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EVIDENCE OF MARINE CONDITIONS IN THE UPPER PART OF THE DEGONIA SANDSTONE (ELVIRAN STAGE, CHESTERIAN SERIES) IN THE ILLINOIS BASIN

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by

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A.S., Rock Valley Community College, 2008
B.S., Southern Illinois University, 2010

A Thesis
Submitted in Partial Fulfillment of the Requirements for the
Masters of Science Degree.

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THESIS APPROVAL

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for the Degree of

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in the field of Geology

Approved by:

Dr. Scott Ishman, Chair

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Joseph Devera

Graduate School
Southern Illinois University Carbondale
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AN ABSTRACT OF THE THESIS OF

John Michael Larson, for the Masters of Science degree in Geology, presented on July 23, 2012, at Southern Illinois University Carbondale.
TITLE: EVIDENCE OF MARINE CONDITIONS IN THE UPPER PART OF THE DEGONIA SANDSTONE (ELVIRAN STAGE, CHESTERIAN SERIES) IN THE ILLINOIS BASIN

MAJOR PROFESSOR: Dr. Scott E. Ishman

The purpose of this study is to document and describe newly observed marine fossils from the upper part of the Degonia Sandstone and to infer the depositional setting of this horizon. Previous studies have shown that the Degonia Sandstone (Elviran Stage, Chesterian Series, Mississippian Subsystem) contains sedimentological evidence of several depositional environments (i.e. terrestrial, fluvial, nearshore deltaic, tidal, and possible marine zones); however, no body fossils had been observed. The only fossils identified in the Degonia were non-diagnostic trace fossils and Carboniferous plant remains such as *Lepidodendron* trunks and *Stigmaria* casts, suggesting a terrestrial environment. In 2010, Mary Seid and Joseph Devera of the Illinois State Geological Survey found marine fossils in the upper Degonia Sandstone in a stream bed located within the Wolf Creek Fault Zone. They associated these fossils with a marine environment, contradicting earlier assessments.

Four study localities were found throughout the study, one each in the Gorham, Cobden, Glendale, and Raddle Quadrangles of southern Illinois. Sampling localities were found using geologic maps to locate the Degonia-Kinkaid contact, specifically areas where large stream valleys cut through the Kinkaid Formation and into the Degonia Sandstone throughout southern Illinois. The boundaries between the Degonia Sandstone and the overlying Kinkaid Formation were walked in order to find indicators

of marine conditions (i.e. the presence of the shaly layer of the upper Degonia Sandstone).

The reference section (the Gorham locality) contains the largest diversity of fossils and represents a storm deposit. The Cobden locality appears to contain dwarfed and normal sized specimens, and represents a storm deposit. The Glendale locality is dominated by a single bivalve and represents brackish water conditions. The Raddle locality is non-fossiliferous, but was within the intertidal zone.

The fauna identified by this study consists of four Phyla: Arthropoda, Brachiopoda, Bryozoa, and Mollusca. The only Arthropoda observed was a burrowing barnacle (Acrothoracica). The Brachiopoda observed consist of *Diaphragmus nivosus*, *Orthotetes kaskaskiensis, Anthracospirifer occiduus,* and *Composita* sp. The Bryozoa observed include Fenestrate and Trepostome. The Mollusca are the most diverse phyla observed, consisting of bivalves (*Wilkingia walkeri*, ?*Edmondia* sp., *Aviculopecten winchelli*, *Promytilus illinoisensis*, *Myalina* sp., ?*Septimyalina* sp., *Myalinella meeki*, ?*Sphenotus monroensis,* and four species of unknown bivalves), cephalopods (*Reticycloceras* sp., *Endolobus* sp., *Liroceras* sp., *Metacoceras* sp., and *Domatoceras* sp.), and gastropods (*Euconospira sturgeoni,* ?*Eotrochus cf. marigoldensis*, and an unknown gastropod). Other fossils observed were crinoid stem molds and plant material. The characterization of invertebrate fossils occurring in the upper Degonia supports the previous suggested marine sedimentological features of the Degonia Sandstone.

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CHAPTER 1

INTRODUCTION

The Degonia Sandstone was first described by Stuart Weller from its type locality in the Degonia Township of Jackson County, IL (Weller et al., 1920). It is predominantly a massive, quartz arenite that is generally well sorted and fine grained; however, it can be medium grained in certain exposures. It typically contains well-developed cross-bedding in the lower part and ripple marked, thinner bedding in the upper part (Kolesar, 1964; Jacobson et al., 2005). The Degonia Sandstone is typically white when fresh (weathering to yellow or orange brown) and commonly ferruginous with an orange speckled appearance caused by the dissemination of iron (Kolesar, 1964).

Marine fossils previously unknown in the upper Degonia Sandstone were discovered during the geologic mapping of the Gorham Quadrangle by Mary Seid and Joseph Devera of the Illinois State Geological Survey in 2010. This study is a follow-up and detailed description of the paleontology and depositional setting of this horizon. Previous to this study, the paleoenvironment of the Degonia Sandstone had been characterized as terrestrial, fluvial (Potter, 1962), nearshore deltaic (Kolesar, 1964), zones of possible marine origin (Potter and Desborough, 1965), and tidal (Roush, 1972). Now it is known that near the end of the deposition of the Degonia Sandstone there was either a storm surge deposition of normal marine fauna or a rise in sea level that resulted in transitional marine environments and brackish water conditions across the Illinois Basin transitioning into the overlying Negli Creek Member of the Kinkaid Limestone. Previous to this study, the only known fossils were floral and were confined to specific zones.

CHAPTER 2

PREVIOUS WORK

The Degonia Sandstone was deposited during the Elviran Stage, Chesterian Series of the Mississippian Subsystem and was named by Stuart Weller from its type locality in the Degonia Township of Jackson County, IL (Weller et al., 1920). Weller described the unit as a “conspicuous cliff-making sandstone in the bluffs of the Mississippi River and especially in the sides of the valleys tributary to the Mississippi” (Weller et al., 1920). Typically in its type area the Degonia is a massive formation similar to the Cypress Sandstone of the Chesterian Series (Weller,1920). Mapping in Union County has shown that the Degonia portrays the same characteristics as it does in Randolph and Jackson Counties, but further to the east it becomes more thinly bedded with a 60% decrease in thickness in Hardin County (Joseph Devera, personal communication, May, 2012). The Degonia Sandstone is coarser than most of the Chester sandstones and contains liesegang banding in its weathered bluff surfaces (Figure 1) similar to that of the Caseyville Sandstone (Weller et al., 1920). Iron present in porous sandstones was probably deposited by ancient groundwater (Joseph Devera, personal communication, April, 2012). Weller described the color of the Degonia as “commonly light brown upon freshly broken surfaces, becoming darker upon weathered surfaces through the oxidation of iron” (Weller et al., 1920). The Degonia has a maximum thickness of slightly more than 30 meters in Randolph and Jackson counties, but it may be considerably thinner in some localities (Weller et al., 1920). The Degonia outcrop in southeastern Illinois is generally less than 12 meters thick and lacks cross-bedding (Potter et al., 1958). Weller compared the paleontology of the Degonia Sandstone to that of the other Chesterian sandstones, noting that there have been very few fossils observed (Weller, 1920). The fossils found consist of fragmentary Carboniferous plant remains (*Lepidodendron* trunks and *Stigmaria* casts) and non-diagnostic trace fossils (Weller et al., 1920; Knight, 1968; Nelson et al., 1991).

Since the initial description of the Degonia Sandstone by Stuart Weller in 1920, much has been learned about the unit. “Upper and lower portions of the Degonia Sandstone are often shaly, consisting of greenish to greenish blue to gray and dark gray shales, siltstones, and interbedded thin shaly ripple marked sandstones” (Jacobson et al., 2005). In the Murphysboro Quadrangle the Degonia contains ripple marks in localities where it is thin to thick bedded, yet is commonly cross-bedded in localities where it is massively bedded (Kolesar, 1964). Extensive honeycomb weathering (Figure 2) is present throughout the formation (Jacobson et al., 2005).

In the Rockwood Quadrangle where the Degonia is in contact with the overlying Kinkaid Limestone, the thin interbedded sandstones of the Degonia are highly bioturbated; however, near the Degonia-Clore contact, the Degonia consists of “gray, argillaceous, calcareous, sandstone, interlaminated with gray micaceous, ripple laminated, micaceous, bioturbated sandy siltstone and shale” (Jacobson et al., 2005). Throughout southern Illinois, red and green shale is a characteristic of the upper Degonia (Swann, 1963). This variegated red and green claystone may represent a paleosol (Jerzykiewicz and Sweet, 1986).

The Degonia Sandstone consists of three dominant facies: (1) an upper, thin-bedded facies; (2) a middle, “massive” thick bedded facies (Figure 3); and (3) a lower, thin-bedded shale facies (Lamar, 1925). Due to the nonresistant character of the upper and

Figure 1. Liesegang banding (indicated by yellow arrows) in the Degonia Sandstone near locality #1 in the Gorham Quadrangle. This shows medium bedded quartz arenite below the storm deposit with marine fauna.

lower facies, the middle facies is the one that occurs most frequently in outcrops (Reinbold, 1961). Baxter et al. (1967) described the Degonia Sandstone in the Herod and Shetlerville quadrangles of southern Illinois as a very thin bedded, fine grained sandstone, siltstone, or shale; "it is common to find the lower part composed of interbedded siltstone and greenish gray, thin to medium bedded, fine-grained, micaceous sandstone and the upper part largely composed of shale." Up to 2 meters of ripple-marked chert is present at the top of the formation, and up to .6 meters may occur at the base, both of which appear to be derived from the alteration of extremely fine-

Figure 2. Honeycomb weathering within the Degonia Sandstone near locality #1 in the Gorham Quadrangle. Geologic hammer (16" long handled Estwing) circled for scale.

grained, calcareous siltstone (Baxter et al., 1967). In the Bloomfield Quadrangle in the western part of the Illinois Basin where the Degonia Sandstone is "massively" bedded, it is "yellowish tan to buff, medium to fine-grained, moderately well cemented, and often cross-bedded" (Knight, 1968). Knight (1968) described the upper facies of the Degonia as being "olive drab-tan, very fine-grained, silty micaceous, very hard, thin-bedded, and often containing interbedded siltstone and shale."

Figure 3. "Massive" facies of the Degonia Sandstone near locality #1 in the Gorham Quadrangle. Shows honeycomb weathering and lamination.

CHAPTER 3

PURPOSE OF STUDY

3.1: Hypothesis

The current view of the upper Degonia Sandstone is that it is a terrestrial sandstone unit similar to those of the other Chesterian sandstones, with the only known fossils being Carboniferous plants and non-diagnostic trace fossils (Weller et al., 1920; Nelson et al., 1991). The purpose of this study is to document and describe the fossils found in the upper part of the Degonia Sandstone in the Gorham, Cobden, and Glendale localities, and to describe the depositional setting of these deposits. Are the fossils that were collected terrestrial, brackish, or marine based on the paleoecology of the fossil types? If the upper Degonia Sandstone was affected by a marine incursion, then the fossils observed will indicate brackish or marine paleoenvironments. In order to determine this, once the fossils are positively identified, their specific paleoenvironment will be identified based on existing literature. If the fossils indicate either brackish or marine paleoenvironments, this will provide supporting evidence for the previous suggested marine sedimentological features of the Degonia Sandstone.

3.2: Objectives

The objectives of this study are to:

1) Create a faunal list from the various locations collected and describe the fauna.

2) Determine if the upper Degonia Sandstone had a marine influence.

3.3: Importance of study

This study of the upper Degonia Sandstone (Chesterian Series) will enhance the understanding of the upper Mississippian stratigraphy by exploring an early sea level shift between the Degonia Sandstone and the Kinkaid Limestone. This will allow for a more accurate understanding of the Chesterian Series in regards to life and the environment at the time of Degonia Sandstone deposition. Previous studies have shown that the Degonia Sandstone contains characteristics of being marine, brackish, or fluvial in nature, but the paleontology only portrays the Degonia as being terrestrial. Most importantly, a faunal list will be created for this marine fauna. This study will also redefine a portion of the stratigraphy (Elviran Stage, Chesterian Series) in southern Illinois. If this study is successful, it can be used in further studies to determine the spatial extent of this zone.

3.4: Geologic Setting

This study will be limited to the upper Degonia of the late Mississippian Subsystem (Figure 4). The rest of the Degonia Sandstone and the surrounding units (Kinkaid Formation above and Clore Formation below) were not studied, but are important to know for accurate stratigraphic context of the Degonia Sandstone.

In southern Illinois, the Clore Formation is dominantly shale with the proportion of limestone increasing southward and ranges from 12-37 thick (Willman et al., 1975). It consists of three members: the Cora Limestone Mb, the Tygett Ss Mb, and Ford Station Limestone Mb (from the base up). The formation is fossiliferous, consisting of mainly bryozoans (commonly *Archimedes* sp., *Batostomella nitidula,* and

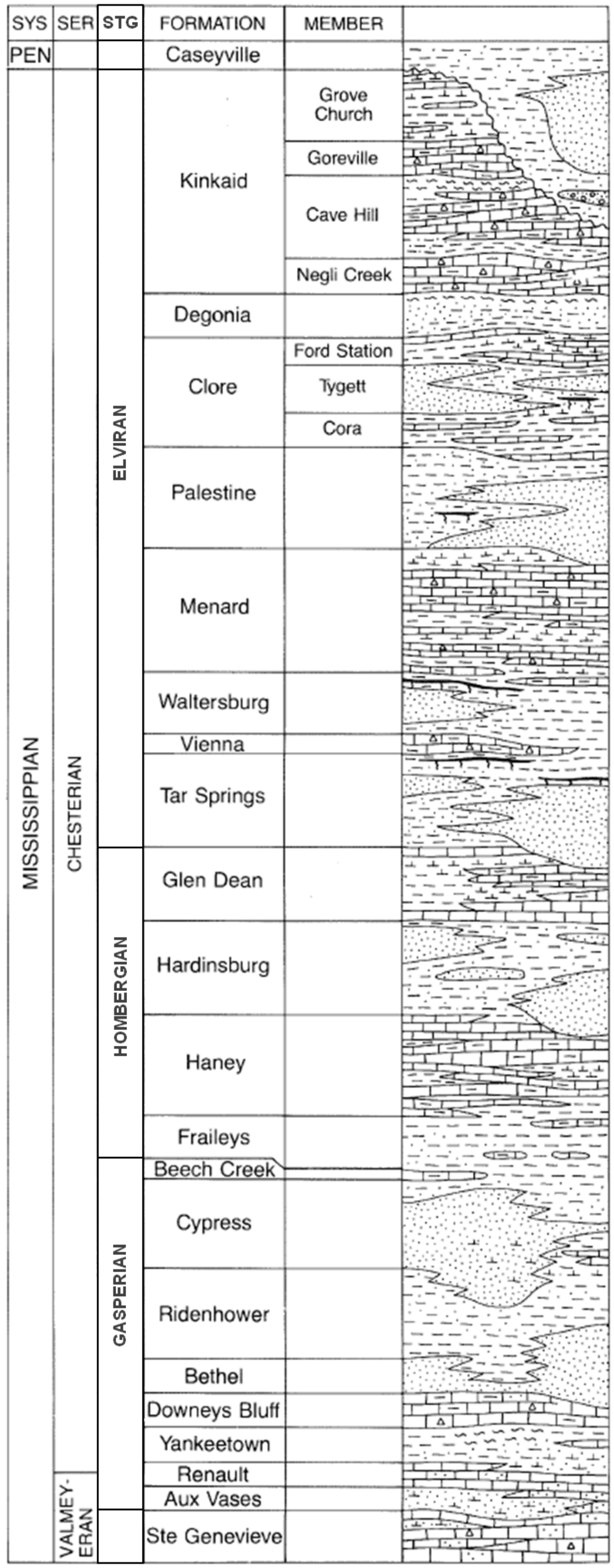


Figure 4. Stratigraphic section of the Chesterian Series without the WCSD added. Modeled after Nelson et al., 1991.

Rhombopora sp.) and brachiopods (commonly *Anthracospirifer increbescens* and *Composita subquadrata*). Unconformably overlying the Clore Formation is the Degonia Sandstone.

Overlying the Degonia Sandstone is the Kinkaid Formation, which is dominantly limestone with large shale beds and ranges from 26-70 meters thick (Nelson et al., 1991). It contains four members: the Negli Creek Limestone Mb, the Cave Hill Mb, the Goreville Limestone Mb, and the Grove Church Mb (from the base up). The formation is fossiliferous, consisting of brachiopods (*Anthracospirifer increbescens, Composita* sp., and *Diaphragmus* sp.), bivalves, bryozoans (*Archimedes* sp., *Fenestella* sp., and *Eridopora* sp.), bellerophontid gastropods, cephalopods (*Platyceras* sp. and *Bellerophon* sp.), crinoids, *Girvanella* oncoids, and *Chaetetella*.

CHAPTER 4

METHODS

4.1: Field Methods

Sampling localities were found using geologic maps to locate the Degonia-Kinkaid contact, specifically areas where large stream valleys cut through the Kinkaid Formation and into the Degonia Sandstone throughout southern Illinois. The boundaries between the Degonia Sandstone and the overlying Kinkaid Formation were walked in order to find indicators of marine conditions (i.e. the presence of the shaly layer of the upper Degonia Sandstone). When these localities were found, they were explored extensively to try to locate fossils. When fossils were found, they were collected. Collected specimens were labeled with their locality noted and treated with Krylon in order to prevent damage to the specimen due to the nature of the preservation within the Degonia Sandstone. The specimens were then wrapped in aluminum foil in an attempt to prevent additional damage during transportation to the lab. Field notes were taken at each locality to document their various characteristics. Sections were also measured at each locality in order to document their stratigraphy.

4.2: Lab Methods

Specimens were treated with Krylon a second time in order to prevent damage and then were separated according to locality. Once they were separated by locality, the specimens were organized taxonomically by phyla, genus, and species (if possible) and then curated. Casts of some specimen were created using molding clay, and molds of other species were created using liquid silicone, both in order to aid identification. The casts and molds (as well as some of the actual specimens) were prepared for photographic documentation using a sublimate apparatus to apply a light coating of powdered ammonium chloride to give the specimen a white coating for better contrast of shell morphology for photography. Pictures were then taken (using a 9.1 megapixel Sony Cybershot model DSC-H50) of specimens and later enhanced with Photoshop. The pictures were then sent to various experts in order to confirm the identification. The lengths and widths of some of the specimens were measured in order to get a range of sizes.

CHAPTER 5

SEDIMENTOLOGY AND DEPOSITIONAL ENVIRONMENTS OF THE DEGONIA

During late Chester time, sedimentation was dominated by common and widespread transgressions and regressions as indicated by alternating marine shales, limestones, and sandstones (Potter et al., 1958). One of these transgressive periods occurred during late deposition of the Degonia Sandstone.

Previously in southeastern IL, "only limited inferences could be made on depositional environments of the Degonia because of lack of exposures, absence of body fossils, and the few trace fossils that were observed being non-diagnostic" (Nelson et al., 1991). The extensive ripple marks and cross-beds of the Degonia in the Murphysboro Quadrangle suggest it was formed in shallow water where currents were common, with thick intervals of channel sandstone indicating low stand conditions, transitioning to more thinly-bedded and shaly sandstones being deposited as the sea began transgressing the area (Kolesar, 1964). The extent of this Chesterian sea can be seen in Figure 5.

Other studies have also indicated a marine origin for part of the Degonia Sandstone. It was suggested by Potter and Desborough (1965) that the Degonia Sandstone of the southeastern portion of the Illinois Basin indicates a marine origin, stating that it may have been deposited on a marine shelf. Research by Roush (1972) (Table 1) discovered that the Degonia Sandstone in the Makanda Quadrangle possess many similarities to sediments of modern tidal origin except for the total lack of observable marine fossils. These similarities include bimodal planar cross-stratification, small and large scale cross-beds, reactivation surfaces, and flaser and/or lenticular

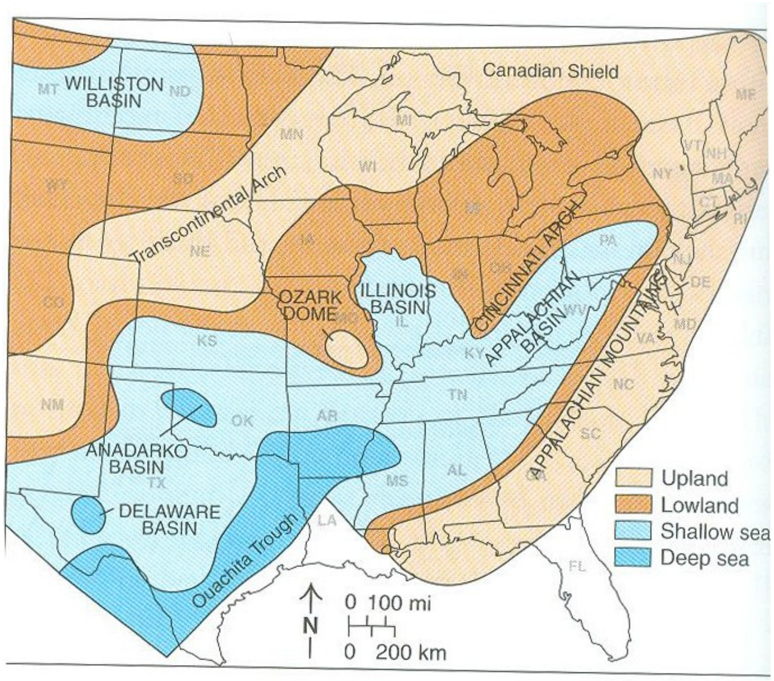


Figure 5. Map indicating the extent of the maximum transgression of the Chesterian seas (Devera et al., 2010)

bedding, all of which are indicative of a tidal origin (Roush, 1972). However, proof of a marine origin for detrital sediments normally depends on various salinity indicators such as trace and body fossils. According to Deraaf and Boersma (1971), the bimodal cross-beds (i.e. herring bone sedimentary structures) are indicative of flood (landward) and ebb (seaward) tidal current flow.

Table 1. Sedimentary features of the Degonia Sandstone compared with modern tidal sand bodies. Original table from Klein (1970); Degonia Sandstone added by Roush (1972). Modeled after Roush (1972).

SEDIMENTARY FEATURES IN THE DEGONIA
SANDSTONE COMPARED WITH TIDAL SAND BODIES

Degonia Sandstone	Tidal Sand Bodies
Cross-stratification, with sharp upper and lower set boundaries	Characteristic of intertidal sand bodies; formed by lateral cutting of small creeks in sand wave troughs and by tidal current flow*
Cross-stratification, with rounded upper surfaces resembling "reactivation surfaces" of Collinson (1970) and Klein (1970a, 1970b)	Characteristic of tidal sand bodies formed by reversed flow of tidal currents where on tidal phase is dominant and forms dunes and sand waves (constructional phase), and alternating phase is subordinate and produces rounded surface (destructional phase)*
Multimodal distribution of set thickness data of cross-stratification	Characteristic of tidal sand bodies produced by alternating constructional and destructional history*
Bimodal distribution of dip angles	Suggested by Swett, et. a., (1971) to demonstrate the alternating constructional and destructional processes correlative with modern tidal environments
Current ripples superimposed at right angles on slip faces of cross-stratification	Common to intertidal sand bodies reflecting change in flow direction in response to late stage sheet run-off flow
Presence of current ripples on top of sets of cross-stratification	Common to tidal environments where secondary modification of dunes produces superimposed current ripples; common to internal organization of metaripples (Imbrie and Buchanan, 1965) produced in modern sand body by late stage reworking of dune by emergent phase tidal outflow*
Several sets of current ripples observed have tops planed off	This feature was noted by Klein (1963) in the Bay of Fundy

Table 1 continued. Sedimentary features of the Degonia Sandstone compared with modern tidal sand bodies. Original table from Klein (1970); Degonia Sandstone added by Roush (1972). Modeled after Roush (1972).

SEDIMENTARY FEATURES IN THE DEGONIA
SANDSTONE COMPARED WITH TIDAL SAND BODIES

Degonia Sandstone	Tidal Sand Bodies
Occasional occurrence of bipolar-bimodal (i.e. modes 180 degrees apart) distribution of cross-stratification orientation	Common to sand bodies subjected to ebb and floor directional tidal currents which are bipolar*
Usually poorly developed sequential regularity	Terwindt (1971) determined that no sequential order of grains on a large scale (tens of meters) exists in the tidal deposits of Haringvleit
Textural maturity and mineralogical super maturity of sediments	Shown by Swett, et. al. (1971) to be characteristic of an ancient tidal sand body
Slight bioturbation	This is a curious feature of ancient tidal deposits (DeRaaf and Boersma, 1971)
Horizontally laminated sandstone	Terwindt (1971) suggests that this deposit is formed by severe wave action in the breaker zone
Wavy flaser bedding	Represents linguloid ripples migrating across submerged shallow shoals; clays are deposited on rippled surface when they settle out of suspension during slack water period (Reineck, 1967)
Lenticularly interbedded sandstone and shale	Result when isolated small scale ripples migrate across clay beds, and then are covered by a later clay deposit (Reineck, 1967)

*Klein (1970)

CHAPTER 6

STRATIGRAPHIC PROBLEMS WITH THE DEGONIA SANDSTONE

6.1: Misidentification of the Degonia Sandstone

Elviran siliciclastics from the base upwards include: the Palestine Sandstone, the Tygett Member of the Clore Formation, and the Degonia Sandstone (Figure 4). All of these sandstones are dominated by fine grained, well sorted, quartz arenites. They were also deposited under similar paleoenvironmental conditions (i.e. fluvial to tidal [Potter, 1962; Roush, 1972]). Because of these similarities, the units have been confused with each other in the literature. Also, fine grained facies of the overlying Caseyville (Pennsylvanian) have been confused with the Degonia Sandstone where the intervening Kinkaid Limestone was eroded (Weller et al., 1920). This can be seen in Figure 11.

Stuart Weller noted that "earlier fieldwork [previous to 1920] in Jackson, Union, Johnson, and Pope Counties in southern Illinois had included the Degonia Sandstone as a member of the Clore Formation" (Weller et al., 1920). Since the classification of the Degonia Sandstone as a separate unit in 1920, it has been misidentified with the Palestine, Tygett member of the Clore Formation, and the fine grained facies of the Caseyville Formation. Circa 1920's, the Tygett was called the Degonia Sandstone in the Robbs Resettlement well by L.E. Workman (Joseph Devera, personal communication, March 2012).

According to Swann (1963), sandstones of the Tygett generally have been assigned to either the Degonia or the Palestine Sandstones. Some of the confusion stems from lateral pinching of one sandstone unit and increased thickness of another. For example, in Jackson County, IL, the Degonia Sandstone is 30 meters thick and thins to a 9 meter thick siltstone with shale eastward in Pope County, IL. In comparison, the Tygett Sandstone is 1.5 meters of shale in Jackson County, IL, and thickens eastward to a 21 meter thick sandstone in Pope County, IL (Figure 6) (Joseph Devera, personal communication, March 2012).

As a result of over thirty years of recent geologic mapping at the 1:24,000 scale, many of the stratigraphic problems with the Degonia Sandstone have been addressed by mappers of the Illinois State Geological Survey. The discovery and documentation of a marine fauna in the Degonia Sandstone may further help to distinguish the Degonia from the other Elviran Sandstones and the fine grained facies of the Caseyville.

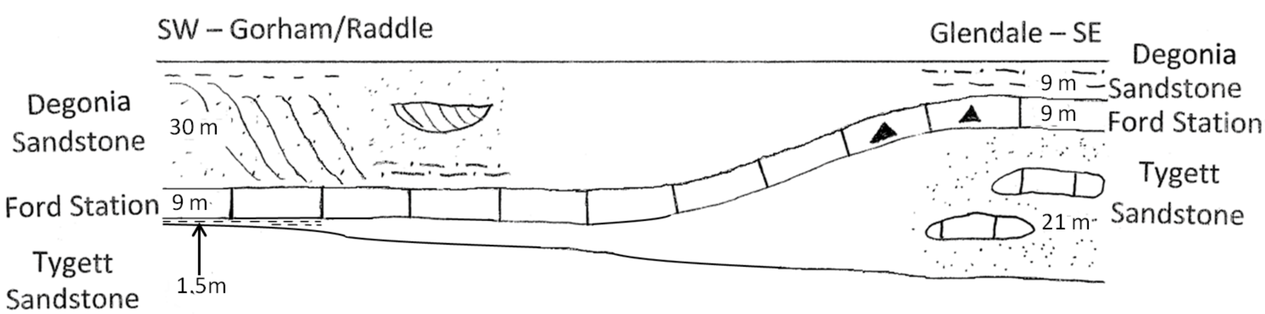


Figure 6. Comparison of the Degonia Sandstone and the Tygett Sandstone in southwestern and southeastern Illinois (Joseph Devera, personal communication, March, 2012).

6.2: Sub-Absaroka Unconformity

Throughout southern Illinois (and much of North America), the late Mississippian rocks were subjected to erosion and/or non-deposition and called the Sub-Absaroka Unconformity (Figure 7). This unconformity separates a mostly marine Mississippian sequence from a mostly terrestrial Pennsylvanian sequence (Sloss, 1963). After the

Mississippian strata were deposited, “nearly all of the central United States was raised above sea level, allowing for the Mississippian strata to be eroded while the retreating sea still occupied central and southwestern areas” (Butts, 1922). During this time, “a series of subparallel, paleovalleys (Figure 8) crossed the Eastern Interior Basin that were eroded to a considerable depth” as the late Chesterian sea regressed southwestward throughout the Illinois Basin (Greb, 1989 [Figure 8]; Droste and Keller, 1989).

This unconformity is part of the reason why this new zone in the upper Degonia was only recently discovered. Much of the Degonia (especially the upper Degonia) has been eroded. Only in areas not affected by the Sub-Absaroka Unconformity is there potential to find the marine zone in the upper Degonia Sandstone.

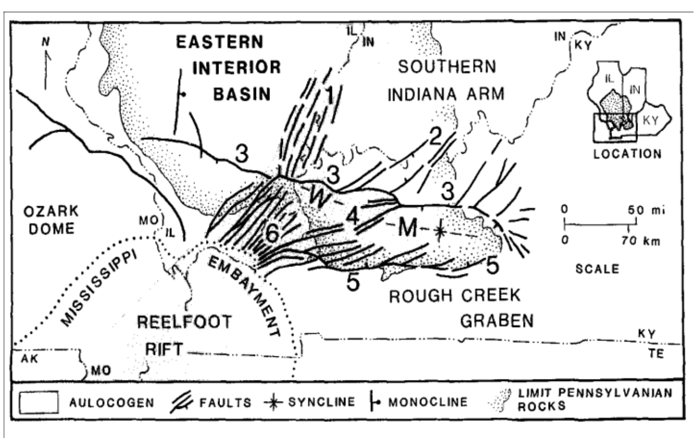


Figure 7. Map indicating tectonic features and the extent of Pennsylvanian rocks in the Eastern Interior Basin (Greb, 1989). Structures include: 1) Wabash Valley fault system; 2) Owensboro graben; 3) Rough Creek-Cottage Grove fault system; 4) Central faults; 5) Pennyrile fault system; 6) Fluorspar district faults; W) Webster syncline; and M) Moorman syncline.

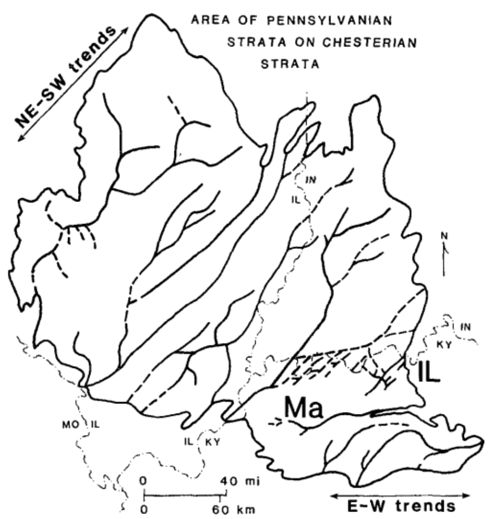


Figure 8. Map indicating the paleovalleys that were formed as the Chester sea regressed southwestward out of Illinois (after Bristol and Howard, 1971; Greb 1989). Also indicates the extent of the sub-Absaroka unconformity.

CHAPTER 7

STUDY LOCALITIES

Fossils were collected at various localities in the upper Degonia Sandstone where the Degonia is in direct contact with the overlying Kinkaid Formation. Overall, four localities were found while field mapping (Figure 9). Three localities have been discovered in Jackson County (localities 1, 2, and 4) and one in Pope County (locality 3). Each of the four localities is distinctly different based on their respective paleoenvironment, and each will be described separately.

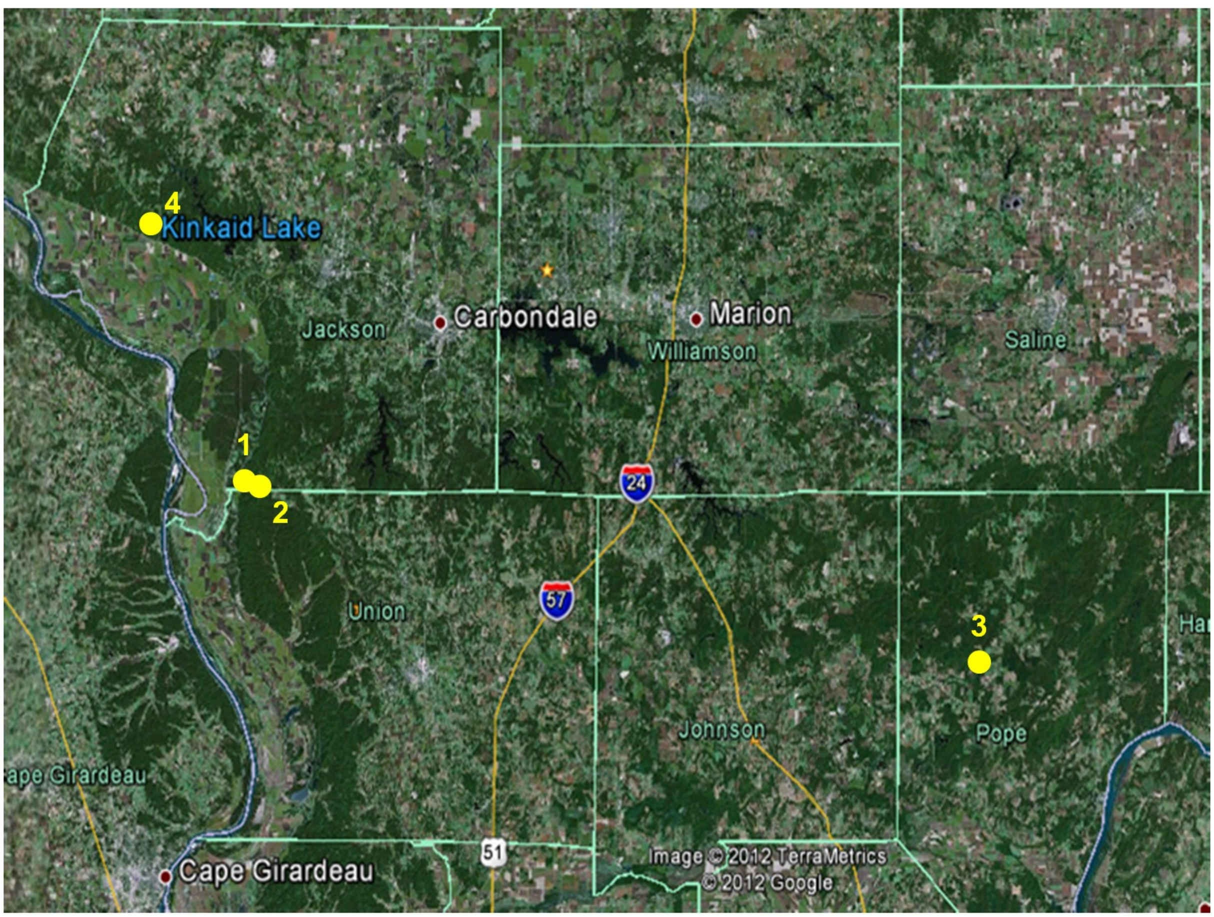


Figure 9. Map indicating the four study localities. 1) Gorham Quadrangle (type locality), 2) Cobden Quadrangle, 3) Glendale Quadrangle, and 4) Raddle Quadrangle.

7.1: Gorham

Location #1 yields the Wolf Creek Storm Deposit (WCSD) in the Gorham Quadrangle of Jackson County, Illinois (T10S, R2W, Sec. 19, Figure 10), and was discovered by Mary Seid and Joseph Devera during previous mapping in the area (Seid et al., 2009). The WCSD lies within a very complicated stratigraphic interval due to a repeat in section (units repeat five times) in close proximity to the collecting site. This is the reference section of the marine fauna in the Degonia Ss. Figure 11 shows a stratigraphic column of the Clore Formation through the Caseyville Sandstone with the WCSD added, and Figure 12 shows the WCSD at the Gorham Locality. The site is constrained by roughly 1.7 meters of green silty shale (Figures 13 and 14), with the fossiliferous Degonia Sandstone slumping down on top. Some large fossiliferous blocks (.6 meters by 1.2 meters) were found in-situ on top of the shale, but most occurred as float. Most of the blocks were up to 30 centimeters thick. Including the 1.7 meters, the WCSD is roughly 3.7 meters thick, with 7.3 meters of Negli Creek resting on top. The contact can be seen in Figures 15 and 16. This locality contains the largest diversity of fossils, including: gastropods, cephalopods, arthropods, plant material, and several genera of brachiopods, bivalves, and bryozoans.

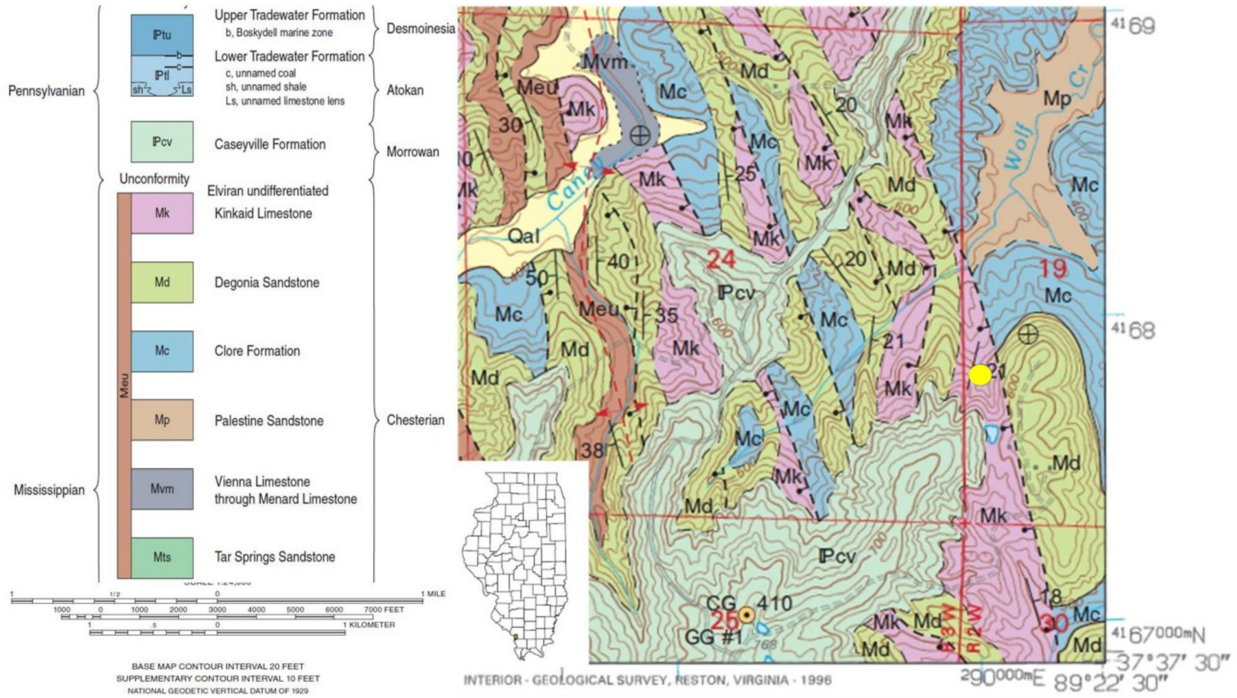
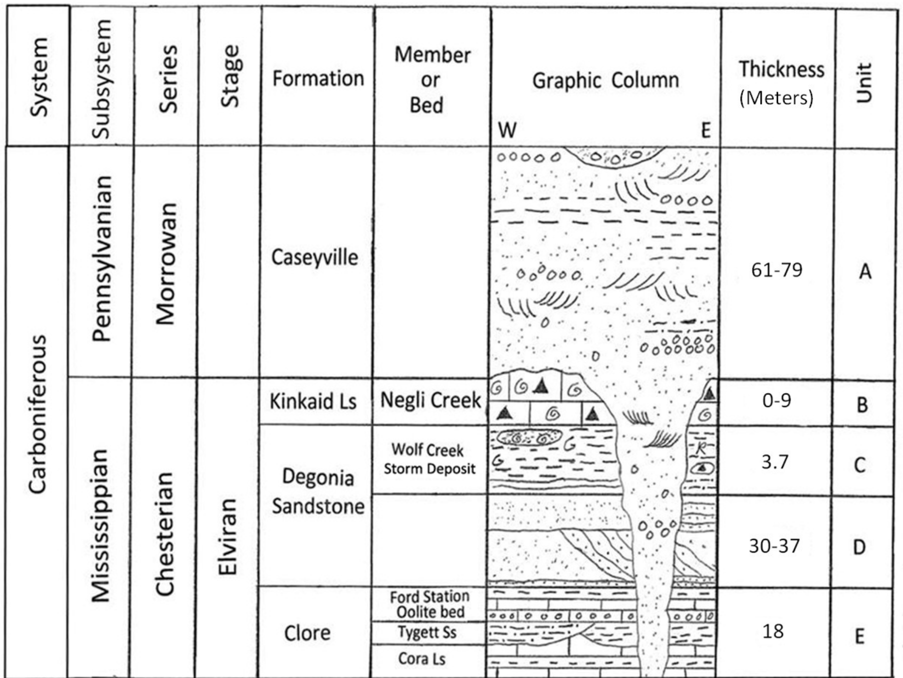


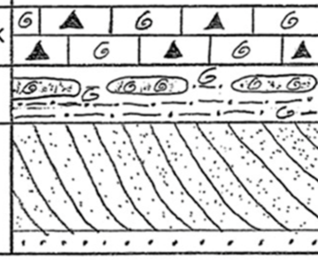
Figure 10. Geologic map of the Gorham Quadrangle taken from Seid et al. (2009). The yellow dot indicates study locality #1. Note: Subsequent detailed mapping yielded the upper Degonia Ss at the yellow dot.



Description

A Caseyville Formation Sandstone, siltstone, shale, and conglomerate. Sandstone is light brown on a fresh surface, quartz arenite, dominantly fine to medium grained, but coarser grains and abundant quartz pebbles occur in places and are diagnostic of the formation; well to poorly sorted, cross bed-ded, ripple marked beds occur, calcareous in places, prominent iron staining and liesegang banding in places; weathered surface is pocky and forms sapping alcoves at the base of large bluffs. Siltstone is gray, laminated with medium grained sandstone and gray shale, carbonaceous, pyritic in places, micro-cross bedded, and contains contorted bedding, flame structures, and calcareous bands. Shale is light gray, micaceous in places, weakly fissile, partly silty, sandy and calcareous in places, and poorly exposed. Conglomerate includes large gray and black rounded limestone clasts and is cemented with quartz pebbles and gray sandstone; the sand matrix is extremely well indurated and appears glassy, as if sand grains are welded together. Scoured contact and angular unconformity with unit below.
B Kinkaid Limestone Limestone and shale. Mostly dark gray crinoidal wackestone to packstone, lime micrite with conchoidal fracture at base, medium bedded; becomes shaly in places and can in-clude shale beds a few feet thick; fossils include brachiopods, Bellerophontid gastropods, crinoids, and *Chaetetes* sp.; *Girvanella* sp. is diagnostic of this unit. Sharp contact with unit below.
C Wolf Creek Storm Deposit All locations where transitional marine influences were observed occur in the upper parts of the Degonia Sandstone. A green silty shale at the base of the marine zone is non-fossiliferous in most locations (other than the Glendale Quadrangle where it is fossiliferous in parts). Sandstone is white on fresh surfaces, quartzose, well sorted and fine grained, and ferruginous with an orange speckled appearance caused by the dissemination of iron oxide. Fossilferous sandstone slumps down on top of shale, with most being found as float. The fossiliferous zone contains plant material (rare) and wood, more common Phyla include: Arthropoda, Gastropoda, Mollusca (Cephalopoda and Bivalvia) and several genera of Brachiopoda and Bryozoa. Some fossiliferous zones may be depauperate and contain mainly small Bivalvia. Some blocks contain abundant interbedded shale and/or very little original shell material. Fossils are represented as internal casts or external molds, with some original shell material. The zone is variable: 1) north in the Raddle Quadrangle it is composed of calcareous U-shaped structures in a laminated siltstone-sandstone, 2) east in the Glendale Quadrangle it is composed of a monophyletic fauna with an overlying chert, and 3) in the discovery area of Gorham and Cobden Quadrangles it contains marine, brackish, and terrestrial faunas.
D Degonia Sandstone Sandstone, siltstone, shale, and claystone. Sandstone is white to light brown quartz arenite, fine grained, well sorted, generally very thinly bedded but is a massively bedded bluff former in this quadrangle; dominantly quartz, but 1-2% dark or green mineral grains, and calcareous in places; dark coaly layers and pyrite nodules scattered throughout. Siltstone is rhythmically lami-nated with dark to light gray shale, wavy bedded, and calcareous in part. Shale is very dark gray to black, non-fissile, non-calcareous, and non-fossiliferous. Claystone is green, red, olive, purple, and non-calcareous. The thin bedded nature and abundance of primary sedimentary structures in sand-stone layers can differentiate this unit from the Caseyville. In outcrop, sandstone is well-exposed, and siltstones and shales are not exposed. Sharp contact with unit below.
E Clore Formation Limestone and shale. Ford Station Member is brownish gray crinoidal wacke-stone, becomes clay-rich in places, and öolitic grainstone occurs at the base. Dolostone with a yellowish weathered rind is diagnostic of the upper part of the Ford Station member and is informally referred to as the "yellow bed". Tygett member is dark gray silty shale, laminated, non-fissile, with thin silt lenses and layers in places; trace fossil *Teichichnus* ichnosp. (horizontal, gutter stacked trace fossil) occurs. Cora member is interbedded limestone and shale; limestone is medium gray wacke-stone to packstone; shale is dark gray, non-fissile, non-calcareous; fossils include myalinids, crinoids, fenestrate bryozoans, Archimedes sp., rhomboporid bryozoans, pelmatozoa, *Composita subquadrata*, *Anthracospirifer increbescens*, and productid brachiopods. Sharp contact with unit below.

Figure 11. Stratigraphic column of the Caseyville Sandstone, Kinkaid Formation, Degonia Sandstone, and the Clore Formation with the WCSD added. Modeled after Seid et al. (2009).

System	Subsystem	Series	Stage	Formation	Member or Bed	Graphic Column	Thickness (Meters)	Unit
Carboniferous	Mississippian	Chesterian	Elviran	Kinkaid Ls	Negli Creek		7.3	A
				Degonia Sandstone	Wolf Creek Storm Deposit		3.7	B
							30.5	C

Description

A Kinkaid Limestone Limestone and shale. Mostly dark gray crinoidal wackestone to packstone, lime micrite with conchoidal fracture at base, medium bedded; becomes shaly in places and can in-clude shale beds a few feet thick; fossils include brachiopods, Bellerophontid gastropods, crinoids, and *Chaetetes* sp.; *Girvanella* sp. is diagnostic of this unit. Sharp contact with unit below.

B Wolf Creek Storm Deposit This unit is a non-fossiliferous green silty shale with a fossiliferous sandstone slumping on top. The sandstone is white on fresh surfaces, quartzose, well sorted and fine grained, and ferruginous with an orange speckled appearance caused by the dissemination of iron oxide. Fossiliferous sandstone occurs as float with very little in situ. Fossils include: plant material (rare), arthropods, gastropods, bryozoans, and several genera of brachiopods, bivalves, and cephalopods. Fossiliferous blocks range from 1-12 inches thick. Some blocks contain abundant interbedded shale and/or very little original shell material. Fossils are mainly preserved as steinkerns (molds and casts).

C Degonia Sandstone Sandstone, siltstone, shale, and claystone. Sandstone is white to light brown quartz arenite, fine grained, well sorted, generally very thinly bedded but is a massively bedded bluff former in this quadrangle; dominantly quartz, but 1-2% dark or green mineral grains, and calcareous in places; dark coaly layers and pyrite nodules scattered throughout. Siltstone is rhythmically lami-nated with dark to light gray shale, wavy bedded, and calcareous in part. Shale is very dark gray to black, non-fissile, non-calcareous, and non-fossiliferous. Claystone is green, red, olive, purple, and non-calcareous. The thin bedded nature and abundance of primary sedimentary structures in sand-stone layers can differentiate this unit from the Caseyville. In outcrop, sandstone is well-exposed, and siltstones and shales are not exposed. Sharp contact with unit below.

Figure 12. Stratigraphic column of locality #1 in the Gorham Quadrangle with the WCSD added. Modeled after Seid et al. (2009).

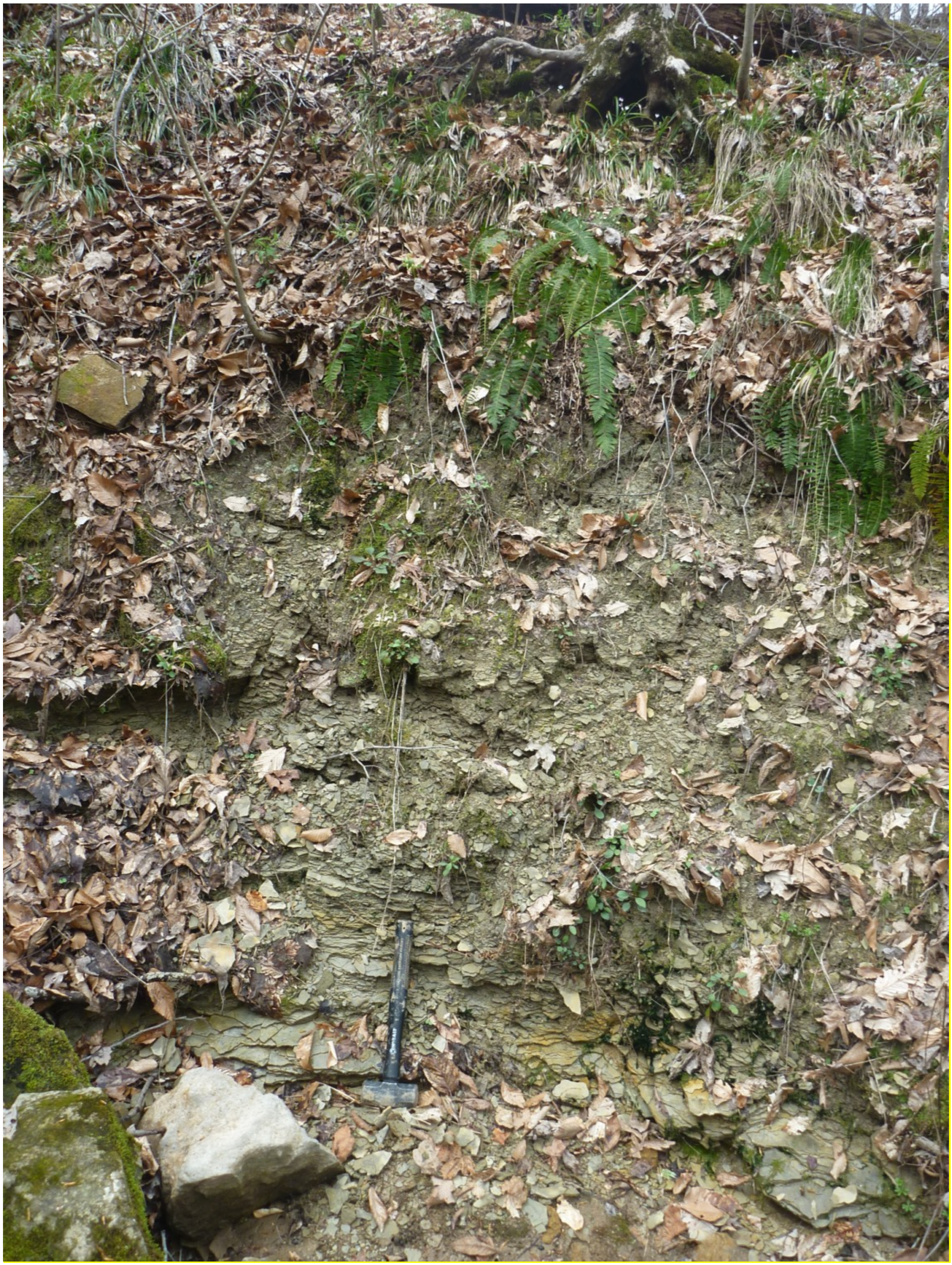


Figure 13. Green shale indicative of the top of the Degonia Sandstone at the Gorham locality.

Figure 14. Green shale indicative of the top of the Degonia Sandstone with some fossiliferous blocks as float at the Gorham locality.

Figure 15. Gorham locality of the WCSD with fossiliferous blocks as float. Contact of the Degonia Sandstone and the Negli Creek Limestone indicated by yellow line.

Figure 16. Close up view of the Degonia-Negli Creek contact at the Gorham locality. Contact indicated by yellow line. Fossiliferous block of the Degonia Sandstone is located behind the hammer; indicated by yellow arrow.

7.2: Cobden

Location #2 was found within the Cobden Quadrangle of Jackson County, Illinois (T10S, R2W, Sec. 30, Figure 17). Like the Gorham locality, the fossiliferous Degonia was located as float within a stream bed, but none was found in-situ. The Degonia Sandstone was present as small blocks (no bigger than .3 meters by .3 meters and no thicker than roughly 15 centimeters) and had its typical appearance (well-sorted, fine grained, white on fresh surfaces with orange speckles, and some ferruginous zones).

There was a limited amount of time at this site, so it was only possible to collect some specimens. A small shale layer observed (a few centimeters thick), but it is unknown if this is the green shale typical of the upper Degonia due to the limited time at the site. The exact location of the WCSD was not pinpointed; however, it appears that the sandstone bed was slumping down on top of the shale slope. The fossils collected from the Degonia float include crinoid stem molds, cephalopods (rare), and several species of bivalves (two unknown) and gastropods

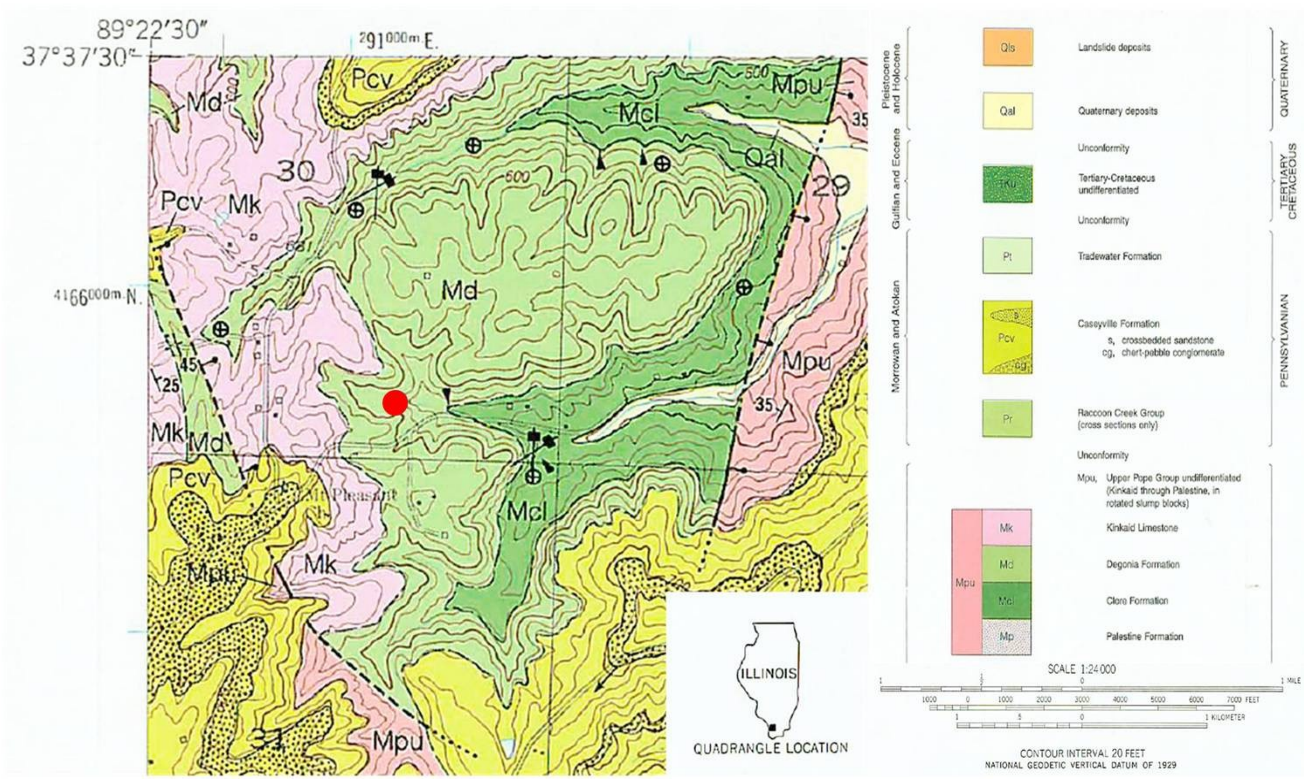


Figure 17. Geologic map of the Cobden Quadrangle taken from Devera and Nelson (1995). The red dot indicates study locality #2.

7.3: Glendale

Location #3 occurs within the Glendale Quadrangle of Pope County, IL (T12S, R5E, Sec. 23, Figure 18) and was discovered by Joseph Devera of the ISGS. The stratigraphic section for this locality can be seen in Figure 19. Here the section is roughly 2 meters thick. It consists of roughly .9 meters of fossiliferous green shale/siltstone (Figure 20), 1.1 meters of sandstone, and 15 centimeters of chert showing primary sedimentary structures (i.e. ripples and laminae) in a stream bed (Figure 21). A short distance away from the fossiliferous shale (and stratigraphically above it) is a red/green shale roughly 4.6 meters thick (Figure 22). No thick sequence of Degonia Sandstone was observed at this locality. This exposure is present in a cut bank, with most of the WCSD still covered due to slumping. The fossils are present in-situ in fossiliferous zones of the shale. The fauna consists of several species of bivalves (two unknown) that show a small amount of pyritization.

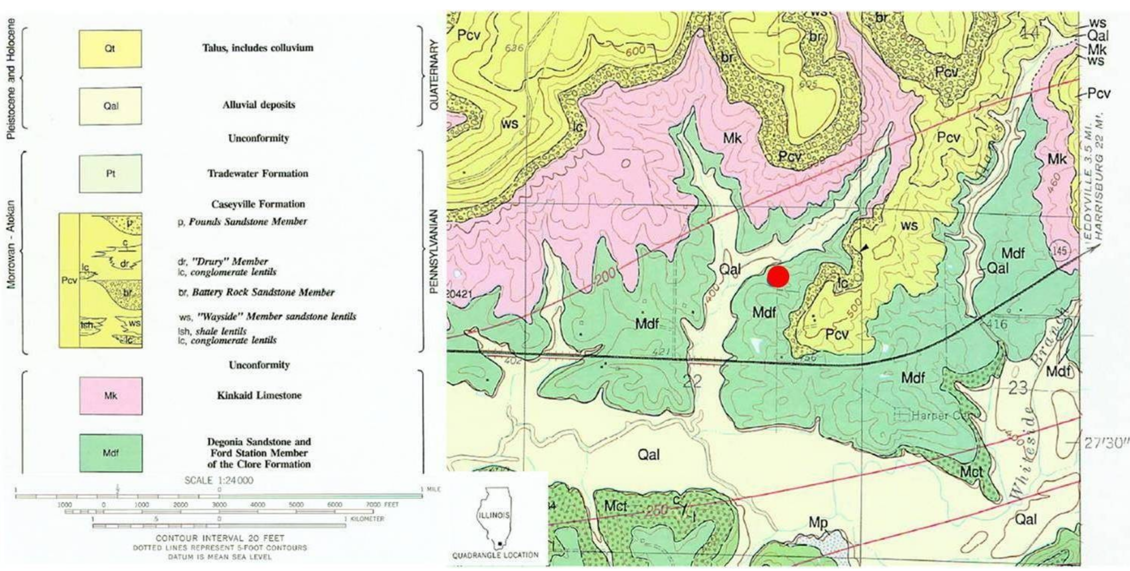
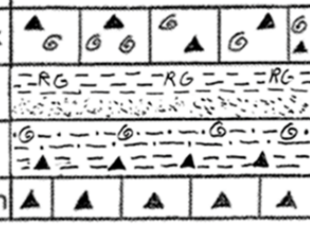


Figure 18. Geologic map of the Glendale Quadrangle taken from Devera (1991). The red dot indicates study locality #3.

System	Subsystem	Series	Stage	Formation	Member or Bed	Graphic Column	Thickness (Meters)	Unit
Carboniferous	Mississippian	Chesterian	Elviran	Kinkaid Ls	Negli Creek		N/A	A
				Degonia Sandstone			9	B
							2.1	C
				Clore	Ford Station		N/A	D

Description

A Negli Creek Limestone Massive, resistant, bluish gray to tan, freshly broken dark gray; dense mudstones at base with packstones and wackestones in upper part. *Girvanella sp.*, large belerophontid gastropods, and *Chaetetella sp.* are common in the lower portion of this unit. Chert nodules, both light gray and dark gray, are common.

B Degonia Sandstone Sandstone, siltstone, and shale. Upper portion of unit nonfossiliferous, containing variegated red and green shales with greenish gray and tan thin-bedded siltstone; yields crawling traces. Sandstone beds are fine grained at base, olive brown, with *Lockeia sp.*, weather to flaggy or tabular beds. Basal contact is gradational.

C Degonia Sandstone The unit is a green shale to siltstone that contains a fauna dominated by a single species of bivalves. The fauna only consists of bivalves. A chert that shows sedimentary structures (i.e. ripples and laminae) occurs below the shale. Above the fossiliferous zone is a reddish/greenish shale. No sandstone is observed at this location.

D Ford Station Limestone Dark gray, weather to light gray to tan, with yellow beds; dense lime mudstones, with dolomite rhombs; poorly fossiliferous; argillaceous in places; shows "hour glass" weathering. Limestone is shaly at base and grades into unit below. Thin chert bed occurs at the top of this limestone.

Figure 19. Stratigraphic column of the Glendale locality with unit C added. Modeled after Devera (1991).

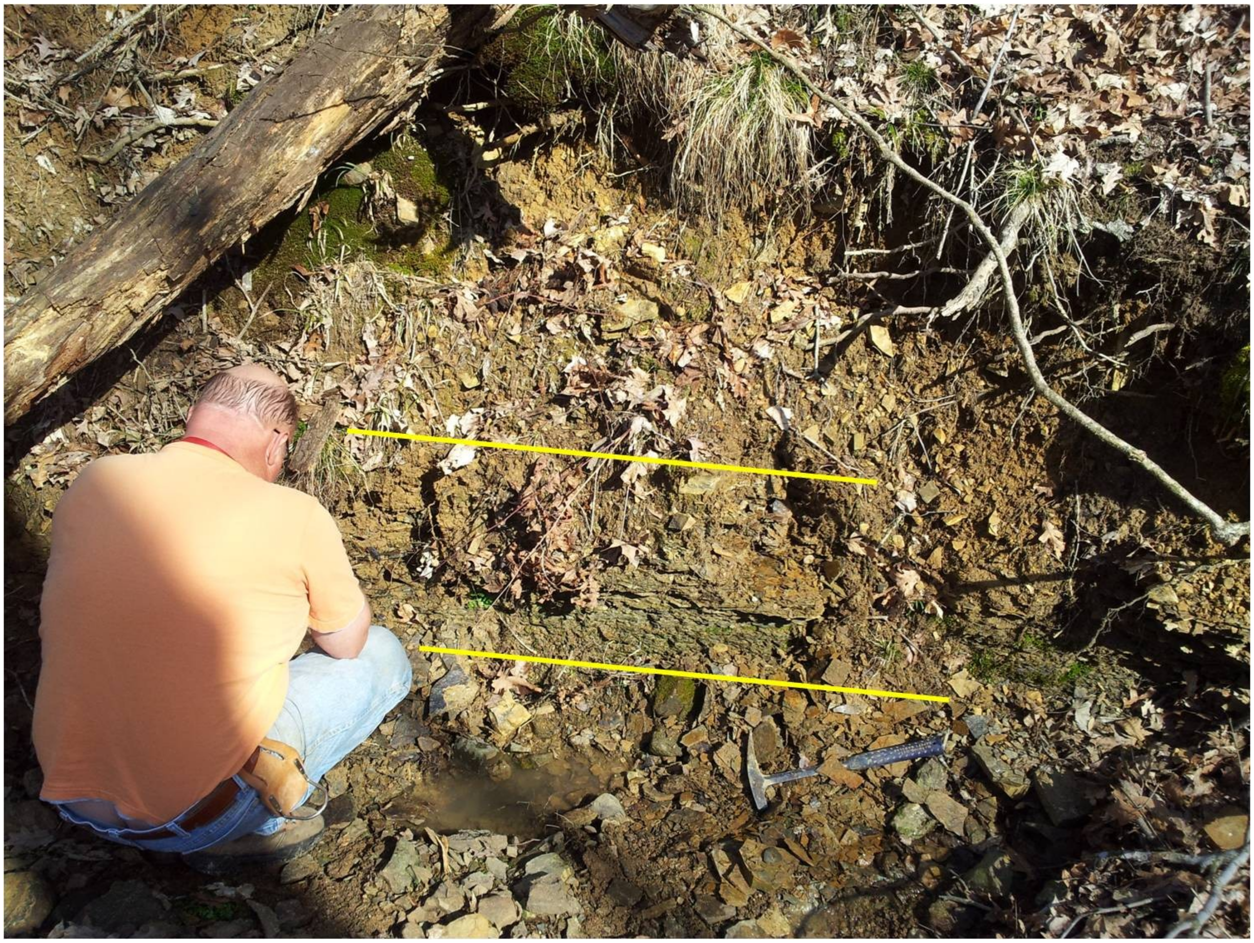


Figure 20. Fossilferous green shale near the top of the Degonia Sandstone at the Glendale locality. Green shale is located between the two yellow lines.

Figure 21. Chert showing sedimentary structures near the base of the Degonia Sandstone at the Glendale locality. The chert makes up the stream bed.

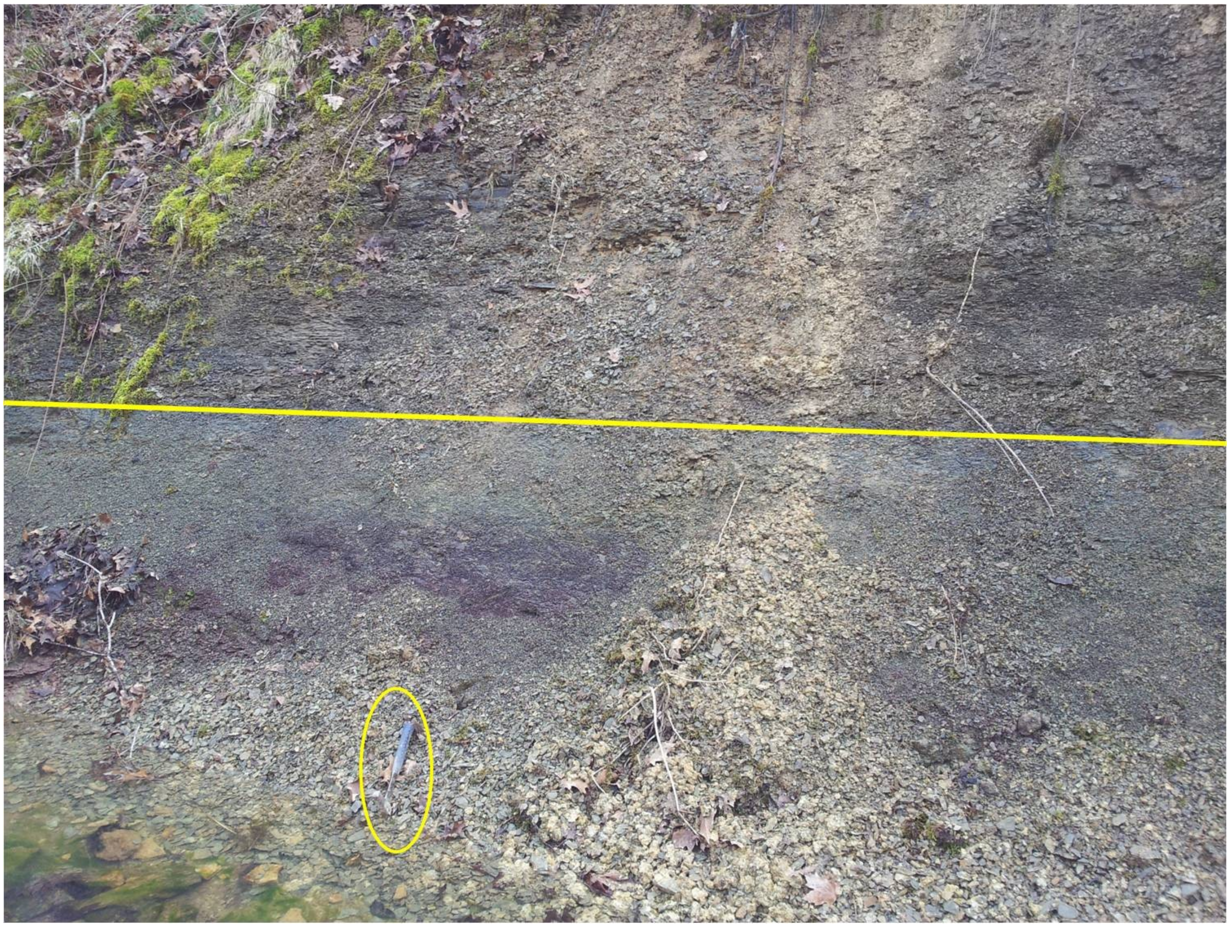


Figure 22. Red and green shale at the top of the Degonia Sandstone near the Glendale locality. Red shale is below the yellow line and green shale is above the yellow line. Geologic hammer (16" long handled Estwing) is circled for scale.

7.4: Raddle

Location #4 is located within the Matusky Hollow of the Raddle Quadrangle of Jackson County, IL (T8S, R4W, Sec. 17, Figure 23) and was discovered by Joseph Devera of the ISGS. The stratigraphic section can be seen in Figure 24. Unlike the previous localities, this is non-fossiliferous, but contains .6 to .9 meter wide U-shaped channels (some slightly more rounded than others). The channels stick out from the rest of the outcrop about .3 meters due to differential weathering (Figures 25-27). The channels are very fine grained, quartz rich, laminated, contain calcareous cement, and are oriented roughly NW-SE. The section containing the channels is roughly 1.2 meters thick with up to .6 meters of gray silty shale that contains trace fossils below. The channels are the only part of this section that react to acid, however, it is a very weak reaction. A short distance away is the characteristic green shale of the top of the Degonia (Figure 28).

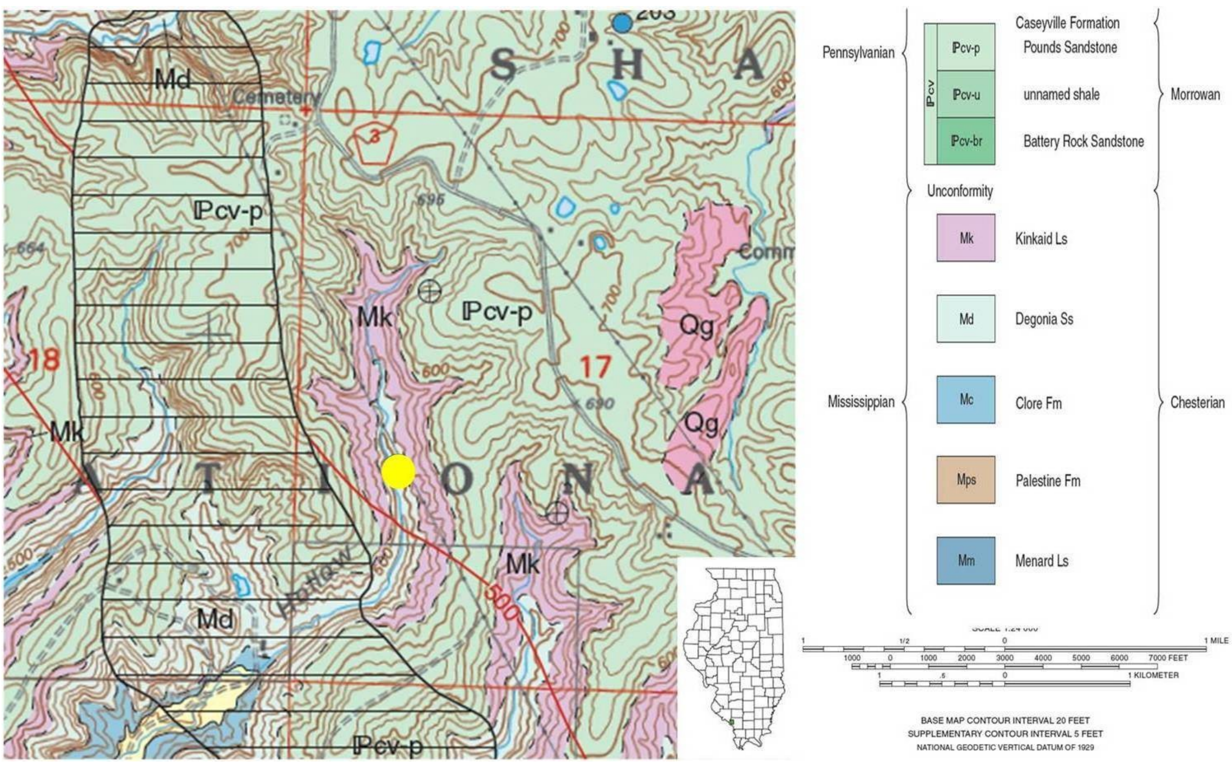
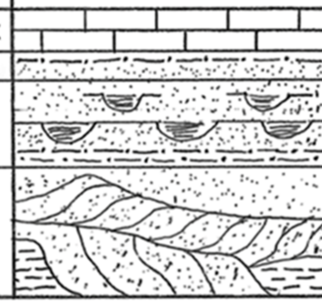


Figure 23. Geologic map of the Raddle Quadrangle taken from Devera (2005). The yellow dot indicates study locality #4.

System	Subsystem	Series	Stage	Formation	Member or Bed	Graphic Column	Thickness (Meters)	Unit
Carboniferous	Mississippian	Chesterian	Elviran	Kinkaid Ls	Negli Creek		7.6	A
				Degonia Sandstone	Shale/Siltstone		1.5	B
							1.8	C
							30	D

Description

A Negli Creek Limestone Dark gray, medium to thick bedded lime-mudstone that contains wackestones and diagnostic fossils (*Girvanella* sp., *Chaetetes milleporaceous*, and large bellerophontid gastropods). Chert is black and nodular. Basal contact is conformable.

B Degonia Sandstone Upper part of unit contains three feet of a micaceous, silty, green shale, followed by two feet of a very fine grained sandstone.

C Degonia Sandstone The major characteristic of this portion of the upper Degonia Sandstone are U-shaped sedimentary structures (two to three feet wide) protruding up to a foot out of the formation. The structures are ornamented roughly NW-SE. The gutter-shaped structures are very fine grained, quartz rich, non-fossiliferous, laminated, and contain calcareous cement. Some of these structures are more rounded. Only the gutter-shaped structures react to acid. The U-shaped structures are contained in a laminated section. Below this interval is a two foot section of gray silty shale that contains trace fossils.

D Degonia Sandstone Well exposed throughout the study area. It is dominated by a white, fine-grained, well sorted quartz arenite that is channel-form multi-stacked, multi-storied cross bedded in the lower part and laminated with rhythmic bedding in the upper part. Another feature of this unit is the presence of *Stigmaria* roots. These sandstone casts are common in the float within the alluvium. A gray, platy shale that either has a locally abrupt contact with the underlying shaly limestone or is unconformable with sandstone channel at the base is present in the lower portion of the sandstone.

Figure 24. Stratigraphic column of the Raddle locality with the U-shaped channels separated as their own facies. Modeled after Devera (2005).

Figure 25. Image showing several of the U-shaped sedimentary channels near the top of the Degonia Sandstone at the Raddle locality. U-shaped sedimentary channels are circled in yellow. The one on the far right has a backpack on it for scale.

Figure 26. Close of view of a U-shaped sedimentary channel at the Raddle locality showing lamination.

Figure 27. Side view of the U-shaped sedimentary structures at the Raddle locality showing the extent they protrude out of the Degonia Sandstone.

Figure 28. Green shale indicative of the top of the Degonia Sandstone near the Raddle locality.

CHAPTER 8

PALEONTOLOGICAL RESULTS AND DISCUSSION

In the Illinois Basin, marine fossils in sandstones are the exception rather than the rule, yet marine fossils have been found in nearly every Chester sandstone unit in the basin (Potter et al., 1958). "With each re-advance of the Chester sea in the Illinois Basin, prolific invertebrate faunas occupied the waters, and their fossil remains have been preserved in the limestones and calcareous shales. These successive faunas were much alike in many respects, but as they are critically studied, it is found that each one of them possesses certain characteristics which serve to differentiate it from the others" (Weller et al., 1920).

8.1: Flora and Fauna

The only fossils previously known to occur in the Degonia Sandstone are plant remains (*Lepidodendron* trunks and *Stigmaria* casts) and some crawling traces (Weller et al., 1920; Knight, 1968; Nelson et al., 1991). This study reports a very diverse marine fauna that consists of four Phyla (Table 2): Arthropoda, Brachiopoda, Bryozoa, and Mollusca. The only Arthropoda found was Acrothoracica (Susann Butts, personal communication, February, 2012). It is a boring barnacle (Cirripedia) that attaches to other shells. The Brachiopoda collected consist of *Diaphragmus nivosus*, *Orthotetes kaskaskiensis, Anthracospirifer occiduus,* and *Composita* sp. The Bryozoa collected include Fenestrates and Trepostomes. The Mollusca collected was the most diverse phyla, consisting of the bivalves: *Wilkingia walkeri*, ?*Edmondia* sp., *Aviculopecten winchelli*, *Promytilus illinoisensis*, ?*Septimyalina* sp., *Myalinella meeki*, *Myalina* sp.,

?*Sphenotus monroensis,* and four species of unknown bivalves; cephalopods: *Reticycloceras* sp.*, Endolobus* sp.*, Liroceras* sp.*, Metacoceras* sp.*,* and *Domatoceras* sp.; and gastropods: *Euconospira sturgeoni,* ?*Eotrochus cf. marigoldensis*, and an unknown gastropod. Other associated fossils were crinoid stem molds and plant material.

The Gorham, Cobden, and Glendale localities each contain a distinct set of fossils (Table 3). The Gorham locality #1 contains the greatest diversity of specimens, including: Acrothoracica*, Diaphragmus nivosus, Orthotetes kaskaskiensis, Anthracospirifer occiduus, Composita* sp.*, Wilkingia walkeri,* ?*Edmondia* sp.*, Aviculopecten winchelli, Promytilus illinoisensis,* ?*Septimyalina* sp., *Myalina* sp., *Reticycloceras* sp.*, Endolobus* sp.*, Liroceras* sp.*, Metacoceras* sp.*, Domatoceras* sp.*,* ?*Eotrochus cf. marigoldensis,* and plant material. A potential branch and an individual chamber of a large cephalopod were also observed. Rarely specimens had original shell material (milky white or red due to iron), and it was typically very thin. Samples showing the extreme diversity of the specimens can be seen in Plate 5.

The Cobden locality #2 contains what appear to be two zones, however all of the samples were collected as float. Two zones are interpreted because one assemblage contains a dwarf fauna and the other is normal size. The dwarf zone contains: ?*Sphenotus monroensis*, *Anthracospirifer occiduus, Aviculopecten winchelli, Promytilus illinoisensis, Myalina* sp., an unknown gastropod, crinoid stem molds, and two unknown bivalves (sp. A and sp. B). The second fauna containing normal sized specimens is similar, but also includes *Euconospira sturgeoni, Reticycloceras* sp.*,* and the specimens of *Aviculopecten winchelli* and *Anthracospirifer occiduus.* The unknown bivalves resemble some of the known genera, but it is not certain that they are the same due to poor preservation.

The Glendale locality #3 is dominated by small bivalves with unknown bivalve sp. D making up the majority of the fauna. Two unknown bivalves (sp. C and sp. D) occur here, as well as *Myalinella meeki* and *Aviculopecten* sp. that appear similar to *Aviculopecten winchelli*. The specimens here are slightly pyritized. The very fossiliferous zones can be seen in Plate 7, Figures 4 and 5.

The Raddle locality #4 contains no body fossils but does contain some trace fossils in the lower shale unit.

Table 2. Faunal list of the taxa observed in the WCSD.

Phylum	Class	Superorder	Order	Family	Genus	Species
Arthropoda	Cirripedia	Acrothoracica				
Brachiopoda	Rhynchonellata		Athyridida	Athyrididae	*Composita*	sp.
			Sprirferida	Spiriferidae	*Anthracospirifer*	*occiduus*
	Strophomenata		Productida	Productidae	*Diaphragmus*	*nivosus*
			Orthotetida	Orthotetidae	*Orthotetes*	*kaskaskiensis*
Bryozoa	Stenolaemata		Cryptostomata	Fenestellidae		
			Trepostomata			
Mollusca	Bivalvia		Anomalodesmata	Edmondiidae	?*Edmondia*	sp.
				Sanguinolitidae	?*Sphenotus*	*monroensis*
					Wilkingia	*walkeri*
			Mytiloida	Mytilidae	*Promytilus*	*illinoisensis*
			Pectionoida	Aviculopectinidae	*Aviculopecten*	*winchelli*
			Pterioida	Myalinidae	?*Septimyalina*	sp.
					Myalinella	*meeki*
					Myalina	sp.
			unknown (4 sp.)			
	Cephalopoda		Nautilida	Grypoceratidae	*Domatoceras*	sp.
				Koninckioceratidae	*Endolobus*	sp.
				Liroceratidae	*Liroceras*	sp.
				Tainoceratidae	*Metacoceras*	sp.
			Pseudorthocerida	Spyroceratidae	*Reticycloceras*	sp.
	Gastropoda		Euomphalina	Pseudophoridae	?*Eotrochus*	*marigoldensis*
			Murchisoniina	Gosseletinidae	*Euconospira*	*sturgeoni*
			unknown			

Table 3. Fauna separated by locality.

Gorham Locality #1	
Genus	Species
Diaphragmus	*nivosus*
Orthotetes	*kaskaskiensis*
Anthracospirifer	*occiduus*
Composita	sp.
Wilkingia	*walkeri*
?*Edmondia*	sp.
Aviculopecten	*winchelli*
Promytilus	*illinoisensis*
?*Septimyalina*	sp.
Myalina	sp.
Domatoceras	sp.
Endolobus	sp.
Liroceras	sp.
Metacoceras	sp.
Reticycloceras	sp.
?*Eotrochus*	*marigoldensis*
plant material	
trepostome bryozoan	
fenestrate bryozoan	
Acrothoracica	

Cobden Locality #1	
Genus	Species
?*Sphenotus*	*monroensis*
Anthracospirifer	*occiduus*
Aviculopecten	*winchelli*
Promytilus	*illinoisensis*
Euconospira	*sturgeoni*
Reticycloceras	sp.
Myalina	sp.
crinoid stem molds	
unknown bivalve sp. A	
unknown bivalve sp. B	
unknown gastropod	

Glendale Locality #1	
Genus	Species
Myalinella	*meeki*
Aviculopecten	*cf. winchelli*
unknown bivalve sp. C	
unknown bivalve sp. D	

8.2: Faunal List and Description of Specimens

Acrothoracica

Plate 2, Figure 3

Discussion – Identified by Susann H. Butts by the numerous holes on some of the specimen. Most notable on a dorsal valve of *Orthotetes kaskaskiensis*). Acrothoracica was found at location #1 Gorham Quadrangle.

Anthracospirifer occiduus

Plate 1, Figures 1-4

Discussion – Identified with the help of Susann H. Butts and from Gordon (1975). Specimens resemble those from Butts (2007) (Figure 5.34-5.36) and Gordon (1975) (Plate 11.19 and 11.20). *Anthracospirifer increbescens* is found in the Clore and Kinkaid Formations. Specimen average 15.4 mm in length and 24 mm wide. *Anthracospirifer occiduus* was found at location #1 Gorham Quadrangle.

A single specimen of *Anthracospirifer occiduus* was found at location #2 Cobden Quadrangle. Identification was made by its' similarities to *Anthracospirifer occiduus* at location #1 Gorham Quadrangle. A picture was not included because the specimen was broken.

Aviculopecten winchelli

Plate 1, Figures 7-8

Plate 6, Figures 1-3

Plate 7, Figure 1

Discussion – Specimens resemble those in Hoare (2007) (Figure 4.16-4.21). Specimen average 19.6 mm in length and 19.5 mm wide. *Aviculopecten winchelli* was found at location #1 Gorham Quadrangle, location #2 Cobden Quadrangle, and location #3 Glendale Quadrangle.

Chamber of unknown cephalopod

Plate 2, Figure 16

Discussion – Identified by Joseph Devera. The chamber was found at location #1 Gorham Quadrangle.

Composita sp.

Plate 1, Figures 13-16

Discussion – The two specimens most closely resemble genus *Composita*. Due to the lack of detail, the identification to species was not attempted, but it most closely resembles *Composita subquadrata* from Butts (2007) (Figure 5.24-5.26). It could potentially be *Composita trinuclea*, but *Composita subquadrata* is common in the Elvira group whereas *Composita trinuclea* is rare or absent (Weller and Sutton, 1940). *Composita subquadrata, Composita trinuclea,* and *Composita subtilita* are found in the Clore Formations. *Composita subquadrata* and *Composita trinuclea* are found in the Kinkaid Formation. Specimen average 12.5 mm in length and 11.5 mm wide. *Composita* sp. was found at location #1 Gorham Quadrangle.

Crinoid stem molds

Discussion – Two crinoid stem molds were found at location #2 Cobden Quadrangle. A picture was not included because they cannot be made out in the image.

Diaphragmus nivosus

Plate 1, Figures 9-12

Discussion – Originally identified simply as a Productid brachiopod due to preservation of mainly the ventral valve (Productids cannot be identified from the ventral exterior [Susann H. Butts, personal communication, March 2012). Identification of a *Diaphragmus* dorsal valve by Robert L. Peck (similar to those in his collection from the Bramwell Member of the Bluestone Formation in West Virginia) led to the identification of the dorsal valves belonging to *Diaphragmus sp.* Resembles both *Diaphragmus nivosus* (Plate 1.16-1.19) and *Diaphragmus cestriensis* (Plate 1.14 and 1.15) from Shannon (2005). More closely resembles *Diaphragmus nivosus* due to being broader at the beak than *Diaphragmus cestriensis*. *Diaphragmus elegans*, *Diaphragmus chesterensis*, and *Diaphragmus nivosus* are found in the Clore Formation, and *Diaphragmus elegans* is found in the Kinkaid Formation. Specimen average 16.1 mm in length and 15.6 wide. *Diaphragmus nivosus* was found at location #1 Gorham Quadrangle.

Domatoceras sp.

Plate 3, Figures 1-3

Discussion – Identified by John McLeod and Mark McKinzie by the suture pattern, the flat top of the shell, and the prominence of *Domatoceras* in the Carboniferous System. This was not able to be identified to species due to the siphuncle not being preserved. The single specimen measures 63 mm in diameter and 22 mm thick. *Domatoceras* sp. was found at location #1 Gorham Quadrangle.

?*Edmondia* sp.

Plate 2, Figure 9

Discussion – Potential identification given by Jack Bailey for some of the bivalve specimens due to their resemblance to *Edmondia*, but is not certain due to poor preservation of the specimens. The surrounding formations (Clore and Kinkaid) both contain species of *Edmondia*, with the Clore containing *Edmondia clavata*. Specimens were broken so measurements were not taken. ?*Edmondia* sp. was found at location #1 Gorham Quadrangle.

Endolobus sp.

Plate 3, Figures 4-6, 8

Discussion – Identified by John McLeod and Mark McKinzie by the suture pattern, the robustness of the shell, and the prominence of *Endolobus* in the Carboniferous System. This was not able to be identified to species due to the siphuncle not being preserved. Specimen average 62.3 mm in diameter and 43 mm thick. *Endolobus sp.* was found at location #1 Gorham Quadrangle.

?*Eotrochus cf. marigoldensis*

Plate 2, Figures 10-12

Discussion – The two specimens are both poorly preserved, but most closely resemble *Eotrochus marigoldensis* from Thein and Nitecki (1974) (Figure 77). Unlike *Eotrochus marigoldensis* from Thein and Nitecki (1974), the two specimens from this study do not contain “numerous thin and rounded revolving lirae”, but that could be due to poor preservation or the sand grains being too large to preserve this fine detail. Specimen average 10.5 mm in diameter and 17 mm high. ?*Eotrochus cf. marigoldensis* was found at location #1 Gorham Quadrangle.

Euconospira sturgeoni

Plate 6, Figure 9

Discussion – The single specimen was identified from Thein and Nitecki (1974) from Figure 30. The specimen measures 14 mm in diameter and 15 mm high. *Euconospira sturgeoni* was found at location #2 Cobden Quadrangle.

Fenestrate bryozoan

Plate 2, Figure 18

Discussion – The several specimens were identified as a fenestrate bryozoan due to the lace-like nature of the specimen. It was not attempted to identify to species since the specimens are very small and poorly preserved pieces. Both the Clore and Kinkaid Formations contain several species of fenestrate bryozoans. Fenestrate bryozoans were found at location #1 Gorham Quadrangle.

Liroceras sp.

Plate 3, Figure 9

Discussion – Identified by John McLeod and Mark McKinzie by the suture pattern and the prominence of *Liroceras* during the Carboniferous System. This was not able to be identified to species due to the siphuncle not being preserved. Specimen average 43.5

mm in diameter and 29.5 thick. *Liroceras* sp. was found at location #1 Gorham Quadrangle.

Metacoceras sp.

Plate 3, Figure 7

Discussion – Identified by John McLeod and Mark McKinzie by the suture pattern, the arched top of the shell, and the prominence of *Metacoceras* during the Carboniferous System. This was not able to be identified to species due to the siphuncle not being preserved. There was not enough of the specimen present to get an accurate measurement. *Metacoceras* sp. was found at location #1 Gorham Quadrangle.

Myalina sp.

Plate 2, Figure 15

Plate 6, Figure 13

Discussion – The specimens were identified as *Myalina* sp. by comparing with the specimens in Newell (1942). The lack of characteristics prevented identification to species. The Kinkaid Formation contains species of *Myalina.* The specimen measures 27 mm in length and 14 mm wide. *Myalina* sp. was found at location #1 Gorham Quadrangle.

A single specimen of *Myalina* sp. was found at location #2 Cobden Quadrangle. Identification was made by its similarities to the *Myalina* sp. from location #1 Gorham Quadrangle.

Myalinella meeki

Plate 7, Figure 2

Discussion – Several specimens were identified using the shell profile from an external mold. Newell (1942) (Plate 14.7-14.10 and 14.12-14.14) was used for identification. Identification was confirmed by Jack Bailey. The specimen measures 18 mm in length and 10 mm wide. *Myalinella meeki* was found at location #3 Glendale Quadrangle.

Orthotetes kaskaskiensis

Plate 2, Figures 1-5

Discussion – Specimens resemble *Orthotetes kaskaskiensis* from Shannon (2005) (Plate 1.7-1.10). Identification was confirmed by Susann Butts. Samples of *Orthotetes kaskaskiensis* are known from both the Clore and Kinkaid Formations. Specimen average 25 mm in length and 34.1 mm wide. *Orthotetes kaskaskiensis* was found at location #1 Gorham Quadrangle.

Plant material

Plate 4, Figures 1-3, 5-8

Discussion – Numerous samples of wood were observed along with interbedded shale but were unable to be identified to genera. Other plant material observed include a potential branch and a mass of leaf debris. The plant material was found at location #1 Gorham Quadrangle.

Promytilus illinoisensis

Plate 2, Figures 13-14

Plate 6, Figures 4-5

Discussion – Specimens most closely resembles *Promytilus illinoisensis* from Busanus and Hoare (1991) (Figure 3.17-3.19) based on shell profile. Identification is questionable due the posterior margins not being preserved and the presence of a sharp carina on the umbonal slope resembling that of *Myalina*. Appears similar to *Myalina copha* from Newell (1942) (Plate 7.3) and *Modiolus cf. waverliensis* from Hoare (1993) (Figure 3.3-3.7). Specimen average 27.6 mm in length and 16.3 mm wide. *Promytilus illinoisensis* was found at location #1 Gorham Quadrangle and location #2 Cobden Quadrangle.

Reticycloceras sp.

Plate 3, Figures 10-12

Plate 6, Figure 10

Discussion – Specimens were identified by shell profile being similar to those of the various *Reticycloceras* sp. from Gordon (1964) (Plate 6). This was not able to be identified to species due to the siphuncle not being preserved. Specimen average 35 mm in length and 11.5 mm wide. *Reticycloceras* sp. was found at location #1 Gorham Quadrangle and location #2 Cobden Quadrangle.

Septimyalina sp.

Plate 2, Figures 6-8

Discussion – The specimen were identified as *Septimyalina sp.* by comparing with those in Hoare (1993) (Figure 3.8-3.11) and Newell (1942). Identification to species was not possible due to poor preservation of distinguishing characteristics. Specimen average 35.3 mm in length and 24.6 mm wide. *Septimyalina* sp. was found at location #1 Gorham Quadrangle.

?*Sphenotus monroensis*

Plate 6, Figures 6-7

Discussion –Specimens were potentially identified as *Sphenotus monroensis* based on the shell profile being similar to that in Busanus and Hoare (1991) (Figure 6.1-6.6). This species is known to occur in the Chesterian Series in the Reynolds Limestone of the Mauch Chunk Group (roughly the same age) of West Virginia, however, identification is uncertain due to there being few specimens and the distinguishing characteristics not being preserved. Specimen average 13.5 mm in length and 7 mm wide. ?*Sphenotus monroensis* was found at location #2 Cobden Quadrangle.

Trepostome bryozoan

Plate 2, Figure 17

Discussion – The single specimen was identified as a mold of a trepostome bryozoan by Joseph Devera. The Kinkaid Formation is known to contain trepostome bryozoans. The trepostome bryozoan was found at location #1 Gorham Quadrangle.

Unknown bivalves

Plate 6, Figures 8 and 12

Plate 7, Figures 3 and 6

Discussion – There were two unknown bivalves observed from location #2 Cobden Quadrangle. A single example of unknown bivalve sp. A can be seen in Plate 6, Figure 8, and was discovered as a mold. Unknown bivalve sp. B from the Cobden locality is seen in Plate 6, Figure 12, and appears to contain both valves but is unable to be identified.

There were two unknown bivalves observed from location #3 Glendale Quadrangle. A few specimens similar to Plate 7, Figure 3 (unknown bivalve sp. C), were observed as fragments, with no distinguishable characteristics. The specimen in Plate 7, Figure 6 (unknown bivalve sp. D) was also unable to be identified, but makes up the majority of the specimens observed at the Glendale locality. Their extreme abundance can be seen in Plate 7, Figures 4 and 5.

Unknown gastropod

Discussion – An abundant unknown gastropod was observed in the dwarf zone location #2 Cobden Quadrangle. Specimens were unable to be identified due to not being able to collect an entire shell. A picture was not included because they cannot be made out in the image.

Wilkingia walkeri

Plate 1, Figures 5-6

Discussion – Specimen were identified using shell profile and comparing to *Wilkingia walkeri* in Hoare (1993) (Figure 7.14-7.18). Specimen average 25.8 mm in length and 25.4 mm wide. *Wilkingia walkeri* was found at location #1 Gorham Quadrangle.

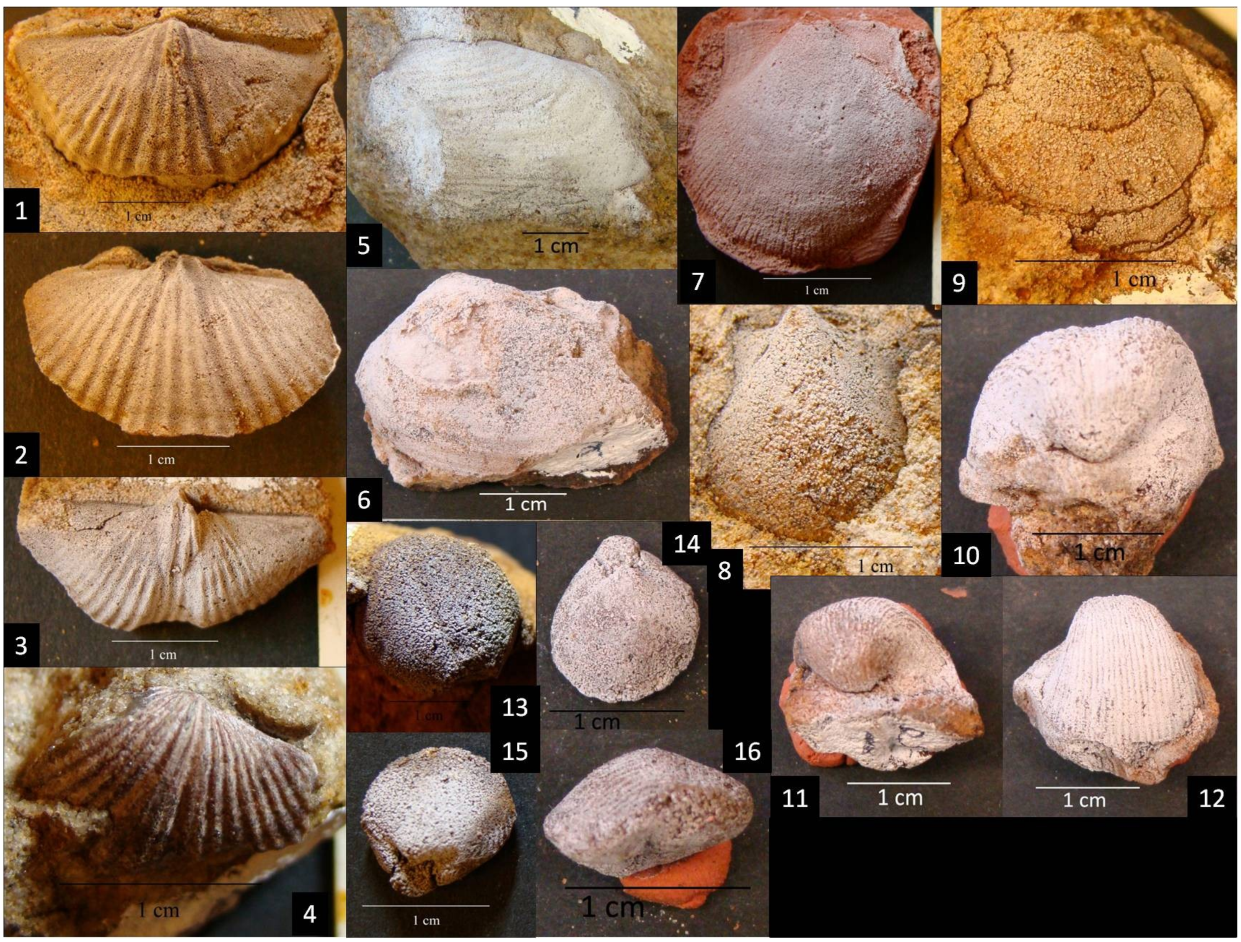


Plate 1: Specimens from location #1 Gorham Quadrangle. 1-4 *Anthracospirifer occiduus*, 1, dorsal valve, 2, dorsal valve, 3, hinge line and ventral valve, 4, red coloring from iron; 5-6 *Wilkingia walkeri*; 7-8 *Aviculopecten winchelli*; 9-12 *Diaphragmus nivosus*, 9, dorsal valve, 10, ventral valve showing slight sulcus, 11, ventral valve, 12, ventral valve; 13-16 *Composita* sp.

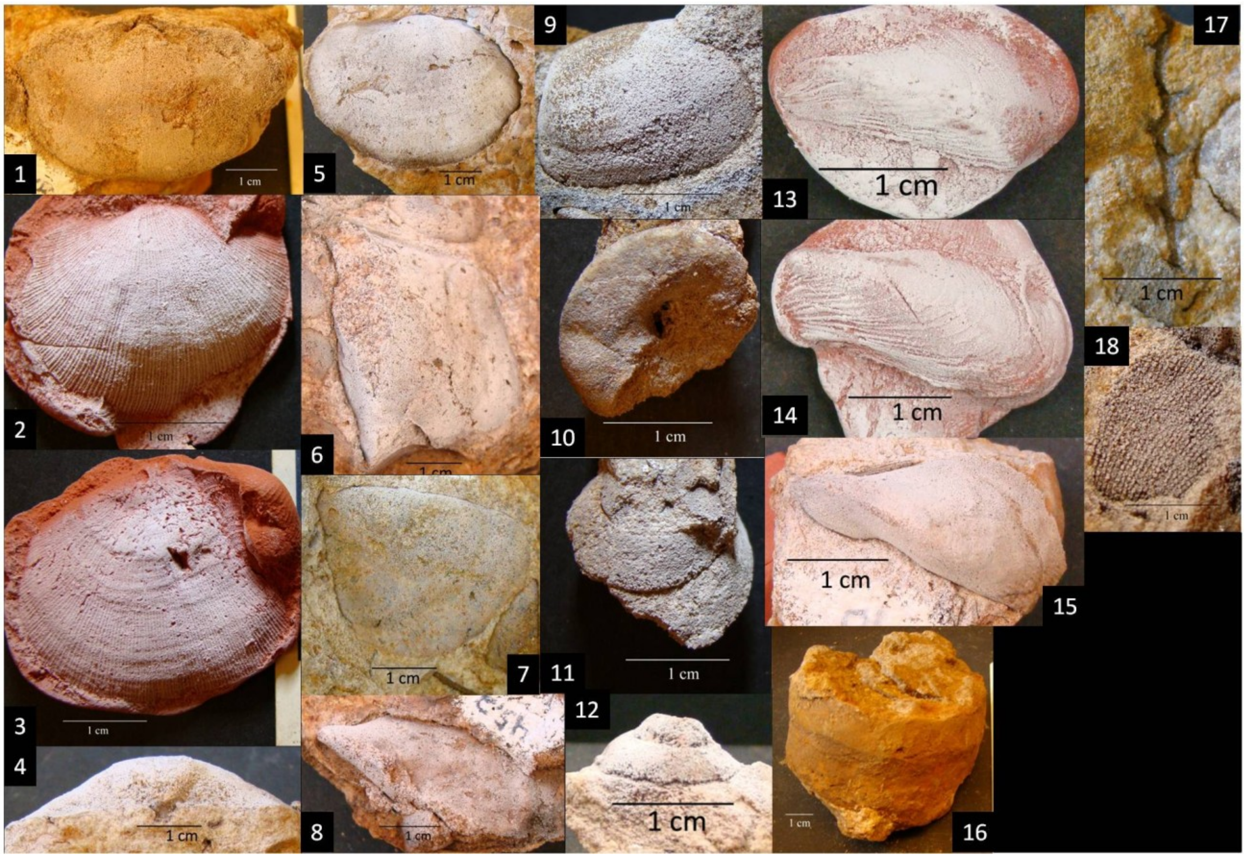


Plate 2: Specimens from location #1 Gorham Quadrangle. 1-5 *Orthotetes kaskaskiensis*, 1-2, ventral valve, 3, dorsal valve, 4, looking down hinge, 5, ventral valve; Acrothoracica, small holes on #3; 6-8 *Septimyalina* sp.; 9 ?*Edmondia sp*.; 10-12 *Eotrochus* cf. *marigoldensis*; 13-14 *Promytilus illinoisensis*; 15 *Myalina* sp.; 16 Chamber of cephalopod; 17 Trepostome bryozoan; 18 Fenestrate bryozoan.

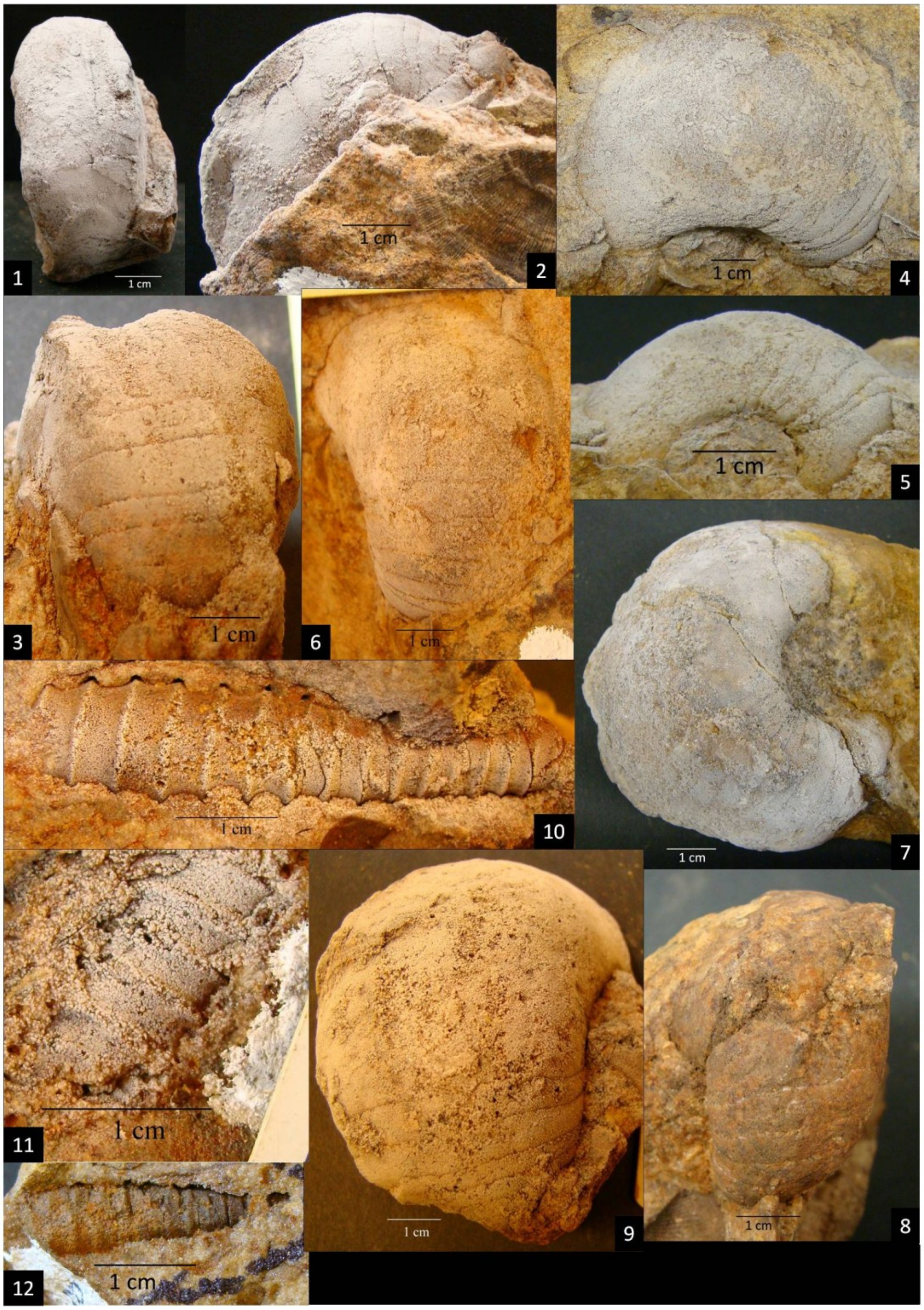


Plate 3: Specimens from location #1 Gorham Quadrangle. 1-3 *Domatoceras* sp.; 4-6, 8 *Endolobus* sp.; 7 *Metacoceras* sp.; 9 *Liroceras* sp.; 10-12 *Reticycloceras* sp.

Plate 4: Specimens from location #1 Gorham Quadrangle. 1 Mass of plant material; 2-3 Potential branch; 4 Interbedded shale; 5-8 Wood.

Plate 5: Blocks showing diversity at location #1 Gorham Quadrangle.

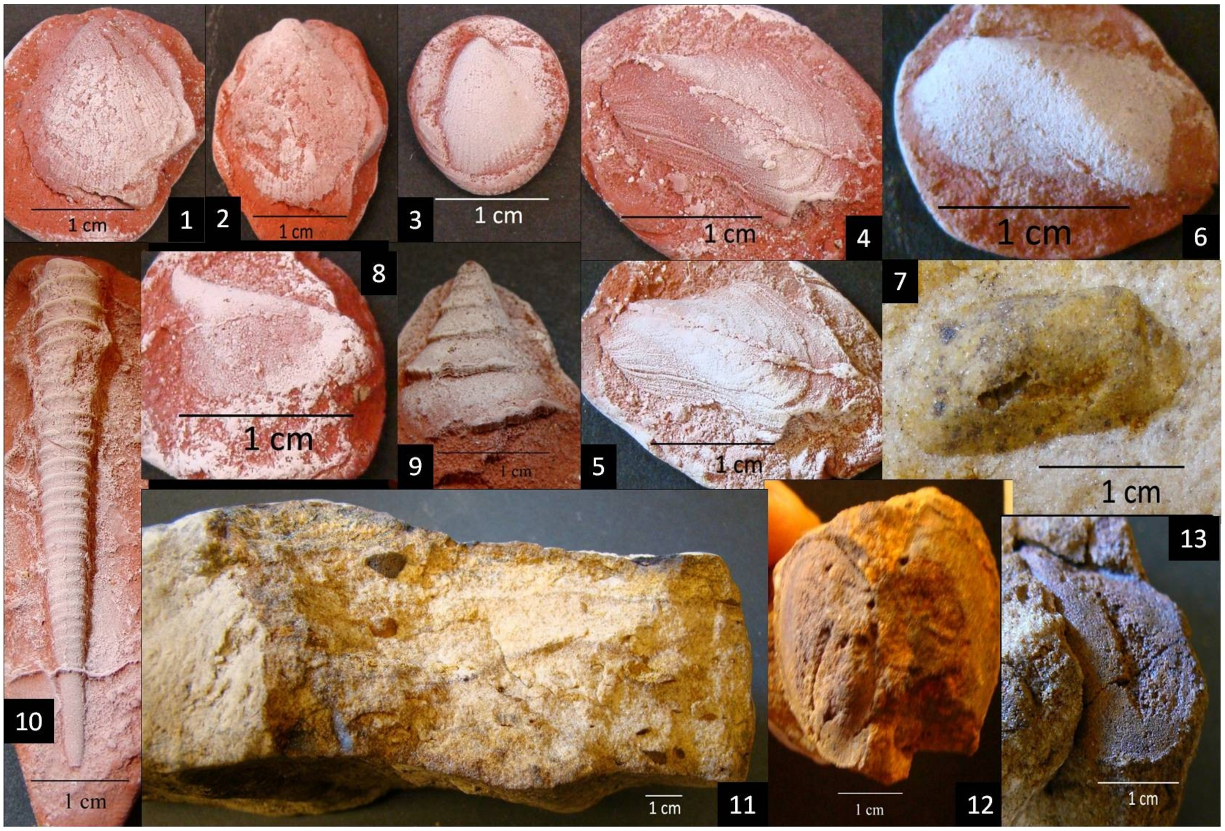


Plate 6: Specimens from location #2 Cobden Quadrangle. 1-3 *Aviculopecten winchelli*; 4-5 *Promytilus illinoisensis*; 6-7 ?*Sphenotus* cf. *monroensis*; 8 Unknown bivalve sp. A; 9 *Euconospira sturgeoni*; 10 *Reticycloceras* sp.; 11 Block containing various specimen; 12 Unknown bivalve sp. B; 13 *Myalina* sp.

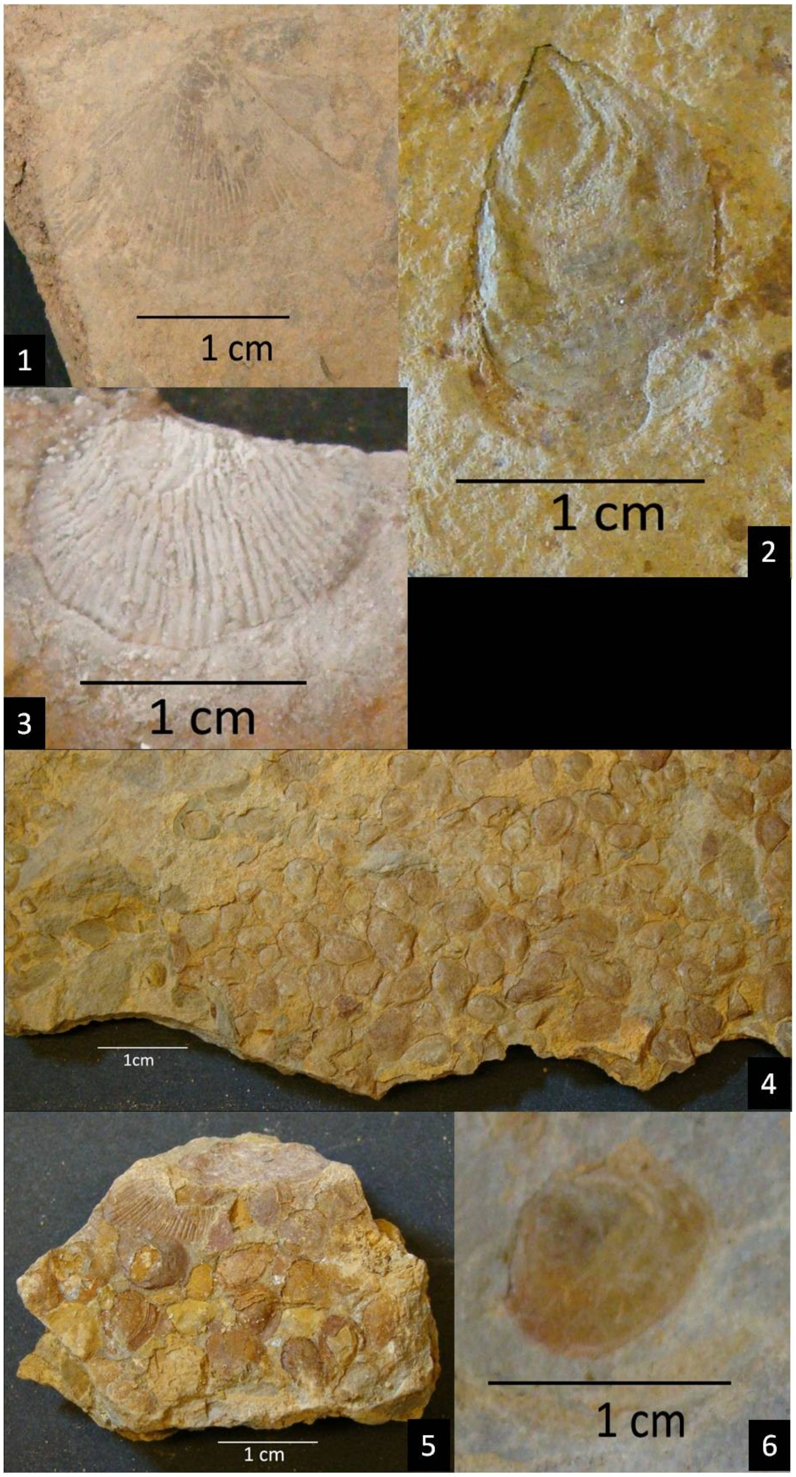


Plate 7: Specimens from location #3 Glendale Quadrangle. 1 *Aviculopecten winchelli*; 2 *Myalinella meeki*; 3 Unknown bivalve sp. C; 4 Fossiliferous layer containing unknown bivalves; 5 Block containing various specimen; 6 Unknown bivalve sp. D.

8.3: Taphonomy

Since the fossils of the WCSD are preserved in sandstone, the preservation is poor. In most cases, the large size of the sand grains (compared to the small size of the matrix of limestone) prevents the preservation of the fine detail required to identify to the generic and specific level. In order to correctly identify to the generic and specific level, it is necessary to have fine characteristics such as muscle scars, hinge details, teeth, resilifer, and other ornamentation (Robert L. Peck, personal communication, February, 2012). Overall, the specimens from the WCSD lack these characteristics. Some of the specimens are preserved as steinkerns, however most are preserved as casts of one valve. In some cases, steinkerns are the best way to identify specific fossils (i.e. steinkerns are the only way to identify cephalopods because they preserve the suture pattern and the location of the siphuncle [John Catalani, personal communication, March, 2012]), however, the main characteristic preserved in the steinkerns of the WCSD is a minor amount of shell ornamentation.

"Using shell profile as the primary identification characteristic can be dangerous because of homeomorphs" (Robert L. Peck, personal communication, February, 2012), but overall shell profile (and the little ornamentation that was present) was used for identification. The danger of using shell profile as the primary identifier was reduced by reviewing the fossils present in the Clore Formation below and Kinkaid Limestone above, and comparing the known species to the specimens from the WCSD.

The paleontological characteristics (along with the shale rip up clasts) of the WCSD in the Gorham Quadrangle point to it being a storm deposit. The brachiopods and bivalves are disarticulated and preserved in random orientations, allowing the internal and external shell characteristics to not be preserved. Also, species that normally are not found associated with each other (i.e. some of the brachiopods and bivalves) are found jumbled together. The Cobden locality is very near the Gorham locality, so it may have been affected by similar storm conditions resulting in a similar deposit, however, the major difficulty in identifying the fauna here is due to the characteristics pointing to it mainly being a dwarf zone. In addition to the poor preservation of the fauna, the small size makes them even harder to identify. The fauna of the Glendale locality were preserved slightly better than the Cobden locality since they were preserved in shale (more shell ornamentation). The Glendale locality does not appear to represent a storm deposit. The Glendale assemblage is more typical of a natural molluscan assemblage where a single species is dominant with a few specimens of other taxa present (Joseph Devera, personal communication, April, 2012). The Glendale assemblage is dominated by a taxa of unknown bivalves with a few specimens of *Aviculopecten winchelli* and *Myalinella meeki* present.

8.4: Paleoenvironment

Previous to this study, the only fossils known from the Degonia Sandstone were indicative of a terrestrial setting. The *Lepidodendron* trunks, *Stigmaria* casts, and crawling traces led to an interpretation of the Degonia Sandstone as fluvial to nearshore transitional marine environments (Potter, 1962; Nelson et al., 1991). This can be supported by the fine preservation of some of the plant material; however, these remains may have floated considerable distances from shore due to their preservation as casts (Weller and Sutton, 1940).

A number of marine and brackish water genera (Tables 4 and 5; Figure 28) were found providing evidence for the marine sedimentary structures that were previously known to occur in the upper Degonia Sandstone. These marine fossils indicate that either the Chesterian seas were transgressing the Illinois Basin during the deposition of the upper Degonia Sandstone or that they represent a nearshore storm event.

Gorham locality #1 is dominated by a molluscan fauna: bivalves and nautiloid cephalopods. Bivalves are the most abundant taxa with brachiopods being the second most abundant. The presence of wood and plant debris, taphonomic characters (i.e. disarticulated bivalves and brachiopods and a mixing of organisms that are not typically found together like myalinids, brachiopods, and cephalopods) point toward a marine nearshore storm deposit.

The Cobden locality #2 is in close proximity (one mile away) and also suggests a storm deposit. This location includes: two species of gastropods, some crinoid stem molds, and does not contain any plant debris.

Glendale locality #3 consists of a dominant bivalve fauna (mainly unknown bivalves species D) that also contains rare *Aviculopecten* sp. A fauna dominated by a single taxon may indicate harsh or highly variable salinity conditions that can exist in paralic environments (Devera, 1989). The high concentration of these bivalves, which also appear to be dwarfed, may indicate brackish water conditions.

Finally, the gray shale unit at the Raddle locality #4 contains some trace fossils, but otherwise is non-fossiliferous. The U-shaped channels that are present are slightly calcareous, indicating a marine connection, whereas the rest of the Degonia at this locality is non-calcareous. "Calcareous laminated channels in an overall fine grained laminated sequence [figures 25-27] with amalgamated micro-ripples in shales, wavy bedding, and flaser bedding indicate an intertidal flat sequence" (Klein, 1970).

Table 4. Table indicating environment, life habit, and attachment of taxa observed in the WCSD. *Acrothoracica is a superorder, Fenestellidae is a family, and Trepostomata is an order.

Genus	Species	Environment	Life Habit	Attached?
Anthracospirifer	*occiduus*	Transitional Marine	Epifaunal	Yes
Aviculopecten	*winchelli*	Marine	Epifaunal	Yes
Composita	sp.	Transitional Marine	Low-level Epifaunal	Yes
Diaphragmus	*nivosus*	Transitional Marine	Low-level Epifaunal	Yes
Domatoceras	sp.	Marine	Nektobenthic	No
?*Edmondia*	sp.	Transitional Marine	Infaunal	Yes
Endolobus	sp.	Marine	Nektobenthic	No
?*Eotrochus*	*marigoldensis*	Transitional Marine	Epifaunal	No
Euconospira	*sturgeoni*	Transitional Marine	Epifaunal	No
Liroceras	sp.	Marine	Nektobenthic	No
Metacoceras	sp.	Marine	Nektobenthic	No
Myalina	sp.	Brackish/Marine	Low-level Epifaunal	Yes
Myalinella	*meeki*	Brackish/Marine	Low-level Epifaunal	Yes
Orthotetes	*kaskaskiensis*	Transitional Marine	Low-level Epifaunal	Yes
Promytilus	*illinoisensis*	Brackish/Marine	Semi-Infaunal	Yes
Reticycloceras	sp.	Marine	Nektonic	No
?*Septimyalina*	sp.	Brackish/Marine	Low-level Epifaunal	Yes
?*Sphenotus*	*monroensis*	Brackish/Marine	Deep Infaunal	Yes
Wilkingia	*walkeri*	Transitional Marine	Deep Infaunal	Yes
Acrothoracica*		Marine	Encrusting	Yes
Fenestellidae*		Marine	Epifaunal	Yes
Trepostomata*		Marine	Epifaunal	Yes

Table 5. Table separating the genera observed into groups by life habits.
***Acrothoracica is a superorder, Fenestellidae is a family, and Trepostomata is an order.**

Group	Constituent Genera		
Tethered Brachiopods (T-Brach)	*Anthracospirifer*	*Composita*	*Orthotetes*
Productid Brachiopods (P-Brach)	*Diaphragmus*		
Infaunal Bivalves (In-Biv)	*?Edmondia* *Wilkingia*	*Promytilus*	*?Sphenotus*
Epifaunal Bivalves (Epi-Biv)	*Aviculopecten* *Myalina*	*Myalinella*	*?Septimyalina*
Gastropods (Gastropods)	*?Eotrochus*	*Euconospira*	
Cephalopods (Cephalopods)	*Endolobus* *Metacoceras*	*Domatoceras* *Reticycloceras*	*Liroceras*
*Acrothoracica (Acrothoracica)			
Bryozoa (Bryozoans)	*Fenestellidae	*Trepostomata	

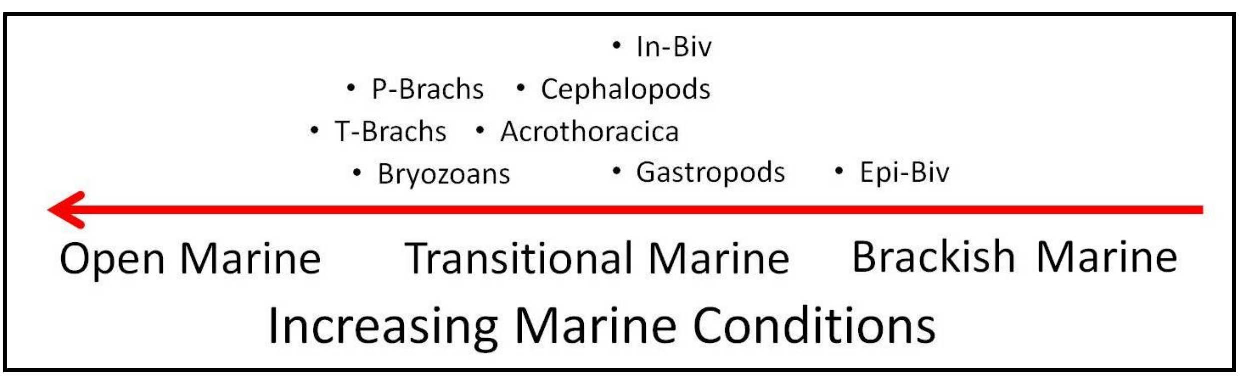


Figure 29. Diagram indicating environments of the groups created in Table 4. In-Biv represent the infaunal bivalves, Epi-Biv represent the epifaunal bivalves, P-Brachs represent the productid brachiopods, and T- Brachs represent the tethered brachiopods.

CHAPTER 9

CONCLUSIONS

The Degonia Sandstone was first classified as a formation by Stuart Weller in 1920 when he described it as being terrestrial. Since then, it has been studied by a variety of people concluding that it represents fluvial (Potter, 1962), nearshore deltaic (Kolesar, 1964), zones of possible marine origin (Potter and Desborough, 1965), and tidal (Roush, 1972) environments. This study describes a newly discovered marine fauna in the late Mississippian Subsystem.

The upper part of the Degonia has been characterized as nearshore deltaic (Kolesar, 1964). Roush (1972) described many of the tidal features of the upper Degonia. Red shale has been documented at the top of the formation (Baxter and Desborough, 1965). Thin coal beds have been documented in the middle and top of the formation (Willman et al., 1975).

Until this study, the only fossils from the Degonia Sandstone published on were plant remains, *Lepidodendron* sp. being the most common (Willman et al., 1975), and non-diagnostic trace fossils (Nelson et al., 1991). This study has resulted in the description of a new marine fauna in the upper Degonia Sandstone, which has been named the Wolf Creek Storm Deposit. Four localities were studied and each exhibit marine influences. The reference section (the Gorham locality) contains the largest diversity of fossils and possibly represents a storm deposit. The Cobden locality contains similar specimen to the Gorham locality, but contains a smaller diversity of brachiopods and cephalopods, but a larger diversity of bivalves. This locality appears to contain a zone of dwarfed specimens and a zone of normal sized specimens. This locality also represents a storm deposit. The Glendale locality contains the lowest diversity of specimen being dominated by unknown bivalve species D, but contains four genera of bivalves. This locality represents brackish water conditions. The Raddle locality is non-fossiliferous, but contains laminated U-shaped tidal channels that contain calcareous cement, indicating that this locality was within the intertidal zone.

The fauna consists of four Phyla: Arthropoda, Brachiopoda, Bryozoa, and Mollusca. The only Arthropoda observed was a burrowing barnacle (Acrothoracica) (Susann Butts, personal communication, February, 2012). The Brachiopoda observed consist of *Diaphragmus nivosus*, *Orthotetes kaskaskiensis, Anthracospirifer occiduus,* and *Composita* sp. The Bryozoa observed include Fenestrate and Trepostome. The Mollusca was the most diverse phyla observed, consisting of bivalves (*Wilkingia walkeri*, ?*Edmondia* sp., *Aviculopecten winchelli*, *Promytilus illinoisensis*, *Myalina* sp., ?*Septimyalina* sp., *Myalinella meeki*, ?*Sphenotus monroensis,* and four species of unknown bivalves), cephalopods (*Reticycloceras* sp., *Endolobus sp., Liroceras* sp., *Metacoceras* sp., and *Domatoceras* sp.), and gastropods (*Euconospira sturgeoni,* ?*Eotrochus cf. marigoldensis*, and an unknown gastropod). Other fossils observed were crinoid stem molds and plant material.

The verification and documentation of marine invertebrate fossils occurring in the upper Degonia supports the previous sedimentological evidence of nearshore marine conditions.

Further studies need to be performed in order to learn more about the marine conditions within the Degonia Ss. These studies include: 1) discovering more localities where the marine fauna is present; 2) further collecting; 3) an attempt to try to locate the shoreline; and 4) a comparison with other stratigraphic units of the same age from other regions to see if they correlate.

REFERENCES

Baxter, J.W., and Desborough, G.A., 1965, Areal Geology of the Illinois Fluorspar District Part 2 – Karbers Ridge and Rosiclare Quadrangles: Illinois State Geological Survey Circular, no. 385.

Baxter, J.W., Desborough, G.A., and Shaw, C.W., 1967, Areal Geology of the Illinois Fluorspar District Part 3 – Herod and Shetlerville Quadrangles: Illinois State Geological Survey Circular, no. 413.

Busanus, J.W., and Hoare, R.D., 1991, Bivalves (Mollusca) from the Mauch Chunk Group (Mississippian, Chesterian) of northern West Virginia and southwestern Pennsylvania: Journal of Paleontology, v. 65, no. 3, p. 465-480.

Butts, C., 1922, The Mississippian Series of eastern Kentucky; a regional interpretation of the stratigraphic relations of the Subcarboniferous group based on new and detailed field examinations: Kentucky Geological Survey, series 6, v. 7.

Butts, S.H., 2007, Silicified Carboniferous (Chesterian) Brachiopoda of the Arco Hills Formation, Idaho: Journal of Paleontology, v. 81, no. 1, p. 48-63.

DeRaaf, J.F.M., and Boersma, J.R., 1971, Tidal deposits and their sedimentary structures (seven examples from Western Europe): Geologie en Mijnb., v. 50, p. 479-504.

Devera, J.A., 1989, Ichnofossil assemblages and associated lithofacies of the Lower Pennsylvanian (Caseyville and Tradewater Formations), southern Illinois: *in* Cobb, J.D., ed., Geology of the Lower Pennsylvanian in Kentucky, Indiana, and Illinois: Illinois Basin Studies, v. 1, p. 57–83.

Devera, J.A., 1991, Geologic map of the Glendale Quadrangle, Johnson and Pope Counties, Illinois: Illinois State Geological Survey.

Devera, J.A., 2005, Bedrock Geology of Raddle Quadrangle, Jackson County, Illinois: Illinois State Geological Survey.

Devera, J.A., and Nelson, W.J., 1995, Geologic map of the Cobden Quadrangle, Jackson and Union Counties, Illinois: Illinois State Geological Survey.

Devera, J.A., Nelson, W.J., and Norby, R.D. 2010. Middle Devonian Series through Mississippian System (Kaskaskia Sequence). In: Kolata, D.C., Nimz, C.K., editors. *Geology of Illinois*. Champaign (IL): Illinois State Geological Survey. p. 167-186.

Droste, J.B., and Keller, S.J., 1989, Development of the Mississippian–Pennsylvanian unconformity in Indiana: Department of Natural Resources Geological Survey Occasional Paper 55, p. 11.

Gordon, M. Jr., 1964, Carboniferous cephalopods of Arkansas: U.S. Geological Survey Professional Paper 460, 322 pp.

Gordon, M. Jr., 1975, Brachiopoda of the Amsden Formation (Mississippian and Pennsylvanian) of Wyoming. Washington: U.S. Dept. of the Interior, Geological Survey Professional Paper 848-D, 118 pp.

Greb, S.F. 1989, Structural controls on the formation of the sub-Absaroka unconformity in the U.S. Eastern Interior Basin: Geology v. 17, pp. 889-892.

Jacobson, R.J., McLeod, J.D., and Amos, D.H., 2005, Bedrock Geology of Rockwood Quadrangle, Randolph and Jackson Counties, Illinois and Perry County, Missouri: Illinois State Geological Survey.

Jerzykiewicz, T., and Sweet, A.R., 1986, Caliche and associated impoverished palynological assemblages: an innovative line of paleoclimatic research onto the uppermost Cretaceous and Paleocene of southern Alberta, *in* Current Research, Part B: Geological Survey of Canada, Paper 86-1B, p. 653-663.

Hoare, R.D., 1993. Mississippian (Chesterian) bivalves from the Pennsylvanian stratotype area in West Virginia and Virginia. Journal of Paleontology, v. 67, no. 3, p. 374-396.

Hoare, R.D., 2007, Bivalve Mollusks from the Maxville Limestone (Mississippian) in Ohio: Ohio Journal of Science, v. 107, no. 4, p.63-75.

Klein, G.D., 1970, Depositional and dispersal dynamics of intertidal sand bars: Journal of Sedimentary Petrology, v. 40, p. 1095-1127.

Knight, L.W., 1968, Areal geology of the Bloomfield Quadrangle, southern Illinois: Master's Thesis, Southern Illinois University Carbondale, 184 pp.

Kolesar, J.C., 1964, Geology of the southwest quarter Murphysboro Quadrangle, Illinois: Master's Thesis, Southern Illinois University Carbondale, 83 pp.

Lamar, J.E., 1925, Geology and mineral resources of the Carbondale Quadrangle: Illinois Geological Survey, Bulletin 48.

Nelson, W.J., et al., 1991, Geology of the Eddyville, Stonefront, and Creal Springs Quadrangles, Southern Illinois: Illinois State Geological Survey, Bulletin 96, 85 pp.

Newell, N.D., 1942, Late Paleozoic Pelecypods: Mytilacea: Kansas State Geological Survey Publications, v. 10, no. 2, 115 pp.

Potter, P.E., 1962, Late Mississippian Sandstones of Illinois: Illinois State Geological Survey, Circular, no. 340, 36 pp.

Potter, P.E., and Desborough, D.E., 1965, Pre-Pennsylvanian Evansville Valley and Caseyville (Pennsylvanian) sedimentation in the Illinois basin: Illinois State Geological Survey Circular 384, 15 pp.

Potter, P.E., Nosow, E., Smith, N.M., Swann, D.H., and Walker, F.H., 1958, Chester Cross-Bedding and Sandstone Trends in Illinois Basin: Bulletin of the American Association of Petroleum Geologists, v. 42, no. 5, p. 1013-1046.

Reinbold, G, 1961, Mineralogy of the Degonia, Pounds, and Boskydell Sandstones: Master's Thesis, Southern Illinois University Carbondale, 59 pp.

Roush, T.L., 1972, Depositional environments of lower Pennsylvanian and upper Mississippian detrital sediments in Makanda Quadrangle, Union County, Southern Illinois: Master's Thesis, Southern Illinois University Carbondale, 66 pp.

Seid, M.J., Devera, J.A., and Weedman, A.L., 2009, Bedrock Geology of Gorham Quadrangle, Jackson County, Illinois: Illinois State Geological Survey.

Shannon, N., 2005, Mississippian (Chesterian) Brachiopods of the Illinois Basin: A Paleoecologic and Paleoenvironmental Analysis of the Clore Formation in the Illinois Basin: Master's Thesis, Southern Illinois University Carbondale, 153 pp.

Sloss, L.L., 1963, Sequences in the cratonic interior of North America: Geological Society of America Bulletin, v. 74, p. 93-113.

Swann, D. H., 1963, Classification of Genevievian and Chesterian (Late Mississippian) rocks of Illinois: Illinois State Geological Survey Report of Investigations, no. 216, 91 pp.

Thein, M.L., and Nitecki, M.H., 1974, Chesterian (Upper Mississippian) Gastropoda of the Illinois Basin: Fieldiana, Geology, v. 34, 238 pp.

Weller, S., 1920, The Chester Series in Illinois: Journal of Geology, v. 28, no. 5, p. 395-416.

Weller, S., Butts, C., Currier, L.W., and Salisbury, R.D., 1920, The Geology of Hardin County: Division of the State Geological Survey, Bulletin 41.

Weller, J. M., and Sutton, A. H., 1940, Mississippian border of Eastern Interior Basin: American Association of Petroleum Geologists Bulletin, v. 24, p. 765-858.

Willman, H.B., Atherton, E., Baschback, T., Collinson, C., Frye, J., Hopkins, M., Lineback, J., and Simon, J. 1975, Handbook of Illinois stratigraphy: Illinois State Geological Survey Bulletin 95, Champaign-Urbana.

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Thesis Title:

EVIDENCE OF MARINE CONDITIONS IN THE UPPER PART OF THE DEGONIA SANDSTONE (ELVIRAN STAGE, CHESTERIAN SERIES) IN THE ILLINOIS BASIN

Major Professor: Scott E. Ishman