Illinois Preliminary Geologic Map
IPGM Vergennes-BG

Bedrock Geology of Vergennes Quadrangle

Perry and Jackson Counties, Illinois

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Stratigraphy

Pennsylvanian System
Atokan and Desmoinesian Series
Tradewater Formation

The lower part of the Tradewater Formation is transitional between the pure quartz sandstones (quartz arenite) of the Caseyville and the sublitharenites of the Upper Tradewater (Potter and Glass 1958). The Tradewater is composed of silty gray shale, fine-grained sandstone, coal, and minor amounts of quartz pebble conglomerate.

The coals are highly variable, from less than one inch to several feet thick. The Murphysboro Coal that has been by mined by surface and underground methods at numerous sites in the Ava Quadrangle to the west. It is the oldest economic coal in this area. The Murphysboro is currently being mined at the Creek Paum Mine in the Ava Quadrangle.

Above the Murphysboro Coal, an unnamed gray, silty-shale commonly showing tidal rhythmites has been observed. Joe Devera (personal communication) observed a *Conosticus sp.* (sea anemone trace fossil) in the northeast corner of the Raddle Quadrangle (Sec. 36, T7S, R4W) above a two-foot carbonaceous zone that may correlate with the Murphysboro Coal. Above the silty gray shale, a thin coal is present in places that correlates with the Mt. Rorah Coal Member. This coal is typically only a few inches to a few feet thick and is overlain by a fine-grained sandstone or silty shale. The Vergennes Sandstone of Shaw and Savage (1912), composed of fine to medium micaeous sandstone, is present in parts of the area.

Utilizing primarily electrical logs, Jacobson (1983) mapped a fluvial sandstone in the region. Jacobson placed this sandstone at the same stratigraphic level as the Murphysboro Coal and attached the name Oraville Channel to this feature. This sandstone is present along the western edge of the Vergennes Quadrangle and the eastern edge of the Ava Quadrangle, as a gentle topographic high west of Beaucoup Creek. Jacobson (1983) considered the Oraville Channel to be adjacent to the Murphysboro Coal in a fluvial-dominated environment. The thicker coals aligned parallel to the sandstone channel and the coal splits are a result of crevasse splays along the margins of the channel.

Cores drilled by the ISGS during the spring of 2005 on the Ava Quadrangle to the west of the Vergennes Quadrangle, suggest some slight differences in the interpretations by Jacobson in 1983. The stratigraphic relationship of the sandstone observed in these borings suggests that the sandstone found in Jacobson's "Oraville Channel" unit is younger than the Murphysboro Coal and may be equivalent in time to the Mt. Rorah Coal, which is normally 30 to 50 feet above the Murphysboro Coal. The fine-grained sediments present at the Murphysboro horizon appear to be part of an eustarine system and not fluvially-dominated as originally inferred by Jacobson. The splits within the upper portion of the Murphysboro indicate that sea level was fluctuating or the area was slowly subsiding. There are limestone and green and red shale beds several feet above the Murphysboro Coal in one of the Ava Quadrangle ISGS borings which fit well with the proposed eustarine model.

Above the Mt. Rorah, a thin coal may be present that is correlated with the Wise Ridge Coal. This coal is overlain by a claystone with abundant plant debris which grades into a calcareous shale and in places a thin limestone. The limestone unit is the Seahorne. The Mt. Rorah, Seahorne, and Wise Ridge are not laterally continuous. Above the Seahorne is the Davis Coal which marks the base of the Carbondale Formation.

Carbondale Formation

The Davis Coal averages about 3 to 4 feet thick throughout much of southern Illinois (Jacobson 1993). The Davis Coal was and appears to be relatively free of pyrite and probably is a high quality bituminous coal.

Directly above the Davis lies a 3-foot shale parting with 0.8 feet of coal resting on the parting. This upper coal bed may be the Dekoven Coal

Member or may be a split within the Davis Coal. The Dekoven Coal is located above the Davis Coal but is thin and discontinuous. Where present the Dekoven is 20 to 30 feet above the Davis.

Above the Dekoven, a coarsening upward sequence is normally present with a sandstone at the top. The Colchester Coal lies atop the sandstone between 60 and 75 feet above the Davis Coal. There usually is a thin sandy underclay at the base. The Colchester in this region is less than 1.0 feet thick and overlain by the Mecca Quarry black shale and a limestone. The limestone is several feet thick and is named the Oak Grove Limestone.

The Houchin Creek Coal is present approximately 40 to 50 feet above the Oak Grove Limestone. The Houchin Creek is less than 0.5 feet thick and overlain by thin black shale and then by a brown micaeous sandstone.

The Springfield Coal lies 70 to 80 feet above the Houchin Creek. The Springfield has been mined extensively throughout southern Illinois. This coal was mined along with the overlying Herrin Coal in most of the northeastern portion of the quadrangle. The Coal is 3 to 5 feet thick and the interval between the Springfield and Herrin Coal is 20 to 40 feet thick and is composed of sandstone, limestone, and shale. The Herrin Coal is 4 to 6 feet thick and is overlain by shale and limestone. The limestone unit is called the Brereton; the black shale is named the Anna Shale; whereas the silty-gray shale is called the Energy Shale.

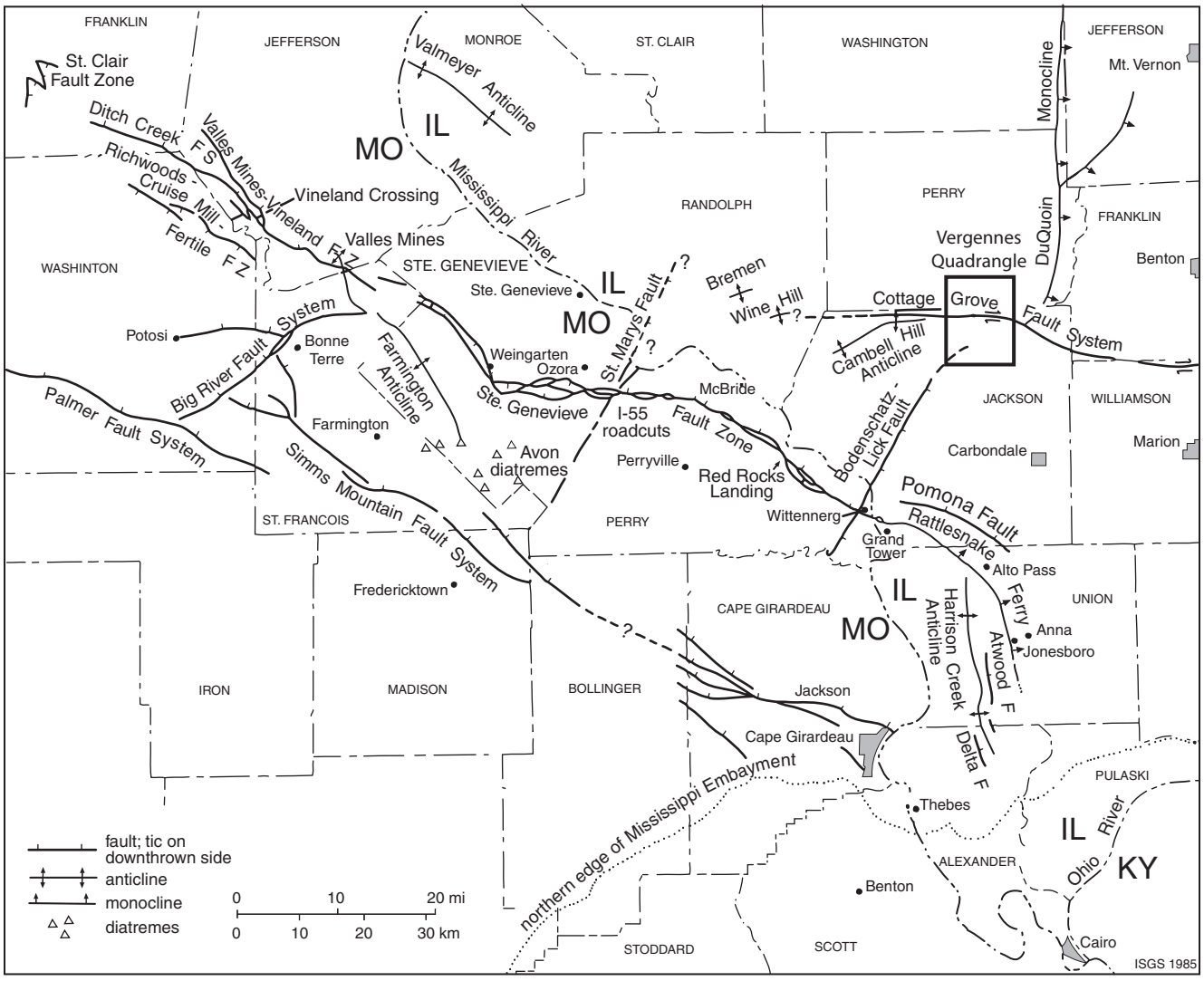

Figure 1 Regional structural geology of southwestern Illinois and southeastern Missouri (adapted from Nelson and Lumm 1985)

Structure

Regional Geology

The Vergennes Quadrangle is situated near the southwestern margin of the Illinois Basin. Across the Mississippi River in Missouri lies the Ozark Dome, a persistently high area that was uplifted repeatedly through geologic time while the Illinois Basin was warped downward. The Illinois Basin subsided intermittently throughout, as well as following the Pennsylvanian Period. As a consequence, Pennsylvanian and older rock strata of Jackson, Perry, and Randolph Counties have been tilted gently toward the northeast. Faults and folds may slightly modify regional dip in the Vergennes Quadrangle.

Several tectonic features have affected the Vergennes Quadrangle: 1) the Ste. Genevieve Fault Zone, and 2) the Bodenschatz-Lick Fault Zone, 3) the Cottage Grove Fault Zone which crosses the quadrangle, extending about 65 miles east-southeast from the Vergennes Quadrangle into western Gallatin County. Here it is a complicated structure having faults and folds of diverse orientations including the following two on the quadrangle: a) The Vergennes Anticline-- one of a series of folds found along the Cottage Grove Fault Zone, and b) a series of small subsidiary normal faults striking NW along the Cottage Grove Fault Zone (fig. 1). Stratigraphic data indicate at least a portion of the faulting occurred after deposition of the Caseyville, but prior to deposition of the Tradewater, producing an unconformity on the Caseyville surface.

Ste. Genevieve Fault Zone

The Ste. Genevieve Fault Zone, located approximately 10 miles southwest of the Vergennes Quadrangle, trends northwest. Structural offset on the Ste. Genevieve in this region exceeds 3000 feet (Nelson 1995). The Ste. Genevieve was active during Ordovician, Devonian, and late Mississippian-Pennsylvanian, with the latest period being reverse movement with the southwest block being uplifted. Several workers have proposed strike-slip movement along this structure (Heyl 1972, Clendenin et al. 1989, Schultz 1992). The Bodenschatz-Lick Fault crosses the Ste. Genevieve at 90 degrees and the relationship between these two faults is not well documented.

Bodenschatz-Lick Fault

The Bodenschatz-Lick Fault (BLF) (fig. 2) crosses the Ava Quadrangle at the extreme southeastern portion of the map and then enters the Vergennes Quadrangle near the middle of the southwestern quarter. At this point we do not have enough data to map it further, however it is likely that this fault terminates in the Cottage Grove Fault system (Nelson and Lumm 1985). We have no indication that it continues north of the Cottage Grove Fault Zone based on available data utilized for this mapping project.

The steeply dipping eastern limb of this fault can be observed at the surface to the south in the Oraville Quadrangle where a prominent topographic ridge is present. This topographic high was recognized by Root (1928) who related this feature to a structure which he named the Levan Anticline. Shaw (1912) depicts this anticline plunging 150 feet per mile toward the east with a diminishing plunge downdip northward. Nelson (1995) suggested the Levan Anticline was actually a monocline related to the Bodenschatz-Lick Fault (BLF) and therefore discarded the term Levan. Nelson and Lumm (1985) traced the BLF using subsurface data and determined the fault extends northeast from south of the Ste. Genevieve Fault Zone in Missouri to where it merges with the Cottage Grove Fault Zone in Jackson County, Illinois. Nelson and Lumm suggested that there was an increase in vertical offset on units lower in the section and that the Pennsylvanian was folded into a monocline at the surface. Bristol (1968) mapped several hundred feet of vertical offset on the base of the Barlow Limestone (Mississippian Beech Creek Limestone) along this feature (fig. 2).

Cottage Grove Fault Zone

The Cottage Grove Fault Zone (fig. 2) crosses this quadrangle from east to west just south of and paralleling the Jackson-Perry county line. While there

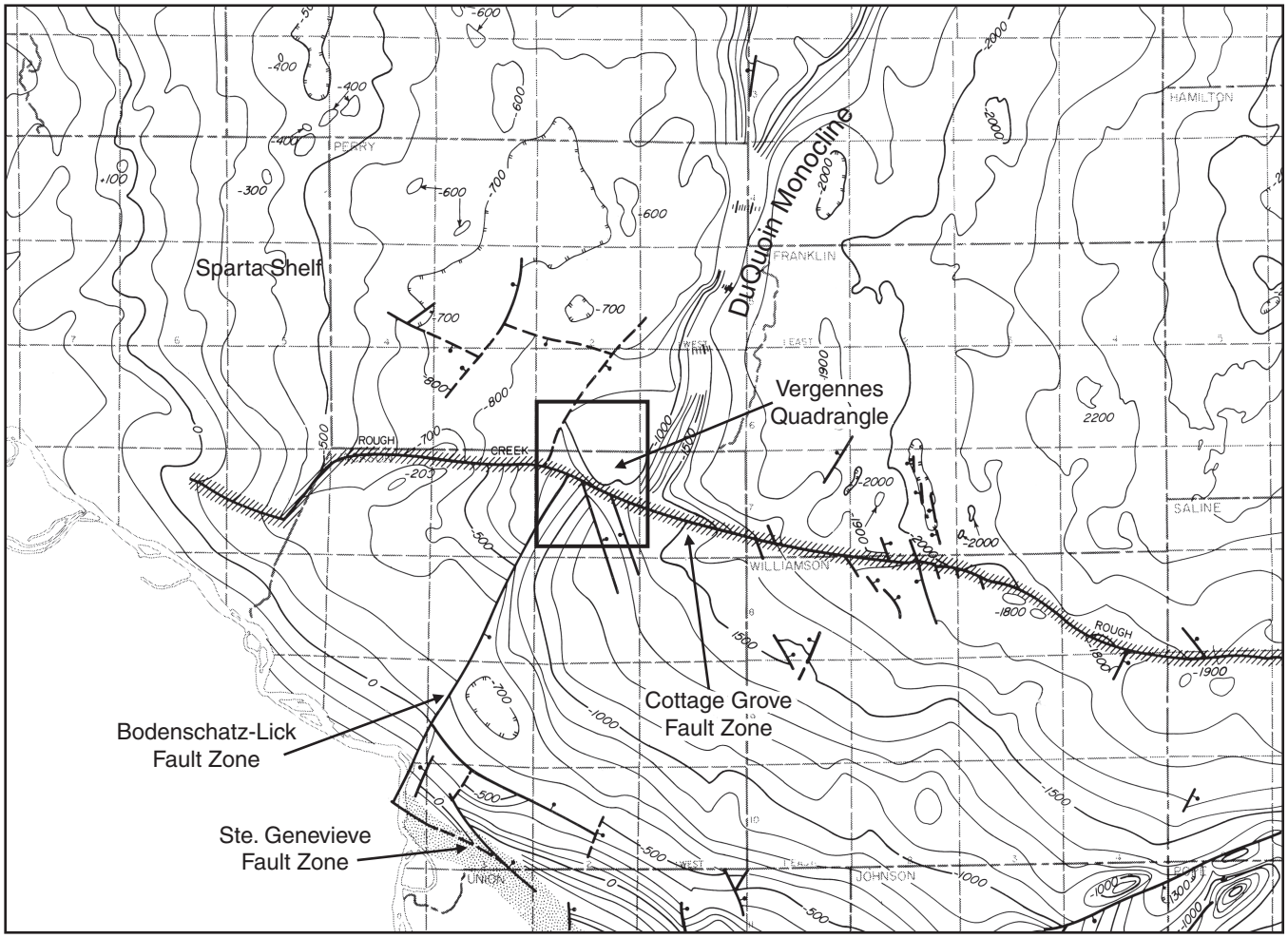

Figure 2 Structure contour on the base of the Barlow Limestone (Mississippian, Golgonda Formation). Note that the Cottage Grove Fault has been labeled the Rough Creek Fault Zone (modified from Bristol 1968).

is significant topographic relief along this feature, there are surprisingly few exposures. This fault zone is undoubtedly more complex than the single master fault depicted on the geologic map in the western portion of the Vergennes Quadrangle, but there is not enough data to accurately project additional fault segments. In the eastern portion of the quadrangle and especially eastward of the quadrangle, the Cottage Grove is better known from outcrops, exposures in surface and underground coal mines, and geophysical data (Nelson and Krausse 1981, Duchek et al. 2005).

The faulting along the east-west trending Cottage Grove Fault Zone is described as a right-lateral strike-slip fault (Nelson and Krausse 1981). This fault extends from Gallatin County westerly into Perry and Jackson Counties. Northwest trending subsidiary faults are theorized to be related to this wrenching movement. Igneous rock has intruded some of these northwesterly trending faults at the eastern end of this fault zone in Gallatin and Saline Counties. An igneous dike in Saline County has been dated as Early Permian (269.61+/-0.39 Ma) using radiometric (40Ar/39Ar) isotopic dating techniques (Denny 2005). These igneous intrusions are thought to be emplaced at or very soon after the strike-slip deformation along this fault zone, thereby yielding an early Permian age of tectonic activity. The structure is also believed to be located over a Precambrian crustal boundary (Heigold and Kolata 1993).

Seismic Data

Recent seismic interpretation by Duchek et al. (2005) describes the Cottage Grove Fault Zone in

an area east of Ava in the West Bend section of the Cottage Grove Fault Zone. Several reflection profiles were reprocessed and the tectonics of the Cottage Grove Fault Zone was discussed. The precise location of the two seismic lines along the West Bend was not determined but should be within a few miles of the Ava Quadrangle. The authors stated that they could not definitively demonstrate dextral displacement along the Cottage Grove due to lack of data. They also concluded that there is no evidence for two or more episodes of movement under different stress orientations.

Vergennes Anticline

The Vergennes Anticline, named by Nelson and Krausse (1981) for the village and township of the same name (on this quadrangle) lies in northeastern Vergennes Township and northwestern Elk Township, Jackson County. The anticline was mapped from coal-test drilling in the Herrin Coal and deeper coals (fig. 3); the axis of the fold lies approximately one-half mile south of the center of the Cottage Grove Fault zone (master fault) and strikes on a heading of about east to southeast. It shows about 100 feet of closure on the Colchester Coal, with a north flank that dips about 1:20. The north flank of the anticline is truncated by the master fault zone of the Cottage Grove, which according to Nelson and Krausse (1981) had a throw down to the north of about 100 feet. The south flank of the Vergennes Anticline is much gentler, with an incline of about 1:30. The anticline affects strata as deep as the Devonian, and oil has been produced from Devonian limestones in the Vergennes oil field found on the crest of this fold.

Northwest Striking Subsidiary Faults Along the Cottage Grove Fault Zone in Jackson County

Northwest striking faults (fig. 4) were mapped by Nelson and Krausse (1981) on both sides of the Cottage Grove Fault Zone in northeastern Jackson County. Examination of mine maps for the Kathleen Mine show a number of such faults that continue NW into Perry County as well. These northern subsiderary faults diminish in displacement as one moves away from the master fault zone, and they seem to be no longer than 2 miles in most cases. South of the Cottage Grove, the northwest striking faults are sometimes slightly longer, being as long as 6 miles in length away from the Cottage Grove Fault Zone. Both high angle normal and reverse faults were observed, and abandoned mine maps also show several northeast striking faults in this area south of the Cottage Grove Fault Zone.

Summary

At least three and probably four periods of movement are needed to explain the tectonic activity within this area. The seismic lines published by Duchek et al (2005) depicts these movements. The first period of movement is extensional and rifted the Precambrian Basement which was then filled with Knox Group sedimentation. The second period of movement is probably related to the regional uplift of the Sparta Shelf northeast of the Ste. Genevieve Fault Zone during the Devonian. The Sparta Shelf is defined as the southern portion of the Western Shelf that defines the western flank of the Illinois Basin (Nelson 1995). This Western Shelf is believed to have a slower rate of subsidence than the area to the east of the Du Quoin Monocline. The unconformity near the top of the Knox Group probably reflects this phase of regional uplifting.

The third period of movement effectively raised the area south of the Cottage Grove Fault. It is also likely that movement on the Bodenschatz-Lick Fault occurred simultaneously with this Early Pennsylvanian (Atokan) event. The unconformity along the flanks of the Campbell Hill Anticline between the Caseyville Sandstone and the Tradewater Formation supports this tectonic event. The stratigraphic correlation of the early Desmoinesian Murphysboro strata indicate that along the down-thrown side of the Bodenschatz-Lick Fault marine limestones are present, while on the upthrown side fine-grained intertidal and eustarine deposits were being deposited. This also indicates that movement may have been active during early Desmoinesian. During middle to late Desmoinesian, the region was apparently fairly stable and characterized by widespread coal formation.

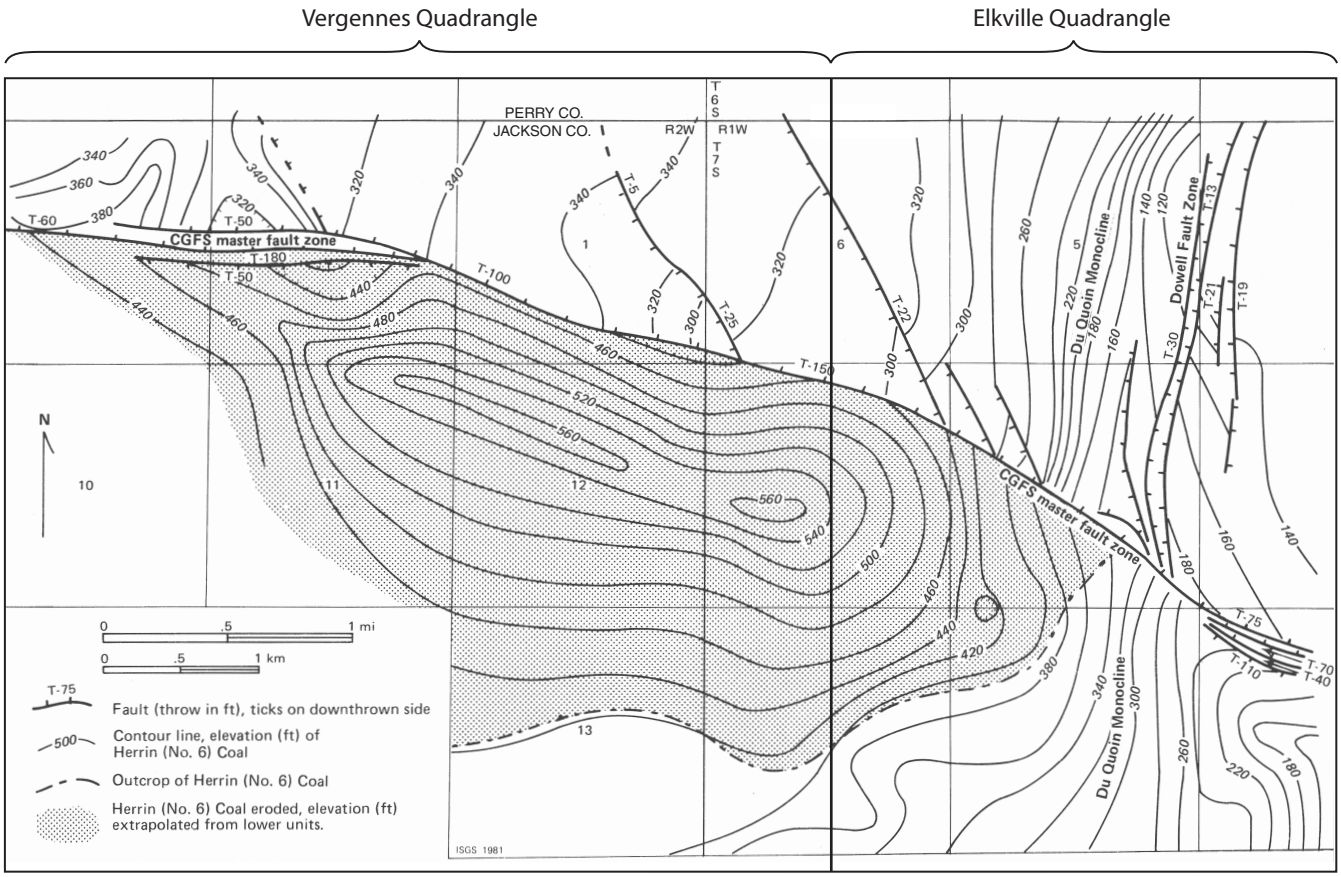

Figure 3 Vergennes Anticline contoured on the Herrin (No. 6) Coal. Vergennes Anticline lies parallel with and south of the master fault zone. DuQuoin Monocline and Dowell Fault Zone are seen on the east side of map. The monocline crosses the master fault zone and begins to die out about one mile (1.6 km) to the south. (after Nelson and Krausse 1981)

The fourth period of movement (post-Desmoinesian) occurs as reverse movement along a south side of the Cottage Grove Fault Zone. Anticlines associated with the Cottage Grove Fault Zone have been described by Nelson and Lumm (1985). With the exception of the Cottage Anticline in Saline County, which is related to a Permian igneous intrusion (Denny 2005), anticlines associated with the Cottage Grove are confined to the southern portion of the Cottage Grove Fault Zone. This leads to the speculation that reverse movement along the western end of the Cottage Grove Fault Zone is related to deep-seated northerly directed post-Desmoinesian compressional force. This movement may be related to continental compression from the Ouachita region. Alternatively, the final period of movement may be a result of east-west transpression along a Precambrian crustal boundary during Permian (Nelson and Krausse 1981, Duchek et al. 2005). The horizontal striations along small northwesterly trending faults observed in the Creek Paum Mine tend to support the transpressional theory.

Economic Geology

Coal

Coal has been mined extensively within the Vergennes Quadrangle. While no mining is currently active in the quadrangle, a single mine extracts the Murphysboro Coal just to the west in the Ava Quadrangle. The Murphysboro Coal is a high quality, low sulfur, bituminous coal (Jacobson 1983). Murphysboro Coal should be present at depths less than 200 feet in much of the western portion of the Vergennes Quadrangle. Borings in the area have encountered up to 5 feet of Murphysboro Coal. Borings done in May, 2006 in this area by the ISGS encountered 3 feet of Murphysboro at depths of 100 feet separated by a 9-foot shale part-

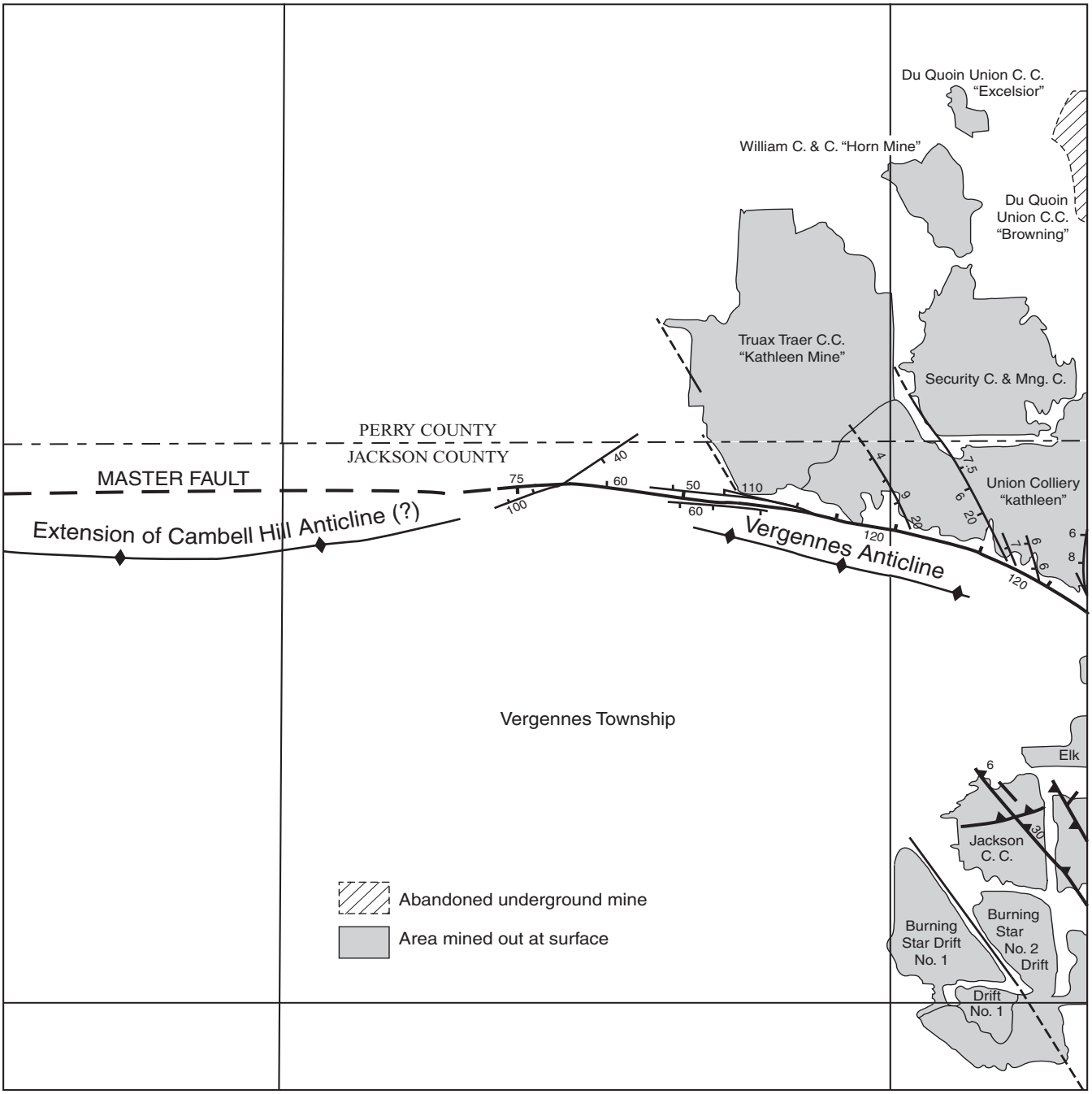

Figure 4 NW – SE striking subsidiary faults in eastern Vergennes Quadrangle along the Cottage Grove Fault Zone (from Nelson and Lumm 1985)

ing, which overlies another 4.4 feet of coal. The lower 1.4 feet of coal contains shale laminations. More of the southwestern quarter of the quadrangle should be drilled to determine the quality and thickness of the Murphysboro in this area south of the Cottage Grove Fault Zone. The Cottage Grove Fault will certainly affect the mineability of the coal in this area as the north side is approximately 150 feet deeper.

The Davis Coal was observed in borings in the adjacent Ava Quadrangle as well as in the Vergennes Quadrangle. It was observed to be bright banded with few partings and little pyrite, and ranging from less than 1 foot to over 3 feet thick. Above the Davis, a coal up to 1.3 feet thick was present

which may be the Dekoven Coal. The Dekoven Coal appears to be shaley and probably would be of marginal quality.

The Houchin Creek and Colchester Coals have been identified in this area, but are less than 2 feet thick in most borings. The Herrin and Springfield Coals have been mined along the northern and eastern half of the Vergennes Quadrangle and are mostly mined-out. There may be a small area of Herrin and Springfield present along Walker Creek near the center of the quadrangle along the Jackson-Perry County line. Core drilling in this area would be necessary to verify this assumption (see geologic map).

Oil and Gas

Oil is produced along the crest of the Vergennes Anticline in the eastern part of the quadrangle from Devonian limestones at a depth of about 3200 to 3400 feet. A few other non-productive wells have been drilled in the quadrangle.

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