on ridge tops, the fragments included within the residuum indicate the parent formation. For instance, residuum derived from the Roubidoux Formation (QTrr) contains large blocks and boulders of sandstone from that formation. Large blocks of cryptozoan chert from the upper part of the Gasconade Dolomite and slabs of sandstone and orthoquartzite from the Gunter Sandstone Member of the Gasconade are mapped on ridge tops as residuum derived from the Gasconade Dolomite (QTgr). Fragments from these residual units also occur on hillsides as colluvium but are only mapped on ridge tops where residual clay and sand form derived deposits from a higher horizon. Also, the residuum derived from the Gasconade was only mapped where it occurs on older formations; Gasconade residuum occurs on all areas mapped as Gasconade Dolomite. The age of the residuum was considered to be Cretaceous to Quaternary by Pratt and others (1992) who speculated that Cretaceous gravel occurs in parts of the Rolla 1°x 2° quadrangle. The development of the residuum probably is younger than Cretaceous and it is considered to be Tertiary and Quaternary herein.

Most hillsides in the Eminence quadrangle contain some colluvium, and therefore it is not a separate map unit. However, one large deposit on the southern side of Coot Mountain is shown on the geologic map because of its size and probable thickness. This colluvial deposit, formed by mass wasting of the volcanic rocks on Coot Mountain, obscures the contact between the Middle Proterozoic volcanic rocks and the Paleozoic carbonate rocks.

Terrace deposits were mapped within the stream valleys and are similar in composition to alluvium. They were mapped as morphologic features along the sides of the stream valleys and at higher elevations than the present-day flood plain. In some areas, the 100-year flood plain may include areas mapped as terrace deposits.

STRUCTURAL GEOLOGY

Deformation in Middle Proterozoic Rocks

The Middle Proterozoic volcanic rocks in the Eminence quadrangle are not penetratively deformed. Primary flow-layered foliation in these rocks, however, consistently strikes northwest and generally dips very steeply (fig. 2). Evidence from the Stegall Mt. 7.5-min quadrangle, southeast of the Eminence quadrangle, indicates that these steep dips are synvolcanic and the result of eruption-related collapse.

Another consideration regarding this structural rotation is a possible relation to the Missouri Gravity Low (MGL). The MGL is a 75- to 100-mi-wide, linear gravity low that extends approximately 450 mi from southeastern Nebraska, through southern Missouri, into northwestern Tennessee (Guinness and others, 1982). Interpretation of the MGL is somewhat controversial. Guinness and others (1982) interpreted the MGL as a failed rift that was directly related to the formation of the St. Francois terrane. Hildenbrand and Hendricks (1995) proposed an alternate interpretation of a granitic batholith having a contrasting density to adjacent, relatively dense, metamorphic rocks in the basement. Both interpretations emphasized that the MGL represents a major crustal inhomogeneity and modeled mafic intrusions along or near its margins. The Eminence quadrangle is centered within the MGL and the axis of rotation defined by volcanic foliations parallels the steep, linear gradients of the MGL. This suggests that the structural rotation is either directly related to processes responsible for the formation of the MGL or represents a reactivation of older structures related to the MGL. An interpretation is that the volcanoes that produced the volcanic rocks were structurally controlled by an axial accommodation zone along the rift system defined by the MGL.

Two types of northeast-trending fractures were identified, those that are filled with quartz and those that are open. Vergence direction and left-stepping en echelon fractures associated with the open fractures, which are more pervasive, show right-lateral shearing; vergence direction of quartz-filled fractures show left-lateral shearing.

Faults in Paleozoic Rocks

Few faults previously were mapped in the Paleozoic rocks in the Eminence area. The northwest-trending Ellington fault, 15 mi northeast of Eminence, is the nearest major mapped fault (see Pratt and others, 1992). Previously, only one fault was identified in the Eminence quadrangle, the northwest-trending Sutton Creek fault, seen in the west-central part of the quadrangle (McCracken, 1971). Our detailed geologic mapping of the Eminence quadrangle found several northeast- and northwest-trending faults.

Faults within the Eminence quadrangle largely were identified by stratigraphic offset as evidence of faulting was seldom observed in outcrop. Two large northeast-trending faults accompanied by small subsidiary faults, and several smaller northeast- and northwest-trending faults are shown on the geologic map. All but three of the faults are shown on the map as normal faults based on stratigraphic offset. However, kinematic indicators (mullion structures and en echelon fractures) as well as observation of faults in nearby mines of the Viburnum trend to the northeast indicate that there may have been significant strike-slip motion. Both left-lateral and right-lateral strike-slip indicators on individual faults suggest reactivation under changing stress regimes. Also, two reverse faults were observed.

The Sutton Creek fault is a west-northwest-trending fault that extends from the western edge of the quadrangle to where it is cut by the northeast-trending McCabe Hollow fault about one mile west of the confluence of the Current River and Jacks Fork. The general trend of the fault is N. 70° W. Near the western edge of the quadrangle a west-trending segment is seen. The southern side of the fault is downthrown with vertical offset increasing to the southeast. Three Middle Proterozoic knobs parallel the fault near Sutton Creek. Shearing in chert of the Eminence Dolomite along a tributary of Sutton Creek and a downdropped extensional structure along the fault in the western part of the quadrangle suggest strike-slip motion although definitive relative movements are difficult to determine.

Three faults in the northern part of the quadrangle trend approximately N. 20° W. These are, from west to east, the Grassy, Tip Top Mountain, and Jerktail Mountain faults. The eastern side of the Grassy fault is downthrown. The western side of the Tip Top Mountain fault is downthrown. Highly fractured and folded rocks of the Potosi Dolomite crop out near the fault 0.25 mi southwest of Bunch Cemetery on the Current River. The Jerktail Mountain fault is downthrown to the west as much as 100 ft and trends S. 20° E. from the Current River southeast of Tip Top Mountain, along the northeastern edge of Jerktail Mountain, and swings to S. 50°–70° E. from southeast of Jerktail Mountain to where it is cut by the McCabe Hollow fault about 1.25 mi north of Junction Ferry along the Current River. The northern end of this fault terminates at a high-angle reverse fault that has placed Middle Proterozoic rhyolite of Sutton Creek (Ysc) and Potosi Dolomite on the south onto Potosi Dolomite on the north. The reverse fault surface dips as much as 75° to the south and can be seen in a tributary to the Current River southwest of the Middle Proterozoic knob.

The McCabe Hollow fault trends northeast and was traced from near Coppermine Hollow north of Eminence, across the Current River upstream from its confluence with the Jacks Fork, across Thompson Creek near Ebb and Flow Spring, to near Matthews Branch where it dies out. Stratigraphic separation of 100 ft or more along the fault indicates that it is downthrown to the southeast. An associated small downdropped structure was mapped near McCabe Hollow. Here, the Gasconade Dolomite was downthrown 160 ft. The McCabe Hollow fault truncates the Sutton Creek fault, the Junction Ferry fault, and the Jerktail Mountain fault.

The Junction Ferry fault is interpreted to trend northwest along the Current River. Evidence for its existence includes the apparent offset of the Potosi and Eminence Dolomites west and northwest of Ebb and Flow Spring, and an outcrop of dolomite breccia in the Potosi Dolomite near river level at the confluence of the Current River and Jacks Fork. Also, the northeast-trending reverse fault near Matthews Branch is thought to be related to the Junction Ferry fault and may indicate right-lateral strike-slip movement along the fault. This reverse fault is exposed in a spillway for a lake on the western side of a Middle Proterozoic knob where Matthews Branch joins the Current River. Potosi Dolomite has moved up relative to the Middle Proterozoic rocks. The fault surface is marked by gouge and mullions and is overlain by dolomite breccia. In addition, antithetic slickolites and calcite veins occur in the dolomite on the western side of the fault. The fault surface dips 25° to 40° to the northwest and steepens away from the Middle Proterozoic knob. Another fault was mapped on the eastern side of the knob where Middle Proterozoic rocks are in contact with the Eminence and Gasconade Dolomites that dip 38° to the southeast. This fault is shown on the map as a normal fault, but may be a reverse fault related to the reverse fault exposed on the western side of the knob. A normal fault was mapped east of this fault where the Gasconade was dropped down relative to the gently dipping Potosi and Eminence Dolomites to the east.

The northwestern side of the northeast-trending Shawnee Creek fault has been downdropped. The fault extends from near the southwestern corner of the quadrangle, across Shawnee and Little Shawnee Creeks, to Coot Mountain on the eastern side of the quadrangle. Fractures in the Eminence Dolomite along Shawnee Creek just north of the fault contain mullions suggesting horizontal movement. Also, a small downdropped structure occurs where the fault crosses Shawnee Creek.

Joints

On this map, joints were characterized by their orientation, spacing, persistence, and aperture. For the most part, joints in the carbonate rocks are open and have narrow apertures. However, some joints have been widened by solution and are as much as 10 in wide. Most outcrops contain at least two joint sets.

Spacing refers to the mean perpendicular distance between parallel joints in a joint set. Descriptively, widely spaced joints have greater than 6-ft spacing, medium-spaced joints have 2- to 6-ft spacing, and closely spaced joints have less than 2-ft spacing. Because the spacing of joints is related to the number of joints in an outcrop, weighting factors were applied in the statistical analyses of joints, including the generation of compass-rose diagrams (fig. 3). Closely spaced joints were weighted by a factor of 3, medium-spaced joints by a factor of 2, and widely spaced joints were used at unit value.

Joint persistence refers to the degree at which joints have propagated through the rock. Two levels of persistence were defined for the map area, throughgoing and non-throughgoing. Throughgoing joints are those that cut the entire bedrock outcrop and persist through all beds. Non-throughgoing joints are those that are confined to individual beds and do not extend into adjacent strata. In the Eminence quadrangle, only 5.3 percent of joints are throughgoing. The Potosi Dolomite has 7.3 percent throughgoing joints, the Eminence Dolomite 6.3 percent, and the Gasconade Dolomite 2.4 percent.

Joints in the Cambrian and Ordovician rocks occur in two dominant sets, N.10° W. to N–S and N. 70°–85° E. (fig. 3). The well-developed preferred orientations of the joints are indicative of their development under regional stress fields. Cox (1995) interpreted similar oriented joints throughout the Ozarks as far-field deformation related to the Ouachita and Appalachian orogenies.

In addition to the two joint sets observed in the lower Paleozoic rocks, the Middle Proterozoic rocks in the Eminence quadrangle contain N. 35°–55°E., N. 15°–20°W., and N. 35°–40° W. joint sets. These sets are compatible with the structural fabric recognized throughout the St. Francois terrane (Kisvarsanyi and Kisvarsanyi, 1976). Most of the mapped faults in the Eminence quadrangle follow the N. 35°–55° E. and N. 15°–20° W. joint sets suggesting that the faulting in this area was controlled by zones of weakness in the Middle Proterozoic rocks.

MINERAL RESOURCES

Small deposits of copper and iron have been mined or reported in the Eminence quadrangle. Copper was mined in the middle and late 1800's at three localities, the Slater Mine (NE1/4 sec. 36, T. 29 N., R. 4 W.), the Casey Mine (SW1/4 sec. 14, T. 29 N., R. 4 W.), and the Jerktail Mine (S1/2 sec. 5, T. 29 N., R. 3 W.). The Slater Mine was last worked during World War II (Miller, 1982). In most cases, the copper minerals are contained in a dolomite conglomerate unit at the contact between the volcanic rocks and the Potosi or Eminence Dolomites (Bridge, 1930; Evans, 1959). The one exception is the Casey Mine, where the copper minerals are within the Gasconade Dolomite and not in contact with volcanic rocks. Copper minerals include malachite, chalcocite, chalcopyrite, and small amounts of covellite, chrysocolla, and azurite (Evans, 1959).

Iron occurs as secondary limonite and is found in residuum in several areas of the Eminence quadrangle. Small deposits were mined near the town of Eminence (Crane, 1910; Bridge, 1930; Miller, 1982). Limonite was observed at various places in the Eminence quadrangle in stalactite and massive form.

An active crushed stone quarry is located 0.75 mi east of Eminence. Eminence Dolomite is quarried for asphalt stone, base stone, and aglime. The Eminence is considered to be a high-purity dolomite with greater than 40 percent $MgCO_3$ and less than 5 percent noncarbonate material (Rueff, 1987).

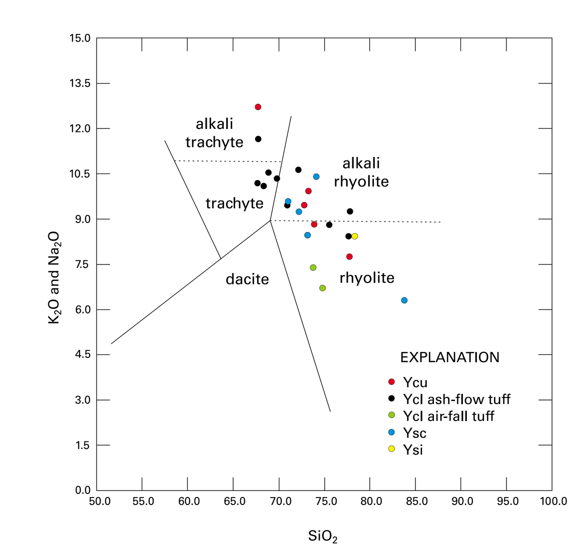


Figure 1.—Total alkali versus silica diagram for Middle Proterozoic volcanic rocks.

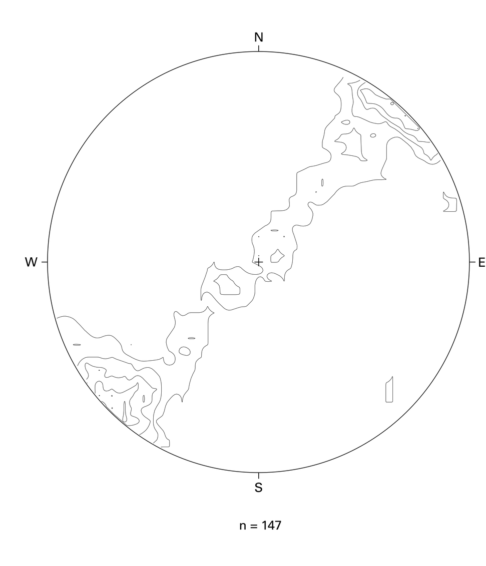


Figure 2.—Lower hemisphere equal-area stereographic projection of poles to foliation of Middle Proterozoic volcanic rocks in the Eminence quadrangle. Contour intervals at 2, 4, 6, 8, and 10 percent of 1 percent area. n, number of measurements.

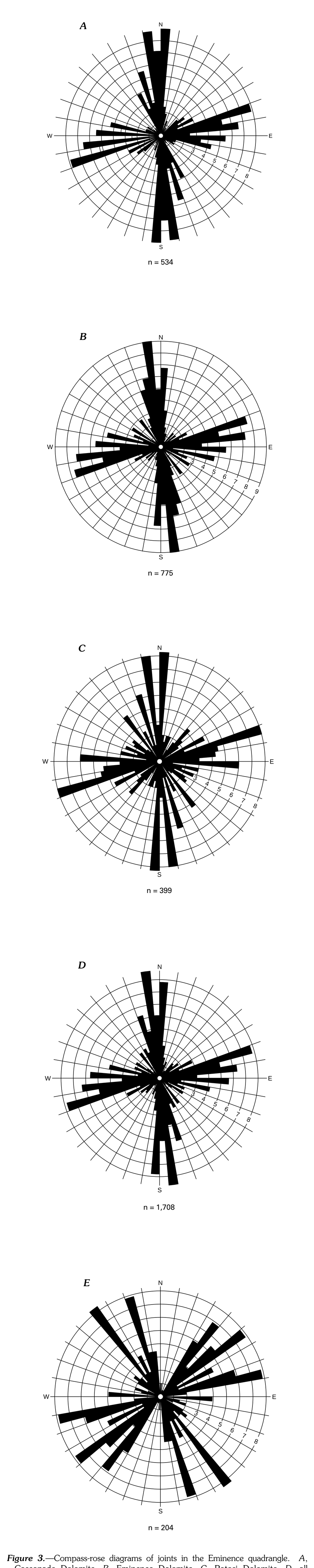


Figure 3.—Compass-rose diagrams of joints in the Eminence quadrangle. *A*, Gasconade Dolomite; *B*, Eminence Dolomite; *C*, Potosi Dolomite; *D*, all Paleozoic units; *E*, Middle Proterozoic volcanic rocks. n, number of joints. Interval is 5 degrees. Numbers on diagram are percent of total.