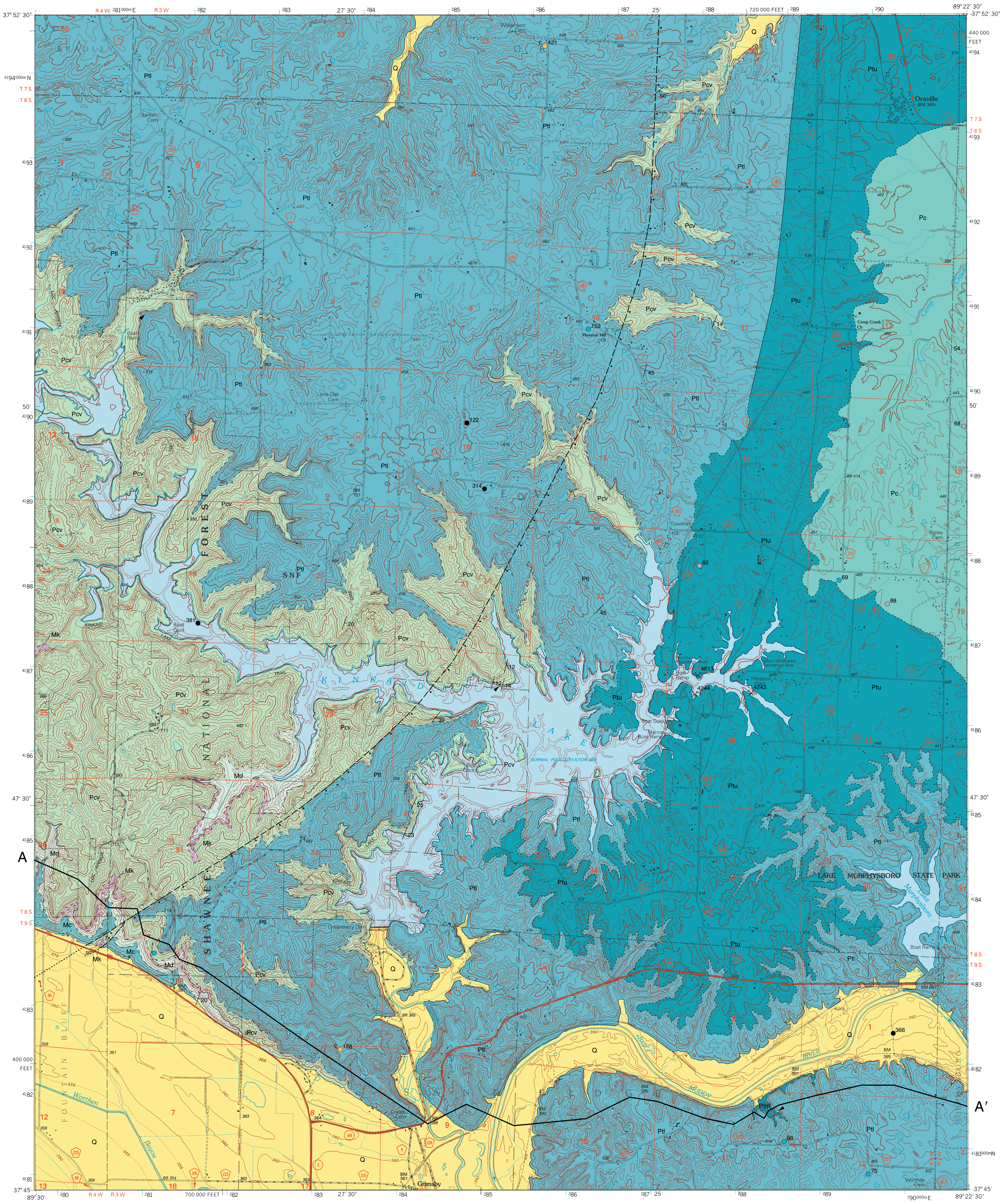
Illinois Department of Natural Resources
ILLINOIS STATE GEOLOGICAL SURVEY
William W. Shilts, Chief

BEDROCK GEOLOGY OF ORAVILLE QUADRANGLE

JACKSON COUNTY, ILLINOIS

Illinois Preliminary Geologic Map
IPGM Oraville-BG

Laura M. Williams, Joseph A. Devera, and James R. Staub
2005



EXPLANATION

Quaternary	Q	Quaternary Deposits	Holocene and Pleistocene
Pennsylvanian	Pc	Carbondale Formation	DesMoinesian
	Pt: Ptu	Tradewater Formation (upper)	
	Pt: Ptl, Ptm	Tradewater Marine Zone (lower)	Atokan
	Pcv	Caseyville Formation	Morrowan
Mississippian	Mk	Kinkaid Formation	Chesterian
	Md	Degonia Formation	
	Mc	Clore Formation	

Symbols

- 40 — Strike and dip of bedding; number indicates degree of dip
- ► Outcrop of special note
- ⚒ Coal mine - closed

Drill Holes

from which subsurface data were obtained
Numbers indicate total depth of boring in feet.

- C ● 128 Stratigraphic boring with core description
- ● 75 Water well
- ● 88 Coal boring
- ● 366 Oil boring

Line Symbols

dashed where inferred; dotted where concealed

- Contact
- Normal fault: bar and ball on downthrown side
- A—A′ Line of cross section

Base map compiled by Illinois State Geological Survey from digital data provided by the United States Geological Survey. Topography compiled 1965. Planimetry derived from imagery taken 1993. PLSS and survey control current as of 1996. Partial field check 1996.

North American Datum of 1927 (NAD 27)
Projection: Transverse Mercator
10,000-foot ticks: Illinois State Plane Coordinate system, west zone (Transverse Mercator)
1,000-meter ticks: Universal Transverse Mercator grid system, zone 16

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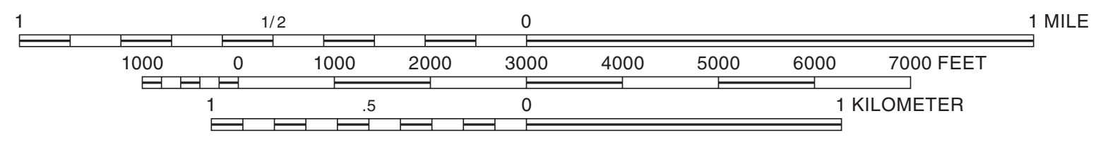
SCALE 1:24 000



BASE MAP CONTOUR INTERVAL 20 FEET
SUPPLEMENTARY CONTOUR INTERVAL 5 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929

Released by the authority of the State of Illinois: 2005

Geology based on field work by L. Williams, J. Devera, and J. Staub, 2000–2005.

Digital cartography by L. Williams, J. Carrell, and T. Goeppinger, Illinois State Geological Survey.

This Illinois Preliminary Geologic Map (IPGM) is a lightly edited product, subject to less scientific and cartographic review than our Illinois Geological Quadrangle (IGQ) series. It will not necessarily correspond to the format of IGQ series maps, or to those of other IPGM series maps. Whether or when this map will be upgraded depends on the resources and priorities of the ISGS.

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For more information contact:
Illinois State Geological Survey
615 East Peabody Drive
Champaign, Illinois 61820-6964
(217) 244-2414
http://www.isgs.uiuc.edu

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ADJOINING QUADRANGLES
1 Willisville
2 Ava
3 Vergennes
4 Raddle
5 Murphysboro
6 Altenburg
7 Gorham
8 Pomona

APPROXIMATE MEAN DECLINATION, 2005

ROAD CLASSIFICATION

- Primary highway, hard surface
- Secondary highway, hard surface
- Light-duty road, hard or improved surface
- Unimproved road
- Interstate Route
- U.S. Route
- State Route

Introduction

This study’s purpose was two-fold; first to map the Oraville 7.5 minute quadrangle and second to define facies associations bounding and within incised valleys along the Mississippian-Pennsylvanian disconformity and along the boundary between the Pennsylvanian, Caseyville and Tradewater Formations in the Oraville quadrangle. A facies association is defined as “groups of facies genetically related to one another and which have some environmental significance” (Collinson 1969, Walker 1992). In depth studies of small areas, when placed into the fabric of the whole, deliver a better, more refined understanding of the processes that created the whole. Understanding of the facies within the Oraville Quadrangle in a three-dimensional framework will define the depositional environment in which the sediments were deposited and add another dimension to the processes that produced the present day Illinois Basin.

Geologic mapping of the Oraville Quadrangle is a part of a larger, ongoing mapping project by the Illinois State Geological Survey (ISGS) for all of Southern Illinois. The Southern Illinois Mapping Project is state funded, originally created for the purpose of finding natural resources in southern Illinois, but more recently it has become a project designed to give a better understanding of the local and regional geology. Mapped areas can be used for site-specific studies such as where to place landfills or as base maps in studying specific geologic research questions (Nelson pers. comm., 2001).

Data Collection and Interpretation Methods

Mapping of the bedrock and surfacial geology of the Oraville Quadrangle was accomplished during the months of October through April for 2000-2001 and 2001-2002. Mappable Upper Mississippian bedrock units in the Oraville Quadrangle include, from oldest to youngest, the Clore Formation, the Degonia Formation, and the Kinkaid Formation of the Chesterian Series. Lower Pennsylvanian units include the Caseyville Formation of the Morrowan Series, basal Tradewater Formation of the Atokan Series, and upper Tradewater Formation and Carbondale Formation of the Desmoinesian Series. Rocks in the Oraville quadrangle include fossiliferous limestones, shales, siltstones, and sandstones. Mapping included walking all ravines and tributaries of ravines and inspecting outcrops, cutbanks, and alluvium deposited in stream channels. Types of deposits were noted, along with grain size, shape, and sorting. Bedding thicknesses were noted and any sedimentary features present, such as ripple marks and/or cross-bedding were described. Fossils and trace fossils were noted if present, as well as any post-depositional features such as de-watering features and iron banding. Erosional features such as lag deposits at the bases of beds were also described in regard to clast size, types, and orientation. Strata were assigned stratigraphic position based on mapped features as described within the previous section.

Subsurface data includes records of water-wells, core holes, and one new core hole drilled during the spring of 2002 as part of this study. Water well and borehole locations were field verified during the summer of 2001.

Regional Setting and Location

The 7.5 minute Oraville Quadrangle is located at 89E 22’ 30” - 89E 30’ latitude and 37E 52’ 30” - 37E 45’ longitude in Jackson County, Illinois, along the southwestern edge of the Illinois Basin. The Illinois Basin is an elliptical basin approximately 155,000 km^2 (60,000 mi^2) in area that underlies central and southern Illinois, southwestern Indiana, western Kentucky, and small areas of Missouri, and Tennessee (Buschbach and Kolata, 1990). The basin contains approximately 417,000 km^3 (100,000 mi^3) of sediment fill (Buschbach and Kolata 1990). Regional dips range from 9 to 21 m/km (30 to 70 ft/mi) and dip inward toward the deepest part of the basin, located within south-eastern Illinois, from surrounding arches (Zuppann 1988). The final arch to be uplifted was the Pascola Arch located at the southern end of the broad, open trough (proto Illinois Basin), between the Ozark Uplift and the Nashville Dome (Atherton 1971). The Pascola Arch uplifted during Pennsylvanian and Cretaceous times and enclosed the once open marine embayment creating the modern day Illinois Basin (Klein and Hsui 1987; Heidlauf et al. 1986).

Geologic History

The Illinois Basin fill is composed of sedimentary rocks ranging in age from the Cambrian through Pennsylvanian, semi- to unconsolidated Cretaceous through Tertiary sediments, and Quaternary alluvial and colluvial deposits. Paleozoic deposits are largely marine limestones, sandstones, siltstones, and shales, changing to cyclic deltaic deposits composed of limestones, sandstones, and shales midway through the Mississippian. Pennsylvanian rocks are primarily cyclic, terrestrial or deltaic deposits of sandstone, siltstone, shale, and coal, with occasional marine limestones (Willman et al. 1995).

Arches, forming the uplands that surround Illinois Basin, have been uplifted and down-warped at various times throughout the history of the basin. Arches include: the Wisconsin Arch to the north of the basin, the Kankakee Arch to the northeast of the basin, the Cincinnati Arch/Nashville Dome to the east of the basin, the Ozark Uplift area to the southwest of the basin, the Mississippi Arch to the west of the basin, and the Pascola Arch, the last arch to rise creating the modern day basin configuration, to the south of the basin.

Structural highs are located within the basin as well. These include the La Salle Anticlinal Belt, the Clay City Anticlines, and Omaha and Hicks Domes located in the eastern half of the state. Central and western highs include the Salem and Louden Anticlines, the Du Quoin Monocline, and the Waterloo-Dupo, Lincoln, and Pittsfield Anticlines.

The Du Quoin Monocline, located just north of the Oraville Quadrangle, is thought to have affected the erosional patterns of pre-Pennsylvanian valley incision. The rising Western Shelf, with the Du Quoin Monocline along the eastern edge, deflected the NE-SW trending erosional valleys to the south (Bristol and Howard 1971).

The Illinois Basin and surrounding region has a long, complex history of recurring tectonic activity (Willman et al. 1975; Ervin and McGinnis 1975; Kolata et al. 1981; Anglen, 2001). The Reelfoot Rift and Rough Creek Graben underlie the Mississippi Embayment just to the south. These features are part of the New Madrid Rift Complex, which is thought to have activated during late Precambrian times, leading to the development of the proto-Illinois Basin (Schwalb 1983; Braile et al. 1986; Collinson et al. 1988). The Fluorspar Area Fault Complex and Wabash Valley Fault Systems are located along the southeastern border of the state of Illinois. The Cottage Grove Fault System and the Ste. Genevieve Fault Zone are located to the northeast and southwest (respectively) of the Oraville Quadrangle.

The Cottage Grove Fault System is an east west trending, right lateral, wrench fault (Wilcox et al. 1973; Nelson and Lumm 1984; Nelson 1990; Henson et al. 1996). Documented activity along the Cottage Grove Fault System ranges from Early to Middle Pennsylvanian to as late as Late Permian.

Stratigraphic characteristics and relationships

Chesterian sedimentary rock outcrops in the Oraville Quadrangle are predominantly deltaic and marine sandstones, shales, and limestones. The Clore Formation crops out along the bluff line in the south western sections of the quadrangle and is approximately 20 to 40 m thick where mapped. It is divided into three members, from oldest to youngest: the Cora Member, the Tygett Member, and the Ford Station Member. Only the Tygett and Ford Station members outcrop in the Oraville Quadrangle. Outcrops in this study area are composed of crinoidal mudstones with beds ranging from 0.3 to 0.9 m thick and separated by wavy clay partings, to a thinly bedded, interbedded limestone and shaly sandstone with well preserved, red brachiopods. Locally the Clore is capped by an orangish-yellow dolomatized limestone of the Ford Station Member. The Tygett Member is represented as fine grained, thinly bedded sandstone, approximately 1 meter thick, located in the NW¼, NW¼, of Section 6, R3W, T9S.

The Degonia Formation outcrops in the southwestern quarter of the quadrangle and ranges from 10 to 30 m in thickness. Strata range from a massive, bluff forming, fine grained, quartz arenite to a wavy, thinly laminated, sublitharenite with shale partings and herringbone cross bedding. The sandstones are topped by 1 to 3 m of red and green shales. These shales only outcrop in a ravine to the west of the Oraville Quadrangle in the NE¼, NW¼, Sec. 36, R4W, T8S of the Raddle 7.5’ Quadrangle. The red and green shales were also identified near the base of the Berry Core located in the NE¼, NW¼, NE¼, Sec. 8, R3W, T9S beginning at 125 meters depth. The base of the hole was at 128 meters and still within the green and red shales of the Degonia Formation.

The Kinkaid Formation is divided into three members, from oldest to youngest, the Negli Creek Limestone Member, Cave Hill Shale Member, and Goreville Limestone Member. Both the Cave Hill and the Negli Creek outcrop in the Oraville Quadrangle. The Kinkaid locally is only about 9 meters thick; each member representing about 4.5 meters of the whole. The Cave Hill Member is mainly dark gray, silty shale that includes occasional lenses of siltstone less than 10 centimeters thick. Negli Creek strata include fossiliferous packstones and wackystones. bellaforonted gastropods, Chaetetes corals, Girvanella algae, Productid brachiopods, and crinoid stem fragments are common fossils found within this unit. The Kinkaid Formation (and the Degonia Formation when Kinkaid is not present) is unconformably overlain by the Pennsylvanian Caseyville Formation.

The Pennsylvanian exposures within the Oraville Quadrangle are mainly fluvial-deltaic sandstones, siltstones, and shales. Bituminous coals are not uncommon in Pennsylvanian strata. Outcrops of the Caseyville Formation are located throughout the quadrangle and range in thickness from 20 to 80 m (80’ to 260 ft). The most diagnostic trait of this formation is the well rounded, large (4 to 16 mm), quartzite pebbles found in graded beds or as conglomeratic beds throughout the formation. Otherwise, strata range from quartz arenite sandstones with occasional sublitharenite beds to siltstones and shales. Sandstones are thin to very thick bedded and within beds bedforms range from massive to cross-bedded with asymmetric and lunate ripples. Observed cross-bedding indicates both unidirectional flow and multidirectional flow patterns (Figure 1). Stigmaria and Calamites casts, and Lepidodendron impressions are common features along bedding plains in the sandstones. Siltstones are usually thin and wavy bedded with occasional flakes of muscovite. Shales are generally found as outcrops of very thin laminar beds that are medium gray and fissile. Fragments of carbonized plants remains are sometimes observed along bedding plains.

The Tradewater Formation consists of sandstones, siltstones, and shales and it is differentiated from the underlying Caseyville Formation by the mineralogy of its sandstones and amount of clay matrix present in them. Tradewater sandstones are sublitharenites to litharenites and are very micaceous. As with the Caseyville strata, Tradewater sandstone beds range from thin bedded to very thick bedded. Bedding structures include asymmetric and lunate ripples and cross-bedding. As with the Caseyville, Stigmaria and Calamites casts, and Lepidodendron impressions are commonly located along bedding planes. A Zoophycos trace fossil was found as float in Sec. 11, R3W, T8S and Cruziana traces were found in situ in a thin bedded siltstone within Sec. 22, R3W, T8S. Siderite nodules were found in many lag deposits at the base of Tradewater sandstone beds. Discontinuous, ferrugenous, crinoidal packstones and limey-sandstones are located in Sec. 11, R3W, T9S. These units are indicative of the change from the Atokan Series to the Desmoinsian Series within the Tradewater Formation and have been located in other quadrangles (e.g. Gorham and Pomona) to the south and southeast of the Oraville Quadrangle (Devera pers. comm., 2003).

Interpretation and Conclusions

An estuary is defined as “a semi-enclosed costal body of water that extends to the effective limit of tidal influence, within which sea water entering from one of more free connections with the open sea, or any other saline costal body of water, is significantly diluted with fresh water derived from land drainage, and can sustain euryhaline species from either part or the whole of their life cycle” (Perillo 1995).
Recognition of ancient estuaries has always been difficult because factors such as fluctuating relative sea levels, coastal morphology, input from both marine and fluvial sources, and sedimentation rates create a highly variable sedimentary record (Rossetti 1998). Hayes (1975) and later Dalrymple et al. (1992) developed an estuarine classification system based on facies associations influenced by three parameters: river dominated, wave dominated, and tide dominated estuaries (Perillo 1995). The characteristics of a tide dominated estuarine system are most compatible with those characteristics observed in the Oraville Quadrangle and will be discussed further.

Sediments, ranging in size from gravel to mud, can be deposited in several different sub-environments including: point bars, tidal flats, tidal channel sands, and tidal sand ridges (Wells 1995; Dalrymple 1992). Point bar sands flanked by overbank mud deposits are produced in the meandering channel area at the head of the estuary where fluvial process may dominate. Point bars become more estuarine, that is the cross-bedded sands become draped and interbedded with mud at the fluvial to tidal transition (Wells 1995; Allen 1991). Tidal flats rim the estuary and are typically vegetated in the supratidal area, mud flats, mixed flats, and sand flats in the intertidal area, and tidal channel sands in the subtidal area. Tidal flat, tidal channel, and fluid mud deposit areas (located in the central part of the estuary) develop distinct sedimentary features that display periodicities of neap-spring tides (Dalrymple 1992). Tidal sand ridges are large scale dunes with superimposed sand waves and ripple laminations that are located in the middle to distal parts of the estuarine funnel (Dalrymple 1992). Sand ridges are aligned approximately parallel to flow direction and are a diagnostic morphologic feature of tide dominated estuaries (Well 1995).

Berry #1 core
Early Pennsylvanian sedimentation in the Oraville Quadrangle is characterized by deposits representing at least seven transgressive/regressive cycles of sedimentation. These seven transgressive/regressive cycles are characterized by seven coarsening upward successions of sediments that range from fine grained shales to coarse grained sandstones. The seven coarsening upward successions can be identified as parasequences based on the Van Wagoner et al. (1990) definition. Parasequences are defined as relatively conformable successions of beds or bedsets that are genetically related and bounded by marine flooding surfaces; where a marine flooding surface indicates a surface separating younger strata from older strata by way of an increase in water depth (Van Wagoner et al. 1990).

In general an increase in water depth will produce fine grained transgressive deposits. However, occasionally a basal lag deposit of reworked coarse grained sediments will develop prior to fine grained sedimentation (Matchen and Kammer 1994; Weimer 1992). The first parasequence identified in the Berry #1 core begins with a thin bed of chert pebble conglomerate, a basal lag deposit that rests unconformably on Mississippian-aged limestone deposits. The shales deposited on top of the lag deposit represent the fine grained deposits of the first transgressive cycle. Fine grained transgressive sediments are often overlain by upward shoaling, prograding deposits of siliciclastic material which is interpreted to represent a gradual decrease in water depth (Van Wagoner et al. 1990). In the first parasequence fine grained sands with interbedded shales grade into coarse grained, rooted sands at the top of the parasequence. These coarsening upward sands indicate the upward shoaling, prograding deposits of the regressive cycle that often follows the transgressive cycle in a parasequence (Matchen and Kammer 1994). The rooted zone at the top of parasequence one is evidence of the upward shoaling of the prograding sands to a point of sub-aqueous to sub-aerial exposure where vegetation could take root. The other six parasequences display similar characteristics.

Sedimentation
Common estuarine sedimentary features, such as planar cross-bedding, trough cross-bedding with entrained basal rip-up clasts, lunate ripple laminations and stacked coarsening upward successions indicate a moderate to high energy, prograding regressive cycle with active channel switching (Wells 1995). Deposits of both the Caseyville and Tradewater Formations found throughout the quadrangle display planar cross-beds and asymmetric rippled bedding common to both tidal channel and sand ridge morphologies (Wells 1995). The south-southwest dipping foresets of the planar cross-beds indicate a southwestern paleocurrent direction. Trough cross-bedding and lunate rippled bedding display multidirectional flow patterns indicate possible tidal influence on sedimentation (Rossetti 1998). Erosional features such as scour and fill features (reactivation surfaces) may indicate channel switching.

Impressions of Lepidodendron and casts of Calamites, and Stigmaria found along many of the bedding planes indicate that parts of the area were probably sub-aerially exposed during Caseyville and Tradewater deposition. Shale deposits could be indicative of floodplain or over-bank environments. Some of the Caseyville shales express sub-aerial exposure, with features such as extensively rooted zones which indicate production of a paleosol (Boul et al. 1980; Retallack 1988). Siderite was identified in the shales of the Berry #1 core as well as rip-up clast deposits in scour and fill features. Siderite forms in a brackish water environment low in sulfur, high in iron, and high in available carbon-dioxide from organic decay (Jackson 1970).

Tidal deposits are sedimentary deposits that show rhythmic internal structures that reflect neap-spring cycles of 14 to 28 layers per cycle. A 14 layer cycle represents a diurnal tide or 1 tide per day setting and a 28 layer cycle represents a semidiurnal tide or 2 tides per day setting (Dalrymple et al. 1991; Kvale and Archer 1991; Martino and Sanderson 1993). The tidal deposits identified in PS1 and PS7 of the Berry #1 core can easily be placed in context of the tide dominated estuarine system as diagramed in Figure 18, where tidally influenced, fine grained, interbedded sandstones and shales are deposited as fluid mud beds within the estuarine funnel or as tidal flat deposits at the margin of the estuary. Tidally influenced cross-bedding can be identified from tidal channels within and marginal to tidal flats (Dalrymple 1992).

Ichnologic and Paleontologic Indicators
Moderate to low ichnofossil diversity in sediments suggests a brackish water environment of fluctuating salinity; conditions that are common to estuarine systems (Devera 1989; Rossetti 1998; Kidder 1990). Teichichnus isp. burrows, such as those identified within the tidal beds in the Berry #1 core, are commonly identified within sediments from shallow to marginal marine coastal settings (Martino and Sanderson 1993). They are categorized within the Cruziana Ichnofacies as feeding structures. Teichichnus isp. are found within many assemblages including tidal flat assemblages (Ekdale et al. 1984). Identification of Zoophycos isp. and Cruziana isp., in the sandy sediments of the Tradewater Formation, indicate that periods of low energy, low sediment influx also occurred (Devera 1989).

The Basal Marine Zone trace fossils assemblage includes five ichnogenera: Gordia isp., Cochlichnus isp., Rabdoglyphus isp., Bilobites? isp., and Olivellites plummari. Gordia isp., Cochlichnus isp., Bilobites? isp. are long ranging ichnogenera that can be found in freshwater assemblages through holomarine assemblages (Devera, pers. comm., 2003). Rabdoglyphus isp. was documented in the Cruziana Ichnofacies by Chamberlain (1978), which indicates near shore shallow shelf to transitional marine environments (Devera, pers. comm., 2003). Olivellites plummari (Fenton and Fenton 1937) is the most significant ichnogenera found in the Oraville Quadrangle. It has been found with marine body fossils in Illinois by Stanley (Devera, pers. comm.). This ichnogenera along with Rabdoglyphus isp. indicates a strong marine (higher salinity) influence on the estuarine environment at least at the beginning of the Desmoinesian Series.

Structural Aspects of the Oraville Quadrangle
Several lines of evidence suggest that structural movement on the Bodenschatz-Lick Fault had a degree of influence on sedimentation during the Early Pennsylvanian. (1) Seven transgressive/regressive cycles of sedimentation preserved on the downthrown side of the fault verses only two up dip, (2) the thinning of Tradewater Formation sediments over the axis of the fault trace, and (3) the substantial variation in the amount of interstitial clay from one side of the structure to the other.

Repetitive coarsening upward successions seen in outcrop and core reflect a system where accommodation space is being created as new sediment is added to the system (Van Wagoner, et al. 1990). Accommodation is defined as new space created for sediments due to an increase in base level and/or subsidence (Van Wagoner, et al. 1990; Jervey 1988; Posamentier et al. 1988). Accommodation space was created for sediments during both Caseyville and Tradewater deposition through subsidence. Differential subsidence along the Bodenschatz-Lick Fault hanging wall is inferred from the seven coarsening upward parasequences identified in the Berry #1 core (drilled on the hanging wall of the structure) verses the identification and/or preservation of only two coarsening upward parasequences from outcrop data located up dip from the Berry #1 borehole. No parasequences were identified in the deposits to north-northwest of the Bodenschatz-Lick Fault trace, which could be expected on the footwall of the structure, if less accommodation space was concurrently being generated.

A Tradewater Isopach Map shows the Bodenschatz-Lick Fault trace coinciding with the thinnest deposits of the Tradwater Formation over the axis of the structure (Williams, 2003). This is also coincident with the erosional windows of Caseyville Formation seen along the structure in the northern half of the quadrangle which also indicate the thinning of Tradewater deposits over the axis of the structure. Tradewater deposits are thickest to the east-southeast of the axis of the Bodenschatz-Lick Fault trace. Normal movement along the fault concurrent with Tradewater deposition would account for the increase of sediments accumulated on the eastern limb of the structure by creating accommodation space with downward movement of the hanging wall.

Normal displacement along the fault structure would account for the thick accumulations of shale and the higher clay content in the sandstones of the Tradewater Formation over the hanging wall of the structure by creating accommodation space. The change within the Tradewater Formation from 5 - 10% interstitial clay in sediments deposited over the foot wall to 15 - 25% interstitial clay in sediments deposited over the hanging wall of the Bodenschatz-Lick Fault probably represents a decrease in flow velocity over the hanging wall. A decrease in flow velocity would decrease the carrying capacity of the currents in the estuary and finer grained clastics would settle out (Boggs 1995).

This would not be the case on the foot wall of the structure where shallower waters could allow for the reworking of the deposited sediments by tidal and/or fluvial currents. If deposition were occurring evenly across structure, that is if no movement occurred on the Bodenschatz-Lick Fault, then it would be expected that beds deposited at the same time would reflect similar mineralogies and similar clay contents due to similar flow regimes.

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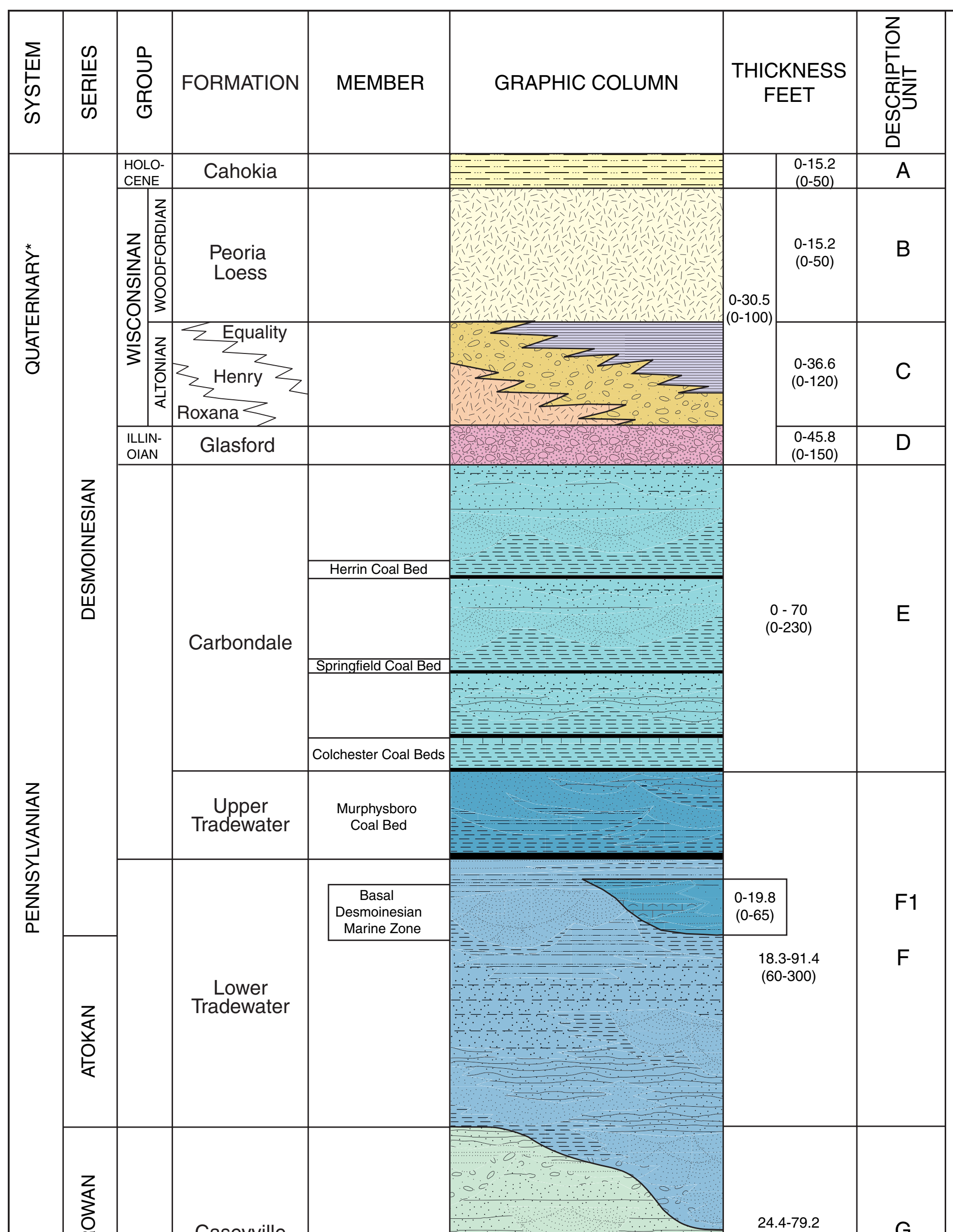

* Quaternary only shown in river bottoms. Surficial deposits not shown on mapped uplands.

A Silt, clay, and silty clay with local lenses of sand and gravel Alluvium is found in the channels of present day rivers and streams and as flood-plain deposits.

B Loess Loess is yellowish-brown to brownish-gray in color, massive, well sorted silt with local lenses of fine to medium sand in the bluff areas. Loess is up to 30.5 meters (100 feet) thick along the Mississippi River bluffs and continues to thin to the north-northeast away from the bluff line. Gastropod shells are commonly found within the loess. Loess is dolomitic.

C Silt, clay, sand and gravel Equality silt and clays are grayish-brown while the sands are an oxidized tan-orange with well sorted feldspar and dark minerals. Can be crudely stratified but mostly lacks bedding or laminations. Frye et al. (1972) described extensive molluscan fauna in these deposits. Henry sands and gravels may contain thin silt lenses locally. Roxana Silt is found underlaying the Peoria Loess and can be differentiated from the loess by color and mineral composition (Glass et al., 1968). Roxana is pinkish-tan to reddish-brown, darker than the Peoria and more clay rich. As with the Peoria Loess the Roxana is thickest along the Mississippi River bluff line and thin rapidly to the north-northeast.

D Till, gravels, sands, and silts, and accretion-gley deposits Glasford tills consist of locally derived sandstone boulders, cobbles, and pebbles through fine sands and clay sized particles and distally derived deposits of granite, greenstone, sandstone, and limestones of varying sizes. Intercalated outwash deposits consist of gravels, sands, and silts that can be deeply weathered. The Glasford Formation is extensive over much of Illinois (Willman et al., 1975).

E Sandstone, siltstone, shale, coals and limestone Sandstones of the Carbondale Formation are sublitharenite and occur as thin sheets or thick, elongate, beds that are laterally extensive. These sandstones more argillaceous than older Pennsylvanian sandstones but only slightly more argillaceous than the Tradewater Formation sandstones. The most abundant sediments of the Carbondale Formation are fossiliferous, gray shales. Siderite nodules and/or bands are common in the lower beds of shale. Occasional, laterally continuous limestone beds develop. Limestones are fossiliferous, gray to dark gray, and argillaceous. Several economically viable coal beds are located within the Carbondale Formation: the Colchester (No. 2), Springfield (No. 5), and Herrin (No. 6). The Colchester (No. 2) is generally accepted to be the base of the Carbondale Formation while the Danville (No. 7) is located at the top (Willman et al., 1975).

F Sandstone, siltstone, shale, and minor coals Sandstones of the Tradewater are tan-brown to gray-brown, medium grained, sublitharenites to litharenites with noticeable mica, feldspar, and lithic fragments. Lower Tradewater can be distinguished from the underlying Caseyville by the amount of clay in the matrix. Coarse grained to conglomeratic sandstones of reworked Caseyville are found in lower Tradewater outcrops. Beds can be thinly laminated to massive, ripple marks and cross-bedding is common. Siltstones are white-tan to medium gray, thin bedded and locally Cruziana and Zoophycos traces can be found on bedding surfaces. Calamites and Stigmaria impressions are locally prominent as well. Shales are medium to dark gray, thinly laminated, carbonaceous, and poorly exposed. Siderite nodules and clay rip-up clasts are common lag deposits. Rhythmically influenced interbedded siltstones/sandstones and shales are found locally. Minor coal lenses can be found locally. The top of the unit is eroded in the study area; the lower contact is sharp. The Murphysboro Coal sub-crop may be locally present in much of the eastern half of the Oraville Quadrangle (Smith, 1958). Upper Tradewater beds can be thinly laminated to massive. Ripple laminations and cross-bedding are common. Siltstones are white-tan to medium gray, thin bedded. Calamites and Stigmaria casts are locally prominent as well. Shales are medium to dark gray, thinly laminated, carbonaceous, and poorly exposed. Siderite nodules and clay rip-up clasts are common lag deposits.

F1 Basal Demoinesian Marine Zone: sandstone, siltstone, limestone, and mudstone with minor coal lenses Upper sandstones are medium brown to dark reddish-brown, fine to medium grained, poorly sorted, micaceous, sublitharenite. Beds range from thick to, planar or wavy, thin beds that may contain abundant crinoid and brachiopod fragments and Zoophycos trace fossils. Siltstones are dark gray, argillaceous, and bioturbated. Trace fossils include Gordia, Rabdoglyphus, Cohlichnus, Olivities plummeri, arthropod scratches, and other non-descriptive burrows (Devera, per. comm.). Limestones are dark gray, brachiopod wackestones to sandy, ferrugenous, crinoidal packstones. Lower sandstones are light tan, fine grained, medium bedded, ripple marked and crossbedded. Crossbeds consist of bi-directional, low angle, troughs to tabular-planar beds.

G Sandstone, siltstone, shale, quartz pebble conglomerate The upper Caseyville consists of interbedded and intertonguing sandstone, siltstone, and shale. The sandstone is white to light gray, very fine to coarse grained quartz arenite. It is thin to massive bedded and commonly crossbedded with crossbeds dipping to the south-southwest. Liesegang banding and iron concretions are commonly found in the sandstone. The siltstones are light gray to tan, laminated to thinly bedded and commonly interbedded with the shales. The shales are medium to dark gray, fissile, and thinly laminated. Lower Caseyville strata consist of tabular-planar and wedge-planar crossbedded, fine to coarse grained, quartz arenites and matrix-supported quartz pebble conglomerates. Pebbles range from 2mm to 16mm across and are well rounded but poorly sorted. Crossbedding continues to dip towards the south-southwest. Thin bedded sandstones and siltstones of the lower Caseyville are light tan to light gray, ripple marked, quartz arenites commonly interlaminated with medium gray, carbonaceous, silty shales. The base of the Caseyville is a major disconformity.

H Limestone and shale The Cave Hill Shale Member is located between the Goreville and Negli Creek Members and mainly consists of a medium to dark gray silty shale. The Negli Creek Limestone is lowest most member of the Kinkaid Formation. It ranges from a medium to thick bedded, dark gray, argillaceous lime mudstone to a light gray, coarse-grained crinoidal packstone. Oolitic packstones can also be found in the upper portion of the Negli Creek; Bellaphrontid gastropods, Girvanella oncoids, and Chaetetes are prominent in lower beds. The lower contact is conformable.

I Sandstone, siltstone, and shale Degonia sandstones are white to light gray, very fine to medium grained, quartz arenites that are thin to thick bedded. Thin bedded sandstones display ripple marks, load casts, tool marks, plant remains including Lepidodendron, and simple trails and burrows. Thick bedded units can be massive to crossbedded. Liesegang banding is common within the sandstones. Degonia siltstones and shales are light to dark gray, and interlaminated with the sandstones: herringbone crossbedding occurs locally. Green-gray and red-gray claystones occur near top of Degonia. The lower contact is conformable to slightly disconformable.

J Shale, limestone, and occasional sandstone lenses The Ford Station Member is a dark-gray to greenish-gray, calcareous clay shale with thin interbeds and lenses of micritic, dolomitic limestone and a thick, light to dark gray, crinoidal packstone to wackestone at its base. The Tygett Sandstone Member is a thin, dark gray, silty shale with laminae and thin lenses of light gray sandstone containing the trace fossil Rhizocorallium. The Cora Member is intercalated shale and limestone. The shale is medium to dark gray, thinly bedded, blocky to fissile, clayey, and partly calcareous. The limestone is mostly dark gray, argillaceous lime mudstone with abundant brachiopods and bryozoans. The lower contact is conformable.