Table 1.—Summary of drill-hole data in the Piedmont Hollow quadrangle, Missouri.

[There are no logs for the upper parts of most of the drill holes. Or, Roubidoux Formation; €e, Eminence Dolomite; €p, Potosi Dolomite; €dd, Derby-Doerun Dolomite (usage of Missouri Geological Survey, 1979); €d, Davis Formation; €b, Bonneterre Formation; €l, Lamotte Sandstone. nd, no data available. Datum is mean sea level]

Drill-hole number	Location	Collar elevation, in feet	Contact elevation, in feet		Bottom elevation, in feet
Drill-hole data on file with Missouri Department of Natural Resources, Geological Survey and Resource Assessment Division					
12026	NW1/4SW1/4 sec. 4, T. 24 N., R. 4 W.	825	all	Or	610
82W7	NW1/4NW1/4 sec. 3, T. 25 N., R. 4 W.	745		No data to -254	
			-521	€e–€p	
			nd	€p–€dd	
			nd	€dd–€d	
			-873	€d–€b	
			-1277	€b–€l	-1277
83W22	NE1/4NW1/4 sec. 3, T. 25 N., R. 4 W.	930		No data to -70	
			nd	€p–€dd	
			-600	€dd–€d	
			-868	€d–€b	
			-1276	€b–€l	-1276
83W35	NW1/4SW1/4 sec. 3, T. 25 N., R. 4 W.	735		No data to -265	
			-291	€e–€p	
			nd	€p–€dd	
			-618	€dd–€d	
			-866	€d–€b	
			-1252	€b–€l	-1252

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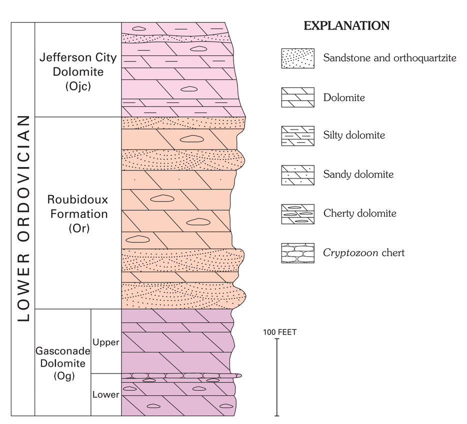
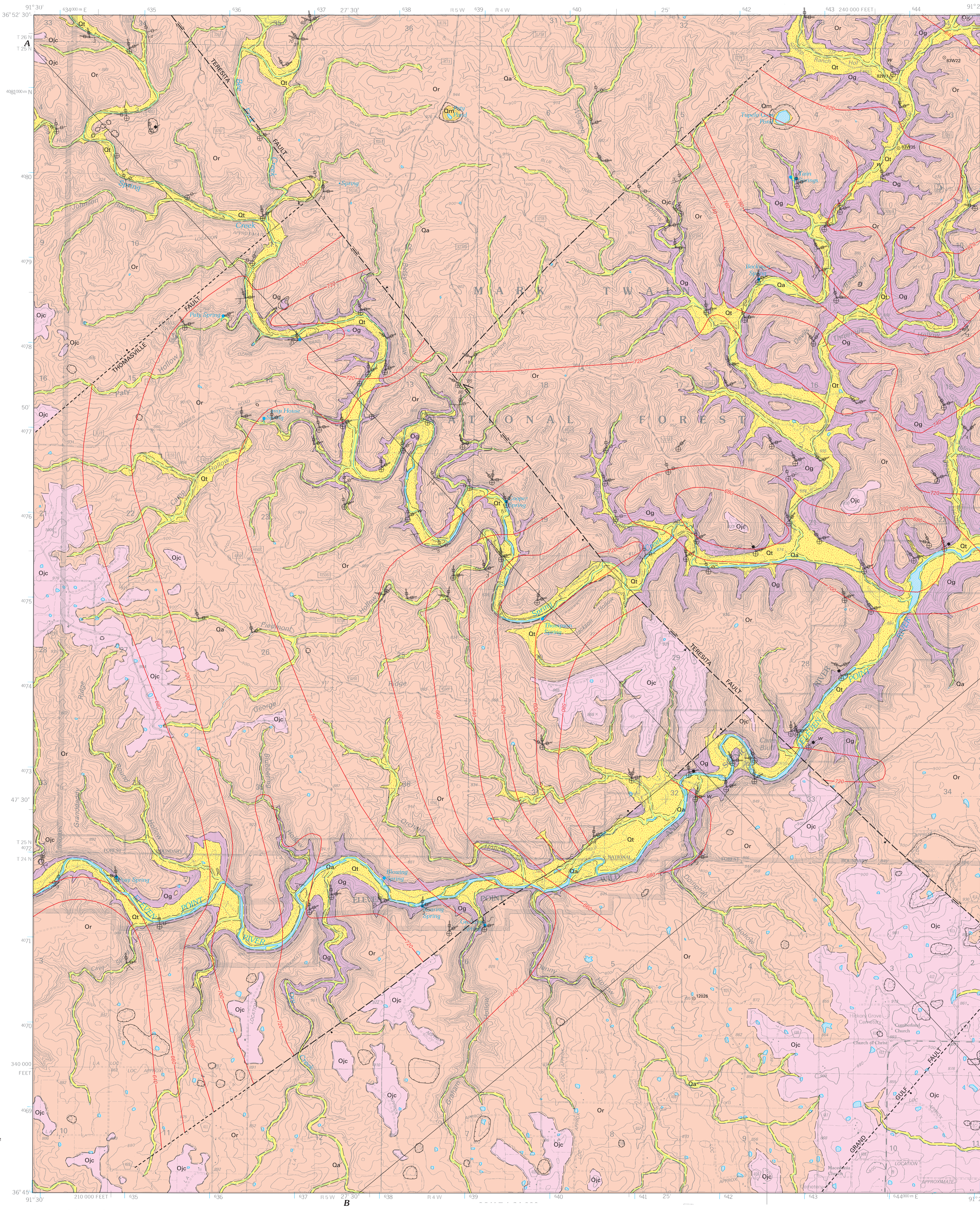


Figure 2.—Columnar section of exposed Paleozoic units in the Piedmont Hollow quadrangle.



CORRELATION OF MAP UNITS

Units	Series	System
Qa, Qm, Qt	Holocene and Pleistocene	QUATERNARY
Unconformity		
Ojc, Or, Og	Lower Ordovician	ORDOVICIAN
€e, €p, €dd, €d, €b, €l (in cross section only)	Upper Cambrian	CAMBRIAN
Unconformity		
Yu (in cross section only)		MESOPROTEROZOIC

DESCRIPTION OF MAP UNITS

Qa — **Alluvium (Holocene and Pleistocene?)**—Gravel, sand, and clay along the bed and active flood plains of modern stream valleys. Material consists mostly of subrounded to subangular chert, sandstone, and quartzite clasts in a matrix of sand containing silt and clay. Thickness ranges from 0 to as much as 20 ft

Qm — **Muck and clayey silt (Holocene and Pleistocene?)**—Silt, clay, and organic-rich muck filling sinkholes that intermittently retain water. Thickness unknown

Qt — **Terrace deposits (Holocene and Pleistocene?)**—Large cobble-size to sand-size, subrounded to subangular chert, sandstone, and quartzite clasts within a matrix of sand, silt, and clay. In some locations a significant fraction of the matrix is silt-size reworked loess. Deposited on relatively flat areas along floors and flanks of modern stream valleys, but above normal seasonal floods of present streams. Terraces along the Eleven Point River and major streams commonly have a 6- to 10-ft-high cutbank descending to the water or a pronounced slope descending to a lower, flatter area of Qa. Thickness at least 10 ft and possibly more along larger stream courses

Ojc — **Jefferson City Dolomite (Lower Ordovician)**—Argillaceous dolomite and cherty dolomite, with lenses of orthoquartzite and irregular beds of light-colored chert. No outcrop was observed in the quadrangle, but unit is indicated by changes in topography and by its distinctive residuum. Unit weathers to low slopes above the topographic bench formed by the uppermost Roubidoux Formation and produces a distinctive yellowish silty soil having local concentrations of residual boulders and cobbles of orthoquartzite and chert, the outer surfaces of which are commonly stained yellow or yellowish orange. No fossils were observed in the Jefferson City Dolomite in the Piedmont Hollow quadrangle. Unit is as much as 121 ft thick in the quadrangle

Or — **Roubidoux Formation (Lower Ordovician)**—Dolomite, cherty dolomite, sandy dolomite, dolomitic sandstone, quartz sandstone, orthoquartzite, chert breccia, and bedded chert. Dolomite very light gray to medium-gray, pale-orange, or pinkish-gray, very fine grained to medium-grained, thin-bedded to laminated, evenly to irregularly bedded. Dolomite interbedded with quartz sandstone, white to pale-orange where fresh, weathering light-brown or reddish-brown, very fine grained to coarse-grained, poorly sorted, thin-bedded to thick-bedded, commonly crossbedded or ripple-marked; well-rounded quartz grains commonly have angular overgrowths; most beds dolomite-cemented, some silica-cemented. Dolomite locally replaced by white, gray, or brown chert, commonly stromatolitic and occasionally oolitic or fossiliferous. Lower and upper parts of the Roubidoux are sandstone-rich; middle part chiefly dolomite. Fossils rare except for occasional specimens of the snail *Lecanospira*. Bedding surfaces of sandstone beds commonly contain ripple marks formed by currents. Lower contact of unit mapped at lowest orthoquartzite or sandstone bed encountered above the Gasconade Dolomite. The Roubidoux Formation ranges from about 240 to 280 ft thick in the Piedmont Hollow quadrangle

Og — **Gasconade Dolomite (Lower Ordovician)**—Dolomite, chert, basal sandstone, and orthoquartzite. Formation is divided into two parts, illustrated in figure 2 but not shown separately on this map. Dolomite of upper unit, light-gray, medium-grained to coarse-grained, thick-bedded, vuggy; weathers to a pitted surface. Dolomite of upper part of lower unit, light-gray, fine-grained to coarse-grained, medium-bedded to thick-bedded, with white to light-gray chert nodules. Uppermost bed of the lower unit is a persistent white *Cryptozoon* chert, 2 to 10 ft thick. The base of the lower unit is the Gunter Sandstone Member (not exposed in the Piedmont Hollow quadrangle), typically a light-gray to white sandstone, sandy dolomite, or orthoquartzite interbedded with light-gray to tan, fine-grained, thin-bedded dolomite. Maximum exposed thickness of the Gasconade in the quadrangle is about 140 ft; the total thickness in the quadrangle is estimated to be about 520 ft. Contact with underlying Eminence Dolomite is placed at base of lowest sandstone or sandy dolomite of the Gunter Sandstone Member

€e — **Eminence Dolomite (Upper Cambrian)**—Shown in cross sections only. Dolomite, light-gray, occasionally mottled red, pink, or green, medium-grained to coarse-grained, medium-bedded to thick-bedded, commonly massive; minor amounts of chert, locally oolitic or drusy, in nodules and angular fragments, mostly in upper half of formation. Contact with underlying Potosi Dolomite gradational and placed above the highest bed of brown or drusy dolomite. Thickness estimated to be about 400 ft in the quadrangle

€p — **Potosi Dolomite (Upper Cambrian)**—Shown in cross sections only. Dolomite, light-brownish-gray to pale-yellowish-brown, fine-grained to medium-grained, thick-bedded, vuggy and porous, with irregular blebs of silica and quartz druse; locally stromatolitic; bituminous (often referred to as fetid) odor typical of freshly broken rock. Thickness in the quadrangle probably exceeds 400 ft

€dd — **Derby-Doerun Dolomite (usage of Missouri Geological Survey, 1979) (Upper Cambrian)**—Shown in cross sections only. Dolomite, siltstone, and shale. Dolomite, buff to brown or light-gray, fine-grained to medium-grained, thin-bedded to medium-bedded, argillaceous, silty, with minor amounts of chert and sparse sulfide minerals; vuggy and porous. Siltstone and shale, thin-bedded, interbedded with dolomite. The Derby-Doerun averages about 170 ft thick in the quadrangle

€d — **Davis Formation (Upper Cambrian)**—Shown in cross sections only. Siltstone, sandstone, dolomite, shale, and limestone conglomerate. Shale, dark-green, fissile, thin-bedded to thick-bedded; composes as much as 50 percent of formation. Limestone, light-gray, fine-grained to cryptograined, dense, locally glauconitic. The Davis contains intraformational sedimentary breccias and grainstones. Unit averages about 220 ft thick in the quadrangle

€b — **Bonneterre Formation (Upper Cambrian)**—Shown in cross sections only. Dolomite, limestone, siltstone, and shale. Dolomite, light-gray, fine-grained to medium-grained, medium-bedded; commonly contains algal structures; locally glauconitic and shaly. Limestone, brownish-gray to pink, fine-grained, thin-bedded, fossiliferous, locally oolitic; more common in lower part of formation. Siltstone, quartzose, light-gray to dark-gray, laminated. Shale, dark-green, thin-bedded; occurs as sparse thin interbeds and partings. Where the underlying Lamotte Sandstone is missing, basal 2 to 20 ft of Bonneterre consists of dolomite-cemented porphyry pebbles and cobbles. Unit is a major host of base-metal deposits in the Ozark region, and averages about 380 ft thick in the Piedmont Hollow quadrangle

€l — **Lamotte Sandstone (Upper Cambrian)**—Shown in cross sections only. Sandstone, quartzose, light-gray, yellow, brown, or red, dominantly medium-grained, moderately sorted to well sorted, well indurated; locally contains interbeds of red to purple silty shale and, in upper part, scattered lenses of arenaceous dolomite. Felsite pebble or boulder conglomerate is commonly present at base. No drill holes penetrated the full thickness of the Lamotte in the quadrangle; its estimated thickness ranges from 0 to about 70 ft

Yu — **Igneous rocks, undifferentiated (Mesoproterozoic)**—Shown in cross sections only. Probably rhyolite or granite. No drill holes reached the basement rocks in the quadrangle

EXPLANATION OF MAP SYMBOLS

Contact—Dashed where approximately located; dotted where concealed

Fault—Long-dashed where approximately located; short-dashed where inferred; dotted where concealed. Displacement is chiefly strike-slip; arrows indicate movement where known. Bar and ball on downthrown side. In cross sections, paired arrows indicate local vertical offset

Structure contour—Drawn on base of Roubidoux Formation; projected where above land surface. Contour interval 20 ft

PLANAR FEATURES

Strike and dip of beds

Inclined

Horizontal

Strike and dip of cataclastic deformation bands—Point of observation at intersection of symbols

Strike and dip of joints—Point of observation at intersection of multiple symbols. Apertures are narrow (<0.5 in.), except where noted by *w* (solutionally widened)

Throughgoing, vertical

Widely spaced (>6 ft)

Moderately spaced (2–6 ft)

Non-throughgoing, vertical

Widely spaced (>6 ft)

Moderately spaced (2–6 ft)

Closely spaced (<2 ft)

Non-throughgoing, inclined

Moderately spaced (2–6 ft)

OTHER FEATURES

83W22 **Drill hole**—Number refers to well records from Missouri Department of Natural Resources; see table 1 for summary of well data

Cataclastic deformation bands in sandstone float

Spring

Large sinkhole—Greater than or equal to 100 ft in diameter

k **Small sinkhole**—Less than 100 ft in diameter

DISCUSSION

INTRODUCTION

The Piedmont Hollow 7.5-min quadrangle is located in south-central Missouri within the Salem Plateau region of the Ozark Plateaus physiographic province (Fenneman, 1938; Bretz, 1965) (fig. 1). Almost all of the land in the quadrangle north of the Eleven Point River is part of the Mark Twain National Forest. Most of the land immediately adjoining the river is part of the Eleven Point National Scenic River, also administered by the U.S. Forest Service. South of the Eleven Point River, most of the land is privately owned and used primarily for grazing cattle and horses. The quadrangle has topographic relief of about 480 feet (ft), with elevations ranging from 550 ft on the Eleven Point River at the eastern edge of the quadrangle to 1,030 ft on a hilltop about a mile to the west-northwest. The most prominent physiographic feature in the quadrangle is the valley of the Eleven Point River, which traverses the quadrangle from west to northeast.

STRATIGRAPHY

Mesoproterozoic Basement Rocks

Mesoproterozoic rocks are not exposed in the Piedmont Hollow quadrangle. However, they are ubiquitous beneath the Paleozoic sedimentary rocks at depths usually exceeding 2,000 ft below the ground surface. The Mesoproterozoic rocks underlying the quadrangle are part of a granite/rhyolite terrane that is extensive in the Midcontinent region. Outcrops of this terrane occur in the Big Spring, Van Buren North, Stegall Mountain, Powder Mill Ferry, and Eminence quadrangles to the northeast and in the Saint Francois Mountains 70 miles (mi) to the northeast (fig. 1). Typically these rocks are encountered in deep (>2,000 ft) exploration drill holes, but no drill holes in the Piedmont Hollow quadrangle reached them (table 1). Uranium-lead isotopic analyses on these rocks in nearby quadrangles yielded radiometric ages of (1) 1,461.8±5.5 Ma for the granite exposed in the Big Spring quadrangle (Harrison and others, 2000), (2) 1,473±15 Ma for granite from a corehole in the Van Buren South quadrangle to the northeast, (3) 1,480±42 Ma for granite from a corehole in the Winona quadrangle to the northeast (Van Schmus and others, 1993) and (4) 1,473±15 Ma for granite from a corehole in the Round Spring quadrangle to the north (Bickford and others, 1981). A uranium-lead age of 1,470.4±2.7 Ma was obtained from the "Rhyolite of Shut-In Mountain" in the Stegall Mountain quadrangle to the northeast (Harrison and others, 2002).

Paleozoic Stratigraphy

The Piedmont Hollow quadrangle is underlain by about 2,500 ft of lower Paleozoic marine strata, chiefly dolomite, chert, sandstone, and orthoquartzite. From oldest to youngest, these units are the Upper Cambrian Lamotte Sandstone, Bonneterre Formation, Davis Formation, Derby-Doerun Dolomite (usage of Missouri Geological Survey, 1979), Potosi Dolomite, and Eminence Dolomite; and the Lower Ordovician Gasconade Dolomite, Roubidoux Formation, and Jefferson City Dolomite. Only the last three units crop out in the quadrangle. The stratigraphic column, figure 2, summarizes the general lithologies and thickness of the Paleozoic strata that crop out in the Piedmont Hollow quadrangle.

Previous maps produced by this U.S. Geological Survey (USGS) project placed the Cambrian-Ordovician boundary in the upper part of the Eminence Dolomite (McDowell, 1998; Orndorff and others, 1999; McDowell and Harrison, 2000; Orndorff and Harrison, 2001; Harrison and others, 2002; Weems, 2002; Harrison and McDowell, 2003). However, recent international agreement on redefinition of this boundary requires that it be placed at the contact between the Eminence and Gasconade Dolomites (Cooper and others, 2001).

The Gasconade Dolomite is the oldest mapped unit in the Piedmont Hollow quadrangle. The Gasconade was named by Nason (1892) for exposures along the Gasconade River about 100 mi to the northwest, in Laclede, Pulaski, and Phelps Counties, central Missouri.

Pratt and others (1992) discussed a lower part and an upper part of the Gasconade Dolomite that are divided by a persistent *Cryptozoon* chert. This distinctive chert is located about 80 to 100 ft below the top of the Gasconade. Outcrops of the chert bed are rare in the Piedmont Hollow quadrangle and are restricted to a small area near its eastern edge along the Eleven Point River and Spring Creek at elevations between [illegible]

[illegible]

fault movement. The deformation bands are of tectonic origin and are created by millimeter-scale displacements through shearing that involves a combination of pore-space collapse and fracturing of grains (Davis, 1999; Harrison and Schultz, 2002). Because development of deformation bands is a strain-hardening mechanism (Davis, 1999), the bands are usually more resistant to weathering than the surrounding rock and are commonly found in raised relief on the surfaces of sandstone boulders.

Faults in this area are difficult to observe directly, due to vegetation and residuum cover, and have to be inferred on the basis of indirect evidence. This evidence includes (1) vertical offset of strata having insufficient observed dip to explain the change (vertical stratigraphic offset along faults may reverse in sense as the result of horizontal offset of gentle folds along both sides of the fault); and (2) cataclastic deformation bands observed in outcrop or in float blocks of sandstone.

The most prominent fault is the Teresita fault, a right-lateral strike-slip fault running from northwest to southeast across the central part of the quadrangle. This fault is regional in scale and has been traced from the central western edge of the Spring Valley 30- x 60-min quadrangle to the southeast corner of the West Plains 30- x 60-min quadrangle, a distance of at least 74 mi (fig. 1). The fault trace passes near the town of Teresita, Mo. (about 16 mi northwest of the Piedmont Hollow quadrangle), from which it is herein named. A set of cataclastic deformation bands that was found in-place in the quadrangle is in an outcrop in the E1/2 sec. 13, T. 25 N., R. 5 W., near the trace of the Teresita fault. This set has measured orientations that indicate strike-slip shearing along a northwest-southeast trend with a right-lateral sense of motion (fig. 4).

Several shorter faults trending southwest to northeast are mapped on the basis of stratigraphic offsets or alignment of areas with deformation bands, or are projected from mapping in nearby quadrangles combined with interpretation of regional aeromagnetic data (Richard W. Harrison, USGS, unpub. data).

ECONOMIC GEOLOGY

A few small, low-quality deposits of iron, which are described by Crane (1910) as secondary limonite, occur in Oregon County and vicinity. None has been mined for significant amounts of iron ore.

Gravel, derived from alluvial stream bottoms, and fill earth, derived from residuum, are widely available and are used locally for road-base and dam construction. Dolomite bedrock in the quadrangle, especially the Gasconade Dolomite, could be quarried for road metal or dimension stone.

HYDROLOGY

With the exception of the Eleven Point River and parts of Spring Creek, most water flow in the quadrangle is subterranean, with surface flow occurring only at times of abundant rainfall. Many small streams have short reaches where water flows from a spring or seep and then is lost to subterranean drainage downslope. Within the map area, the Gasconade, Eminence, and Potosi Dolomites are the major stratigraphic units that produce ground water (Dreiss, 1983). Collectively, these units are part of the regional Ozark aquifer that underlies the Salem Plateau (Imes and Emmett, 1994). Many of the springs in the Piedmont Hollow quadrangle issue from the Roubidoux Formation, but are not very large and appear to be derived from perched water, rather than representing the actual ground-water surface.

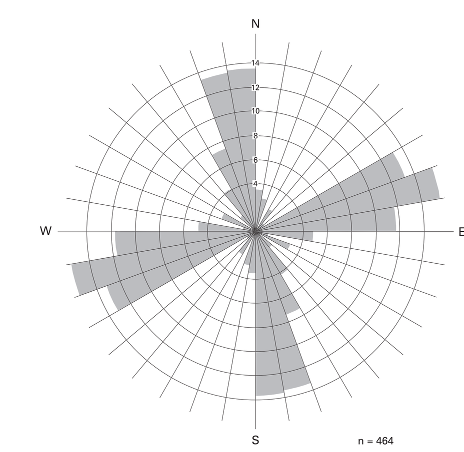
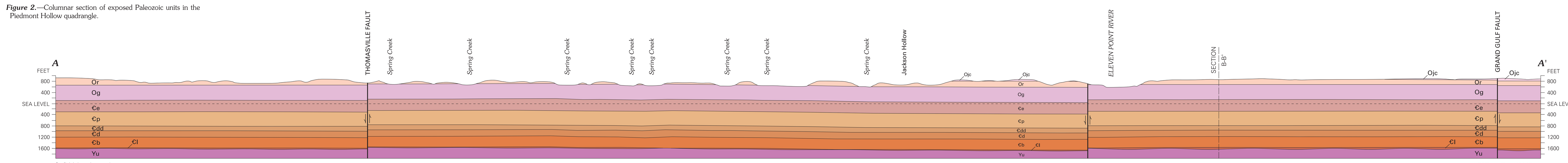
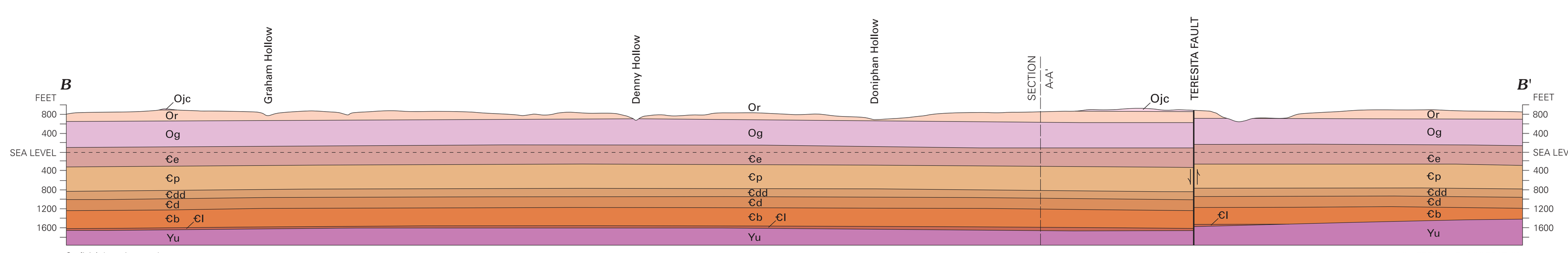


Figure 3.—Compass-rose diagram showing the dominant joint trends in the Paleozoic rocks of the Piedmont Hollow quadrangle. Joint sets were weighted by counting closely spaced joint sets three times, moderately spaced sets two times, and widely spaced sets one time. This system approximates the importance of each set relative to the volume of the rocks. Interval is 10 degrees. Numbers on diagram are percent of total. n, number of joints.





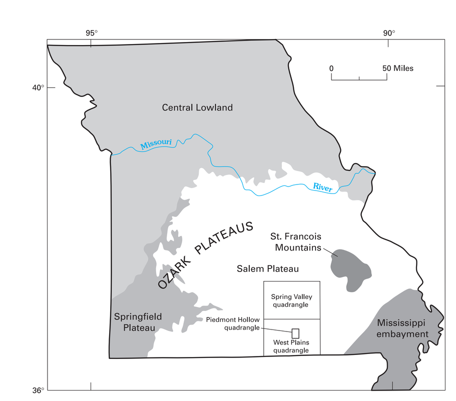


Figure 1.—Map showing location of the Piedmont Hollow 7.5-min quadrangle, the Spring Valley and West Plains 30- X 60-min quadrangles, and the geomorphic subdivisions of Missouri. [illegible]

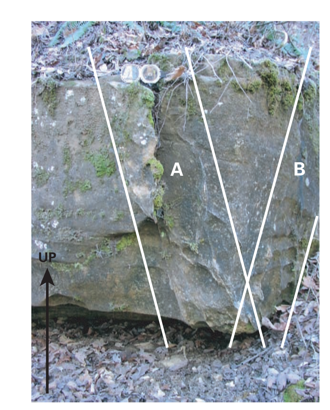


Figure 4.—Photograph of cataclastic deformation bands in an outcrop of Roubidoux Formation sandstone (Brunton compass for scale). Location is in E1/2 sec. 13, T. 25 N., R. 5 W.; view is toward the southeast. There are two conjugate bands of anastomosing segments (web structures): A - strikes 290° and dips 85° NE; B - strikes 140° and dips 80° SW.

GEOLOGIC MAP OF THE PIEDMONT HOLLOW QUADRANGLE, OREGON COUNTY, MISSOURI

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