STATEMAP
Dekoven-BG

Bedrock Geology of Dekoven Quadrangle

Hardin County, Illinois, and Union and Crittenden Counties, Kentucky

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Introduction

The Dekoven 7.5-minute Quadrangle occupies the area between 37˚ 30’ and 37˚ 37’ 30” N latitude and 88˚ and 88˚ 07’ 30” W longitude. It is situated in the southwestern portion of the western Kentucky coal basin, a region with valuable coal resources. The area is dissected by minor faults that extend northeastward from the Illinois-Kentucky Fluorite District (IKFD).

Bedrock is composed of Mississippian (Chesterian) and Pennsylvanian sedimentary rocks, and the regional dip is 3˚ to 5˚ to the northeast. The more resistant sandstone units form dip slopes that stand out in the topography, and the limestones and shales are more easily eroded and form more gentle slopes between sandstone ledges.

The quality and quantity of rock exposures range from excellent to non-existent, with the best exposures being in steep bluffs, and the poorest exposures being in wide alluvial valleys.

Structural Geology

The Dekoven Quadrangle lies between two major regional structures—the IKFD and the Rough Creek fault system, which are thoroughly discussed by Nelson (1995). Within the quadrangle, fault displacements have been determined mostly from coal-test borings (Kehn 1974).

The NE-trending faults are related to the IKFD. Faults in the southeastern part of the quadrangle offset the Caseyville and Tradewater Formations by about 120 feet. They are probably linked to the Lola (Dyer Hill) and Commodore fault systems and die out to the northeast. An extension of the Peters Creek fault zone and the Rock Creek Graben occurs in the northwestern part of the quadrangle (Denny et al. 2013). The Peters Creek fault downdrops the Bond Formation on the northwest side by about 200 feet in the Rock Creek Graben, but displacement dies out to the northeast.

In the northeastern corner of the quadrangle, the WNW-trending fault is a splay that is related to the larger Rough Creek fault system, which crosses the adjacent Grove Center Quadrangle (Palmer 1976).

Stratigraphy of the Pennsylvanian Subsystem

The Dekoven area has special significance for Pennsylvanian stratigraphy, for D.D. Owen and associates (1856, 1857) conducted some of the earliest stratigraphic studies in the Illinois basin. Owen and his successors named numerous units that are still in use today. The Dekoven quadrangle is particularly significant because type sections of the two lowest Pennsylvanian formations, the Caseyville and Tradewater, are situated wholly or partly within the quadrangle. This area also contains type sections of numerous beds and members throughout the Pennsylvanian column. Many of the member names described in this report are new, being based on regional correlations between the Illinois basin and the Midcontinent basin.

The Pennsylvanian has recently been reclassified as a subsystem of the Carboniferous System (Heckel and Clayton 2006). A regional unconformity separates the Mississippian and Pennsylvanian Subsystems throughout the Illinois Basin. This erosional surface exhibits approximately 200 feet of relief within the Dekoven quadrangle. As shown on the column, basal Pennsylvanian rocks rest variably on units ranging from the Cave Hill Member of the Kinkaid Formation to the uppermost part of the Menard Limestone.

Repetitive vertical sequences have been noted in the Pennsylvanian rocks by geologists; these have historically been called cyclothems (Wanless and Weller 1932). Although this term may be considered “out of vogue” it does describe the cyclic nature of the Pennsylvanian section. Modern interpretation of these cyclic sequences relates the cycles to global sea level fluctuations (eustacy) possibly related to glacial cycles (Heckel 1990). The depositional cycles are a result of sea level rise and fall and depositional environments shifting from marine to terrestrial. The cyclic sequences are readily observable in the highwalls of surface coal mines throughout the region in the Carbondale Formation and younger units. Illinois Basin Consortium Study 5 (Tri-State Committee 2001), a collaborative effort between the Illinois, Kentucky, and Indiana geological surveys, proposed a unified stratigraphic classification of the Pennsylvanian System for the Illinois Basin. The accompanying geologic map adheres to this stratigraphic classification.

Despite this collaborative study, some issues of classification have not been resolved. Coal seams historically have been classified as formal members in Illinois and as informal beds in Kentucky. Also, numbers assigned to coal seams by the earliest geological surveys in the respective states are still widely used by the mining industry. The numbering scheme differs between Indiana and Kentucky. Thus, for example, the Springfield Coal is No. 5 in Illinois and No. 9 in Kentucky. For reference, both sets of classifications are indicated on the geologic column.

The following stratigraphic and lithologic descriptions supplement the geologic column and descriptions of geologic units on map sheet 2. Data used to compile the column and descriptions include about 30 coal-test borehole records on file in the ISGS Coal Section, and electric logs of about 15 oil-test holes obtained from the Kentucky Geological Survey. Also, the core record from Kentucky Geological Survey’s Gil 15 test hole is available (Williams et al. 1982). This core spans the interval from the Survant Coal to the

Bell Coal (lower part of Carbondale Formation and all of the Tradewater). Further information was drawn from published maps and reports.

Caseyville Formation

Owen (1856) used the term "Caseyville conglomerate" in reference to rocks exposed near Caseyville, Kentucky in the Dekoven quadrangle. Glenn (1912) was the first to use Caseyville in a formational sense. Lee (1916, p. 15) described the type section of the Caseyville "on the Illinois shore of the Ohio River between the mouth of the Saline River (in the Saline Mines 7.5-minute Quadrangle) and Gentry's landing below Battery Rock (in the Dekoven 7.5-minute Quadrangle).

As thus established, the Caseyville is composed of sandstone, siltstone, shale, non-fissile mudstone, thin local coal, and rare marine limestone. Sandstone is predominantly quartz arenite containing at most a few percent of feldspar, lithic grains, and mica flakes. Well-rounded granules and small pebbles of quartz commonly are present. Bluff-forming, crossbedded to massive sandstone units attain thicknesses greater than 150 feet. Shale, siltstone, and mudstone of the Caseyville are various shades of gray, interlayered in varying proportions, and generally poorly exposed, eroding to slopes (Nelson 1989).

Two named members of bluff-forming, pebbly sandstone are present. The Battery Rock Sandstone Member in the mid-lower Caseyville was named for Battery Rock in the Dekoven Quadrangle (Cox 1875, p. 204); whereas the Pounds Sandstone Member at the top of the Caseyville takes its name from Pounds Hollow in Gallatin County, Illinois, less than 10 miles west of the map area (Weller 1940). The Wayside Member, underlying the Battery Rock Sandstone, comprises interbedded shale, siltstone, and sandstone confined to paleovalleys eroded into the sub-Pennsylvanian surface.

The top of the Caseyville has been variably mapped at the top of the Pounds Member (Baxter et al. 1963) and at the base of the Bell coal bed (Kehn 1974). Given the local extent of the Bell even within the Dekoven quadrangle, the regional upper contact of the Caseyville is the highest occurrence of quartz arenite, contrasting with more lithic sandstone of the overlying Tradewater Formation (Nelson 1989).

Tradewater Formation

Glenn (1912) first used the name Tradewater Formation for rocks cropping out near the mouth of the Tradewater River in the southern Dekoven quadrangle. Lee (1916) formalized the Tradewater Formation and published a type section based on unspecified outcrops and borehole records in the area. The core from the Kentucky Geological Survey's Gil 15 borehole at Dekoven, described in Williams et al. (1982), penetrated the entire Tradewater and serves as a reference section. As designated by Lee (1916) and endorsed by the Tri-State Committee (2001), the top of the Tradewater is mapped at the base of the Davis Coal.

Mapping the contact between the Caseyville and the Tradewater in the field can be problematic. The transition from clean quartz arenite of the Caseyville to micaceous litharenite and sublitharenite of the Tradewater is gradual. Quartz pebbles, like those of the Caseyville, occur locally in sandstone of the lower Tradewater. Some of the quartz pebble conglomerates in the Tradewater may have been reworked from the underlying Caseyville Formation. Within the Dekoven quadrangle, the top of the Pounds Sandstone can be mapped in direct continuity from Illinois to Kentucky.

Coal seams are present in the Tradewater, but typically lack the thickness and lateral continuity of those in the overlying Carbondale Formation. Several Tradewater coal beds within the Dekoven quadrangle locally attain a mineable thickness. The Bell Coal, which formerly was mined in the southern part of the map area, range from a streak to more than 4½ feet thick. A second coal bed occurs approximately midway between the Bell and the Ice House. One driller's log recorded thin limestone above the second coal, suggesting a marine zone. Several drilling records indicate a limestone bed 2 to 4 feet thick, and locally sandy, about 35 to 45 feet below the Smith Coal. The limestone is believed to be the Lead Creek Member. Lee (1916) identified as the Ice House Coal two coal beds less than 2 feet thick and separated by 25 feet of clastic strata. Few drilling records indicate coal at that position. Logs do indicate a coal seam, locally over 2 feet but generally less than 1 foot thick, approximately 100 feet above the Bell Coal.

Lack of lateral persistence characterizes all coal beds older than Western Kentucky No. 4. The Smith coal bed, as mined at the Smith Mine, had very high (unspecified) heating value and low ash and sulfur content, according to Lee (1916). Based on drilling records, Lee positioned the Smith Coal about 275 feet above the Bell Coal and 100 feet below the Curlew Limestone. Drilling records from the southern part of the Dekoven quadrangle consistently show a coal seam 0.3 to 2.8 feet thick at the indicated position of the Smith. These same records show the Smith being younger than a limestone unit believed to be the Lead Creek Limestone. Using palynology, Peppers (1996, chart) plotted the Smith Coal as older than the Lead Creek; however, where Peppers obtained his coal samples is unknown. The Smith Mine is long abandoned, and its precise location (most likely in the southeastern part of the Dekoven quadrangle) is not known.

The Western Kentucky No. 4 coal bed is bright-banded coal as thick as 2 feet. Peppers (1996, p. 53) identified fossil pollen from this coal in the Gil 15 core as indicating late Atokan age. Peppers further correlated the No. 4 coal with the Rock Island Coal of northwestern Illinois, and matched the overlying Curlew Limestone with the Perth Limestone in Indiana and the Seville Limestone in Illinois. However, Peppers

disagreed with Greb et al. (1992), who identified the No. 4 with the Mannington, Mining City, and Lewisport coals elsewhere in western Kentucky. Peppers considered those named coals to be Desmoinesian age, overlying the Curlew Limestone, while the coal directly beneath the Curlew is the Empire coal bed.

First reported by D.D. Owen in 1857, the Curlew Limestone crops out west of Dekoven and is present in a number of drill logs. This unit is as thick as 12 feet, but it is laterally discontinuous. In the Gil 15 core, the Curlew is 7.8 feet thick and consists of upper and lower beds of gray biosparite (grainstone) separated by nearly 2 feet of highly calcareous, fossiliferous shale. Limestone from this core yielded *Fusulinella iowensis*, indicating late Atokan age (Douglass 1987). The Curlew occurs 185 to 220 feet below the Davis Coal in the Dekoven quadrangle.

Above the Curlew, about 35 to 60 feet of medium to dark gray and greenish gray mudstone, shale, siltstone, and minor fine-grained sandstone are present. Two to four coal beds occur within this interval—they are less than 1 foot thick and tend to be dull and shaly. These beds appear to have little lateral continuity. Above this coaly interval, most drill logs record an interval 40 to 85 feet thick that consists largely of sandstone, with lesser portions of silty shale and siltstone. In some cases, an upward-fining profile is evident. This interval is interpreted as an incised valley-fill deposit. Well records outside the incised valley show largely shaly strata, including a limestone bed about 30 feet below the Creal Springs Limestone. Above the Creal Springs Limestone, an interval of 25 to 40 feet of mostly shale and siltstone is present. Several logs, including that of the Gil 15 core, record green shale in the lower part. Above the Creal Springs an interval of mixed clastics, largely claystone and shale along with minor, lenticular sandstone is present. The Stonefort Limestone is a few inches to 4 feet thick, and typically is an argillaceous lime mudstone to wackestone, containing a variety of marine fossils.

Carbondale Formation

The base of the Davis Coal or Seelyville Coal marks the base of the Carbondale Formation. The Carbondale Formation contains several economic coal seams and the lateral persistence of these coals is much greater than in the underlying formations. The Davis Coal is a single bed of bright-banded coal. Kehn (1974) reported a thickness range of 1 to 4 feet, but logs used for this study show a range from 3.0 to 4.8 feet, and a thickness of 6.5 feet in a single borehole. The interval between the Davis and Dekoven coals is 40 to 70 feet thick and consists of fine-grained, argillaceous sandstone and medium to dark gray, silty and carbonaceous shale. Although most logs indicate an upward-coarsening cycle, some suggest an upward-fining sequence. The Dekoven is a single bed of bright-banded coal. Kehn (1974) reported a thickness range of 1 to 4 feet; logs used for this study show a range of 2.0 to 4.3 feet.

The interval between the Colchester and the Dekoven Coal is 40 to 70 feet thick and consists of fine-grained, argillaceous sandstone and medium to dark gray, silty and carbonaceous shale. Generally less than one foot thick, the Colchester Coal is directly overlain by the black, highly fissile Mecca Quarry Shale.

The Survant Coal typically has thin, weakly developed underclay. Greb et al. (1992) correlated the Survant with the Western Kentucky No. 8b and the Houchin Creek with the Western Kentucky No. 8. Above these coals is a sequence of sandstone to shale 38 to 77 feet thick. The bulk of the interval is sandstone and shale that form a single upward-coarsening cycle. Logs examined for this study indicate the Springfield Coal to be consistently close to 5 feet thick. Kehn (1974) reported the Springfield to range from 3.3 to 6.0 feet. A few logs record a thin limestone, the St. David, at the top of the black, fissile Turner Mine Shale, which overlies the Springfield Coal (Western Kentucky No. 9). Kehn (1974) indicates that the sequence of rocks above the St. David Limestone is complex.

The Briar Hill Coal (Western Kentucky No. 10) is generally 2.5 feet thick, but some logs indicate it may be as thick as 4 feet. Approximately 35 to 40 feet of sandstone and shale separate the Briar Hill Coal from the overlying Herrin Coal. The Herrin Coal is absent due to non-deposition in the northwestern part of the quadrangle, where Anna Shale rests on underclay. In the northeastern part of the quadrangle, the coal ranges up to about 3 feet thick. Kehn (1974) reported a maximum thickness of 46 inches (3.8 feet).

Shelburn Formation

The base of the Shelburn Formation lies at the base of the Brereton (Providence) Limestone or the top of the Herrin Coal. The Shelburn marks the base of the McLeansboro Group. The Shelburn is composed mainly of siliciclastics such as the Anvil Rock Sandstone. In the Shelburn, the limestones are better developed and the coals are typically thinner than in the underlying Carbondale Formation. The Paradise (W. Ky. No. 12) coal may be locally present within a short distance above the Brereton.

In places, sandstone fills channels or valleys incised more than 150 feet below the Pirtle Coal, removing the Herrin Coal (Carbondale Formation) in places, and truncating strata down to within 10 feet of the top of the Briar Hill Coal. Regional correlations indicate that the valley-filling sandstone at this position has not been previously named or documented. It should be noted that the name Anvil Rock Sandstone has been applied to various sandstone units at different positions in the lower half of the Shelburn Formation (Owen 1856; Hopkins 1956), so the use of the term Anvil Rock is problematic.

Kehn shows several thin coals being present at and above the Providence Limestone, and he correlates the No. 13

Coal Zone with two coal beds—the lower coal is 0 to 2 feet thick and the upper coal is 0 to 2.5 ft. thick. These beds correspond, respectively, with the Baker and Danville Coals. Above the Danville, a thick sandstone is present in many places, although other logs record a series of limestone, sandstone, shale, and thin coal. The Pirtle Coal occurs in this interval. Above this section the rocks coarsen upward, and then are capped by soft shale or claystone. The uppermost member of the Shelburn Formation is the West Franklin Limestone, which is 4 to 7 feet thick and light to medium gray. No details on texture or fossils are available.

Patoka Formation

The rocks at the base of the Patoka Formation are sandstone, siltstone and shale with a sandy limestone about 40 to 50 feet above the West Franklin Limestone. There is a single, thick upward-coarsening package overlying the thin, shaly, but persistent Chapel Coal. In some logs there appear to be two upward-coarsening cycles with the upper cycle being much thicker.

Above is a succession 20 to 30 feet thick of shale and lenticular sandstone. A thick upward-coarsening clastic succession, overlying highly persistent black, fissile shale that correlates with the Hushpuckney Shale of the Midcontinent (Heckel and Weibel 1991) is also present at this interval. A few logs indicate thin coal at the base of the Hushpuckney; this would be the Womac Coal of central Illinois. The Macoupin Limestone Member, which overlies the Hushpuckney across much of Illinois, is not recorded on logs in the Dekoven quadrangle. However, several logs indicate limestone at the base of the Hushpuckney.

Two thin coals occur at least locally near the top of the Patoka. The thin W. Ky. No. 16 coal bed correlates with the Raben Branch Coal Member of southern Indiana (Smith and Smith 1967). This bed sits atop a thick upward-coarsening clastic succession. The discontinuous New Haven Coal (W. Ky. No. 17) directly underlies black, fissile shale beneath the Carthage Limestone. This shale has been correlated with the Stark Shale of the Midcontinent on the basis of conodonts (Heckel and Weibel 1991).

Bond Formation

The Carthage Limestone is a highly persistent regional unit that defines the base of the Bond Formation. No lithologic information is available from the Dekoven quadrangle, but typically, the Carthage is gray skeletal wackestone to packstone that is somewhat argillaceous and contains an open marine fauna. Above the Carthage Limestone is an interval containing sandstone and shale that coarsens upward. Two coal-test logs report limestone 3 to 4 feet thick. Above this a pair of thin coal layers that have been traced northward to the type outcrop of the Fairbanks Coal in Sullivan County, Indiana is present. The two coal beds appear to be persistent, although some driller's logs do not record them. Underclay is absent or poorly developed.

Overlying the Fairbanks Coal is a series of sandstone, shale, limestone, and thin coal. The sandstone, the upper part of which is commonly calcareous, grades downward to sandy limestone. Kehn (1974) described outcrops of the limestone as being sandy, "dense" and unfossiliferous. Sandstone units below grade downward to gray, sandy shale. The next coal, which is thin but fairly continuous, matches the Flat Creek Coal of Illinois. No name has been applied to this bed in Kentucky. Above the sandstone, a series of shale and sandstone is present underlying the Lisman Coal.

The Lisman Coal (Glenn 1912 p. 56, Franklin 1969, Greb et al. 1992) is widespread in western Kentucky. This bed is confidently correlated with the Flannigan and Witt Coals of Illinois. Above the Lisman, the interval is largely silty to sandy shale; electric logs indicate siltstone or shaly sandstone near the top and locally in the lower part. Black, fissile shale is present. The black shale, regionally extensive in Illinois, has been correlated with the Muncie Creek Shale of the Midcontinent using conodonts (Heckel and Weibel 1991). Above, two limestone beds, each 2 to 5 feet thick, are widely present. The same two beds are present in the continuous core described by Smith and Smith (1967) in the Sturgis 7.5-minute quadrangle to the east. These two beds appear to match the upper and middle parts of the type Livingston Limestone of east-central Illinois and thus, define the top of the Bond Formation. Separating the two limestone layers is an upward-coarsening interval of shale and sandstone about 40 feet thick.

Mattoon Formation

The lower part of the Mattoon consists of about 80 feet of siltstone and shale that grade upward into sandstone. However, we estimate the base of the Mattoon Formation as the base of the Geiger Lake Coal because more data is available to constrain its position than using the top of the Livingston Limestone. The Geiger Lake Coal was mined in numerous small drifts near the northern edge of the map area and was mapped by Kehn (1974). The type locality of the Geiger Lake is only 1,000 feet north of the quadrangle border (Glenn 1912, Palmer 1976). The Geiger Lake is correlative with the Cohn Coal Member of central and southern Illinois. Above the Geiger Lake, a fine to medium-grained, cross-bedded to massive sandstone crops out near the northern edge of the quadrangle, according to Kehn (1974). Black, fissile shale 40 to 50 feet above the base of the Geiger Lake is widely extensive in Illinois and has been correlated with the late Missourian Eudora Shale of the Midcontinent on the basis of conodonts (Heckel and Weibel 1991). Thin coal in the upper part is believed to correlate with the Shelbyville Coal of central Illinois. Smith and Smith (1967) incorrectly identified this upper coal bed as the Geiger Lake Coal. The top of the Mattoon is eroded and overlain by Quaternary deposits.

Economic Geology

Coal

Coal, sand, and gravel are the principal economic resources in the quadrangle. Coal mining began around 1847 but ceased by 1970. Sand and gravel from the Ohio River is used for concrete and road construction. Included with the coal seam names below are the Western Kentucky seam numbers in parentheses.

The Bell Coal (No. 1b), located at the base of the Tradewater Formation, has been extensively mined in the Bell mines south of the Tradewater River. Extent and thickness of the Bell Coal is not known in other parts of the western Kentucky coal basin.

Defining the base of the Carbondale Formation, the Davis Coal (No. 6) has been mined underground in many places. Operations at the Shotwell (Four-Foot) mine began in 1860. The Pittsburg and Midway Dekoven No. 6 mine operated until 1968. The Davis was also extracted at the Madison Coal Company No. 6 mine. It has been strip mined just south of Dekoven, Kentucky.

The Dekoven Coal (No. 7) was mined underground at the Shotwell (Three-Foot) mine from before 1860 to about 1900. The Madison Coal Company made other openings on the Dekoven Coal to the southeast of the town of Dekoven.

The Springfield Coal (No. 9) began at the Curlew mine about 1847 and at the Mulford mine in 1848. Recent mining operations on the Springfield occurred at the West Kentucky Coal Company No. 1 and No. 8 mines, at the Pittsburg and Midway Dekoven No. 9 mine, and at the Madison Coal Company mine about one mile southeast of Dekoven. The Springfield has been strip mined, but all operations were inactive as of 1969.

The Herrin Coal (No. 11) has been mined underground for local use just southeast of Anvil Rock, although the workings have been abandoned for decades. Sandstone channels incised into the Herrin Coal may give rise to poor roof conditions (Kehn 1974).

A small volume of coal has been produced for local consumption from the Geiger Lake Coal in the northern portion of the quadrangle, although production ceased before 1950.

Reserves of other coal beds in the quadrangle are relatively minor.

Oil and gas

Twenty-six oil and gas wells have been drilled in the quadrangle. One encountered oil in the Mississippian Aux Vases Sandstone. Three holes produced gas from the Devonian New Albany Shale. Other wells were reported as dry and abandoned.

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