STATEMAP
Galatia-BG

Bedrock Geology of Galatia Quadrangle

Saline County, Illinois

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2015

ILLINOIS STATE GEOLOGICAL SURVEY
PRAIRIE RESEARCH INSTITUTE

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Stratigraphy

Following are remarks on some of the units named on the stratigraphic column.

Permian age igneous rocks
Ultramafic dikes have been observed throughout southeastern Illinois and northwestern Kentucky. Excellent exposures of these ultramafic bodies have been encountered in underground and surface coal mine workings within the region. These igneous bodies are ultramafic, vertical or nearly vertical dikes that normally trend in a north-northwest direction. Due to the mineralogy of the dikes, we assume they have ascended from the upper portion of the earth's mantle, deep within the earth, intruding upward into the Paleozoic rocks (Denny et al., 2002). The igneous intrusions were emplaced about 270 million years ago or during the Permian (Fifarek et al., 2001), and are interpreted to be ascending very rapidly along the northwesterly-trending joints and fractures within the Precambrian basement. The igneous features contain several percent magnetite, which provides a strong magnetic contrast compared to the surrounding sedimentary host rock. Success locating theses dikes has been found using magnetic surveys (Hildenbrand and Ravat, 1997; Silverman et.al., 2003).

Mapping of these features indicates that some of these dikes can be traced along strike for several miles. Most dikes are a few feet in width, but a dike encountered in a coal mine at Harrisburg, Illinois was reported to be over 100 feet wide (Denny et al., 2006). The dikes may be associated with faults of small to moderate displacement, but in other instances the dikes split the coal seam without appreciable offset of the coal on either side of the dike. The dikes are usually along very straight linear trends and may intrude through the entire Pennsylvanian units or sill out below the Pennsylvanian coals in lower Paleozoic units. Horizontal sills formed adjacent to the dikes in the Paleozoic units as the velocity of the ascending igneous dike slows (Sparlin and Lewis, 1994). The sills have been mainly documented by oil and gas exploration, where exploration wells intercept a bed of ultramafic rock a few feet to 75 feet thick between horizontal sedimentary layers. In addition to the linear dikes and interconnected horizontal sills, circular pipe shaped features or diatremes are also present that represent venting of the igneous complex to the paleosurface. Diatremes may have formed within the ultramafic magma due to rapid expulsion of volatiles potentially augmented by interaction with groundwater (phreatomagmatic). In some intrusions of this provenance volcaniclastic or diatreme phase features called shatter breccias have been observed. In shatter breccia the primary rock mass is composed clasts of country rock with a lesser amount of igneous material enclosing sedimentary clasts.

Dikes plotted on this quadrangle are based on mine notes, ISGS publications, and drill data. The dikes mostly trend about N 20° W and have an irregular upper surface or top. From previous investigations it appears the dikes in this area are clustered around the Cottage Gove Fault. Along the north side of the Cottage Grove Fault the top surface of the dikes usually dives to the north.

Stark Shale Member. The black, fissile shale that directly underlies the Carthage Limestone has been correlated with the Stark Shale Member of the Midcontinent on the basis of conodont biostratigraphy (Heckel and Weibel, 1991).

Raben Branch Coal Member. The thin coal seam (locally, two coal layers separated by shale) occurring about 70 feet below the Stark Shale is identified with the Raben Branch Coal Member, which was originally described in Posey County, Indiana (Shaver et al., 1970). The Raben Branch is distinct from the younger New Haven Coal (Parker Coal in Indiana), which occurs (where present) at the base of the Stark Shale.

Hushpuckney Shale Member. The black, fissile shale associated with the Macoupin Limestone has been correlated with the Hushpuckney Shale of the Midcontinent on the basis of conodont biostratigraphy (Heckel and Weibel, 1991). This unit is present through much of the Illinois Basin.

Womac Coal Member. There is some question as to the correct identity of the Womac Coal in the Galatia quadrangle. Cores reveal a very thin coal layer or carbonaceous streak at the base of the Hushpuckney Shale and overlying a thick, well developed underclay (paleosol). At its type locality in Macoupin County, Illinois the Womac Coal occupies the same position (Kosanke et al., 1960). The much thicker coal that lies 23 to 30 feet below the Hushpuckney and apparently represents an older cycle of deposition. Pending resolution of the question, the older and thicker coal layer has been labeled "Womac Coal".

Mound City Shale Member. The black, fissile shale associated with the Cramer Limestone Member has been correlated with the Mound City Shale of the Midcontinent on the basis of conodont biostratigraphy (Heckel and Weibel, 1991).

Exline Limestone Member. A thin but widely persistent limestone unit in the study area is correlated with the Exline Limestone of the Midcontinent on the basis of regional subsurface correlation, supported by conodont biostratigraphy (Heckel and Weibel, 1991) and palynology of associated coal layers (Peppers, 1996). Unpublished cross sections by W.J. Nelson confirm that the Exline is directly continuous with the upper bench of the West Franklin Limestone east of the study area. Thus, the top of the Exline is considered to contact between the Patoka and Shelburn Formations. Moreover, the base of the Exline is the regional boundary between the Missourian and Desmoinesian Stages (Heckel et al., 2002).

Athensville Coal Member. This thin but widely persistent unit has been called both Athensville Coal (for a locality in Macoupin County) and Lake Creek Coal (for a site in Williamson County). Physical correlation and palynology (Peppers, 1996) indicates that both are the same unit. Given that Athensville and Lake Creek both were introduced in the same publication (Kosanke et al., 1960), neither name has priority. My arbitrary choice is to use Athensville, because this unit has a well-described type section in a stream cut, whereas the type section for the Lake Creek is in a drill core that no longer exists.

Attila Shale Member. This widespread unit of black, fissile shale was named by Nelson (2007) for the village of Attila in the Pittsburg quadrangle. The Attila is correlated with the Nuyaka Creek Shale of the Midcontinent on the basis of conodont biostratigraphy (Heckel, 2013).

Rock Branch Coal Member. Like the Athensville, this coal has gone under two names: Rock Branch (from Macoupin County) and Pond Creek (from Williamson County. Again, both names first appeared in the same publication (Kosanke et al., 1960), so neither has clear priority. I select the name Rock Branch to avoid duplication with the Pond Creek coal bed of eastern Kentucky.

Baker Coal Member. The name Allenby Coal Member (Kosanke et al., 1960) previously was used for the thin coal or pair of thin coals that lie a short distance above the Bankston Fork Limestone and below the Danville Coal. However, the Allenby clearly is the same as the Baker coal bed of western Kentucky, and the name Baker has priority (Glenn, 1912).

Survant Coal Member. In the Galatia quadrangle, and throughout much of the Illinois Basin, the Survant Coal Member comprises two coal layers that developed in separate cycles of sedimentation. The upper and lower Survant coals probably correspond, respectively, with the Bevier and Wheeler Coal Beds of the Midcontinent.

Dekoven Coal Member. Without explaining the mechanism, Jacobson (1987, 1993) described and mapped the two "benches" as a simple case of the Dekoven Member "splitting". An alternative proposal is two distinct cycles of sedimentation, corresponding to the Greenbush (older) and Abingdon Coal Members of western Illinois (c.f. Wanless, 1957).

Structure

The map area is situated near the southern margin of the Illinois Basin. Contour lines on the geologic map depict elevation (structure) of the top of the Springfield Coal. These reveal an average northward dip of approximately 50 feet per mile, which translates to a 1% grade or a dip of ½ degree. A statewide map of Springfield Coal structure (ISGS, unpublished data) reveals that the northward dip markedly diminishes near the northern border of Saline County, and that the Springfield attains its lowest elevation through a broad area extending north-northeast from northeastern Hamilton to southwestern Jasper County. Structure of deeper horizons, including the top of the Mississippian Ste. Genevieve Limestone (Bristol and Howard, 1976), base of the Devonian New Albany Shale (Cluff et al., 1981), and top of the Ordovician Kimmswick (Trenton) Limestone (Bristol and Buschbach, 1973), broadly mirrors that of the coal. These maps show the deepest point in the basin roughly 25 miles north-northeast of the Galatia quadrangle in eastern Hamilton and northwestern White Counties. Also, these maps indicate the northward dip to be somewhat gentler on Mississippian and older horizons than on the coal.

The chief structural feature of the region is the Cottage Grove Fault System, the main part of which crosses the southern part of the quadrangle. The system comprises an east-trending "master fault zone" flanked by a series of smaller faults and igneous dikes that trend northwest. In this area, the master fault has two main strands 4,000 to 7,000 feet apart, the southern strand lying along the southern border of the map area. The faults lack surface exposures, but the northern strand has subtle surface expression in a series of small, sandstone-capped hills. The fault traces, approximately located, are based on encounters in underground mines and on borehole data. The southern fault has throw down to the south, whereas the northern fault appears to change direction of throw along the strike.

Between the strands of the master fault and north of the northern strand are numerous northwest-trending faults and several igneous dikes. Most of the faults are high-angle normal, but some may be reverse or oblique-slip. The largest known throw is about 28 feet. These faults and dikes have been mapped only where they were encountered in underground mines.

Regionally, the Cottage Grove is interpreted as a right-lateral strike-slip fault system. Geophysical data indicate that the zone penetrates basement rocks and may follow a Precambrian crustal boundary (Nelson and Krausse, 1981; Duchek et al., 2004). However, the lack of offset where the Galatia paleochannel crosses the fault zone indicates that the strike-slip displacement near the surface is small.

Economic Geology

Coal. Coal is the leading economic resource in the Galatia quadrangle. Mining began more than a century ago, and continues today. Most of the historic mining took place underground in the Springfield Coal, which was 6 feet or thicker across large areas and had unusually low sulfur content for Illinois Basin coal (Hopkins, 1968). As most of the available Springfield Coal in the quadrangle has been mined, underground operations now focus on the Herrin Coal.
The Springfield Coal is absent in the Galatia channel, a

paleochannel that is shown on the geologic map. Close to the margins of the channel, coal quality drops due to the introduction of multiple laminae of shale, and in places the seam "splits" into two or more "benches" separated by clastic rocks up to about 30 feet thick. The coal is thin and/or shaly and probably unsuitable for mining in a large area east of the channel in the central part of the map area. Other features detrimental to mining include faults and igneous dikes. The Herrin Coal is 5 to 7 feet thick throughout the Galatia quadrangle. Roof conditions for underground mining are overall good to excellent, because the Anna Shale is moderately competent and the Brereton Limestone highly competent as the main roof. Faults and dikes are the main obstacles to mining, but for the most part their locations are well known. Large masses of coal balls, composed of limestone, have been encountered in the active New Era Mine of American Coal Company. These features are unpredictable and can be a serious impediment to longwall mining. Surface mining of the Herrin and Danville Coals took place in the Delta Mine at the southwest corner of the map area. Prospects for future surface mining are poor because of excessive depth and surface development.

Oil. Part or all of eight oil fields lie within the Galatia quadrangle (Fig. M1). Largest by far and best documented is the Eldorado consolidated field, only the southwestern end of which falls within the map area. As Hawn (1968) detailed, sandstone of the Chesterian (Upper Mississippian) Waltersburg Formation is the principal productive unit. According to Hawn, the sandstone has maximum thickness of 80 feet and averages about 30 feet thick. It is a relatively clean, well-sorted, fine quartz sand with moderately angular to moderately rounded grains. This reservoir is part of a narrow, elongate, southwest-trending Waltersburg sandstone body mapped by Potter (1962), who noted (p. 19) that the body trends perpendicular to depositional strike and "appears to be dominantly oriented down the paleoslope". This observation is at odds with Hawn's (1968, p. 98) statement that the sand body at Eldorado "is probably of near or offshore marine bar origin". Where a similar southwest-trending Waltersburg sandstone body reaches the outcrop in Johnson County, the sandstone exhibits prominent large-scale crossbedding indicating a southwest paleocurrent, down depositional dip and parallel with the long axis of the body (Nelson, 1993). This observation suggests that the Waltersburg at Eldorado represents fluvial sand of an incised valley.

Other oil fields in the Galatia quadrangle produced from Chesterian sandstone reservoirs, chiefly the Cypress and Aux Vases Formations with lesser contributions from Palestine, Tar Springs, Waltersburg and other sandstones along with limestone reservoirs in the older Ste, Genevieve Formation. Published analyses of these fields are not available, and no investigation was undertaken for this mapping project. Considering the lack of structural closure on the Springfield Coal and older mapped horizons, it is likely that the trapping mechanism in these fields, as at Eldorado Consoldiated, is primarily stratigraphic. Multiple pay zones are developed because the discovery of oil in one formation prompts testing of older and younger units. It is unclear how the igneous dikes have impacted oil fields in this area.

A glance at Table 1 shows that all eight oil fields in the map area have reached advanced old age. Upper Mississippian (and Pennsylvanian) petroleum possibilities in the Galatia area have been tested quite thoroughly. In contrast, only a few wells have penetrated strata deeper than the Ste. Genevieve Limestone. The prospects for production from these deeper units are difficult to evaluate.

Acknowledgements

This research was funded in part by the U.S. Geological Survey (USGS) National Cooperative Geologic Mapping Program under USGS STATEMAP award number G14AC00328, 2014. The views and conclusions contained in this document are those of the authors and should not be interpreted as necessarily representing the official policies, either expressed or implied, of the U.S. Government.

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