CARBONATE SEDIMENTOLOGY AND FACIES CORRELATION OF THE MASON MOUNTAIN WILDLIFE MANAGEMENT AREA

MASON, TX

An Undergraduate Research Scholars Thesis

by

JOHN CAMPBELL CRAIG

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Research Advisor: Dr. Juan Carlos Laya

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TABLE OF CONTENTS

ABSTRACT

Carbonate Sedimentology and Facies Correlation of the Mason Mountain Wildlife Management Area: Mason, TX

J. Campbell Craig
Department of Geology
Texas A&M University

Research Advisor: Dr. Juan Carlos Laya
Department of Geology

A rise in the Cretaceous sea level roughly 140 million years ago resulted in the formation of the Edwards group of carbonate rocks amongst the exposed Precambrian aged igneous rocks of the Llano uplift in Central Texas. Within this region is The Mason Mountain Wildlife Management Area which currently serves as an exotic game ranch for the Texas Parks and Wildlife Department located North of Mason, TX. The geologic setting of the area is unique in that its origin contributes to a variety of different rocks that can be observed within the surrounding location. However, our focus will be centered upon a series of lower Cretaceous carbonate rocks comprising a group of lithostratigraphic units that can be identified as parts of the Fort Terret formation.

The objective of this study is to record the sedimentology of outcrop stations to identify and correlate facies of the Fort Terret formation. Traditional field methods were used to collect and record observations which were depicted as a series of measured sections for each station. This allowed us to break the Mason succession down into five main facies: Town Mountain granite, Hensel Sandstone, mudstone, bioclastic mudstone/wackestone, and rudist floatstone. A

stratigraphic correlation of the succession was later rendered for a visual representation of the facies with respect to each station.

Ultimately, we will be able to explore the formation processes and depositional environments of the carbonate rocks in order to enhance our understanding of the succession within the management area. The facies descriptions supported by their correlations provided enough data for interpretations to be made about the succession leading up until its modern topography. The study concluded that the succession was formed under the general trend of eustatic sea level rise depositing new facies units in coastal environments with each stratigraphic system tract.

DEDICATION

I would like to dedicate this thesis to my grandmother, Donna Craig, who is consistent in urging me to never stop learning and is a constant provider of love and meaningful conversation.

ACKNOWLEDGMENTS

I would like to thank Dr. Laya for the opportunity to pursue such a unique research opportunity as well as for coaching me along the way. I am grateful for the challenges he presented me as well as his general instruction for it resulted in a much greater learning experience.

I would also like to thank Robet Widodo for the guidance and wisdom he provided for me while I was conducting the research for this project. Without Robet’s support none of this would have been possible.

Finally, I would like to thank the staff of the Mason Mountain Wildlife Management Area as well as the Texas Parks and Wildlife Department for accommodating me at such a beautiful location.

NOMENCLATURE

MMWMA	Mason Mountain Wildlife Management Area
mya	Million Years Ago
USGS	U.S. Geological Survey
HCl	Hydrochloric Acid

CHAPTER I

INTRODUCTION

Lower Cretaceous carbonate sedimentary rocks in central Texas comprise a group of lithostratigraphic units found within The Mason Mountain Wildlife Management Area located just north of Mason, TX. The MMWMA is funded through the Texas Parks and Wildlife Department primarily for studying the effects of exotic game animals on local wildlife in Texas. The area presents a unique geological setting in that there are a number of distinguishable lithologies encompassed within the borders of the property.

The objective of this research is to characterize the sedimentary facies of the carbonate succession at the location, specifically the Fort Terret formation. This succession is comprised of mudstone, wackestone, floatstone, as well as sandstone. The aim is to be able to correlate different carbonate facies from three measured sections based on their observed distinguishing sedimentary features. However, if the identified carbonate facies do not correlate because the carbonate deposits present high lateral variability, the focus of the study will be shifted to analyzing the geological processes which caused those changes in depositional dynamics. Analyzing this succession will either confirm or contest previous observations about the carbonates in the Mason area while also offering further insight into the historical development of the carbonate succession leading up to its actual lithology and topography.

In order to proceed with the objectives it is necessary to introduce the different geologic formations that will be discussed throughout the remainder of the project. By presenting contextual background of the geology of the area in part with the geological processes that produced such a unique region it will be easier to formulate explanations as to why we encounter the particular results that will be represented in our data.

Geologic setting of study

The existence of two primary structures contributed heavily to the geological environment of the MMWMA, the Llano Uplift and the formation of the Edwards plateau. The location of the MMWMA is situated where the western extension of the Llano Uplift intersects the eastern extension of the Edwards Plateau. The extent of each area, as well as their influence on the lithologies present within the area of study will be discussed in the following paragraphs.

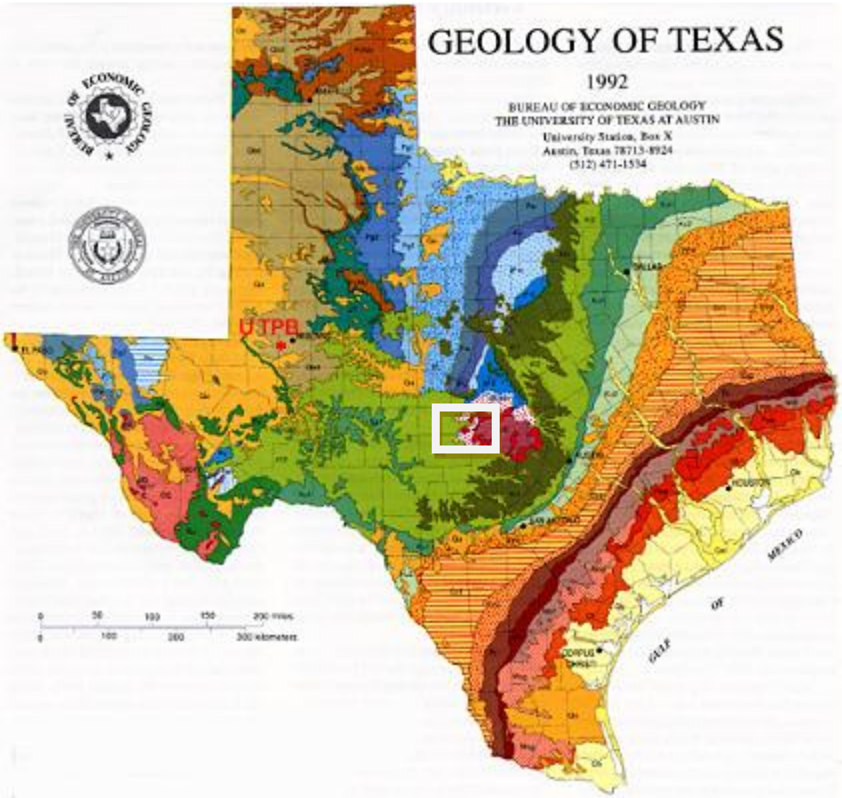


Figure 1.1 Geologic setting of study area in white. (Bureau of Economic Geology, 1992)

Llano Uplift

The Llano Uplift is an igneous craton that formed during the Precambrian era of geologic history. The MMWMA is located near the westernmost extension of the Llano Uplift, which will be the focal point of this study, but also down-dropped Paleozoic sediments, particularly the Hickory sandstone member of the Riley formation, that were exposed due to faults within the Llano Uplift as a result of the Ouachita Orogeny occurring roughly around 270 mya (Morelock, 2005).

The Llano Uplift is characterized primarily by a coarse grained granite that is dominated by quartz, plagioclase feldspars, and orthoclase feldspars. Because it is potassium rich it is naturally pink in color and it can be found in large plutons exposed throughout the area. The igneous component that is prominent in the Mason area is the Town Mountain Granite unit of the Llano Uplift (USGS, 2002). The Town Mountain Granite is the basement rock for the area and is considered to be a part of the provenance for the Cretaceous aged sandstone (Barker, Bush & Baker Jr., 1994), a unit of the Hensel formation, which is found located between the carbonate and igneous units and will be discussed later in further detail. Lastly, there are areas of extensive metamorphism throughout the area that can be categorized as a portion of the Llano Uplift as Pre Cambrian Packsaddle Schist (USGS, 2002). This Schist unit is not a primary influence of the overlaying carbonates, but when weathered it can make up a significant portion of the modern soil, also leaving quartz clasts in the area that were formerly igneous intrusions to the schist prior to weathering and erosion.

Edwards Plateau

The Edwards Plateau is composed primarily of early Cretaceous carbonate limestone spanning over west-central Texas. The Edwards Plateau extends into the Mason area but its modern topography is a result of erosion since its original deposition around 140 mya. The Edwards limestone group was deposited during transgressive cycles as an extensive ocean encroached further into the continent during the cretaceous period. (Barker, Bush & Baker Jr., 1994) The plateau is relatively flat lying and composed of resistant limestones and dolomite rocks of the Edwards Group. A majority of these Edwards Group sediments rest upon the Glen Rose Formation.

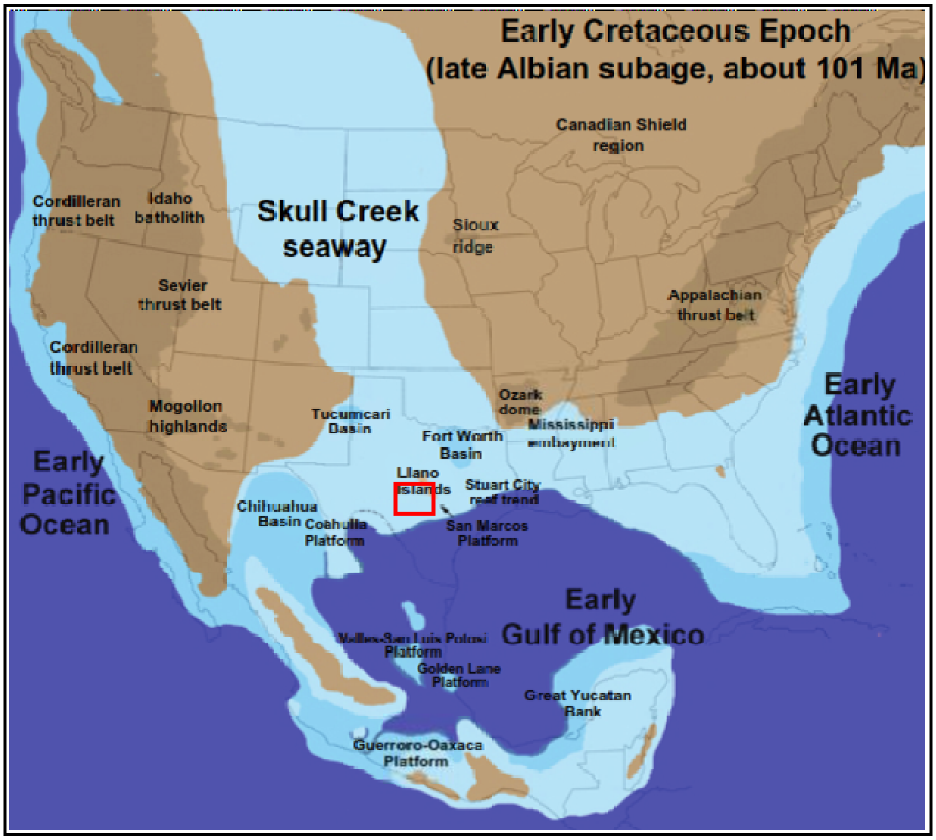


Figure 1.1 Map showing the interpreted full extent of the inland sea transgression during the Cretaceous period. Study area highlighted in red. (Moore, 2010)

At the base of the carbonates of MMWMA is the Hensel sand, a part of the Hensel Formation of the Comanchean series, a direct result of the advancement of the Cretaceous sea (Barker, Bush & Baker Jr., 1994)

As mentioned, the Hensel sand is composed primarily of Precambrian and even Paleozoic provenance fragments. These Hensel sediments are typically tan, brown, maroon, or even grey in color and can range between siltstone to coarse sandstones. Overlaying the Hensel sand in this region is the Fort Terret Formation, a lower stratigraphic unit at the base of the Edward's carbonate shelf (Rose, 1972). Some references include this portion of the Edwards as part of the Comanche Peak Formation (Kilventon, 2006), but our results should provide enough information to reveal that this is not the case. The Fort Terret Formation is composed of both limestone and dolomite facies that contain a variety of bioclasts, chert nodules, and other sedimentary structures. The main focus of this study will be to utilize some of these lithological features specifically within the Fort Terret Formation, to properly characterize the sedimentology and correlate stratigraphically different outcrops on the MMWMA.

Carbonate formation

Carbonates are a type of sediment that is chemically derived from a reaction of calcium and carbonic acid to produce carbon dioxide, water, and calcium carbonate. Calcium is naturally rich in oceans therefore carbonate formation is nearly always in a marine environment. It is valuable to know that the $CaCO_3$ component of the chemical formula can either be a calcium or aragonite component of the reaction (Boggs, Jr., 2012). Carbonates that are compositionally dominated by calcite are considered to be limestone. Although, as present in the Fort Terret formation dolomite may be formed (USGS, 2002).

Oceans cycle through periods of being calcite or magnesium dominated, and the chemical status of the ocean heavily effects the diagenetic production of the carbonates themselves.
Carbonate formation is favored heavily under conditions of high temperature, low pressure, high pH levels, lots of light, and low siliciclastic input (Boggs, Jr., 2012). It is noteworthy that carbonate formation is heavily dependent on the presence of organic materials as it is typically marine organisms that provide the source of this calcite. In order to meet these criteria, carbonate formation occurs in specific depositional environments. In a broad sense, it is likely that the carbonates of this study developed on a carbonate ramp as the interface between terrestrial and marine environments.

Within this specific area of study, a majority of the carbonate rock will be comprised of either lime mud or bioclasts. Lime mud is produced in different ways but is primarily formed by disaggregation of calcareous green algae, fecal secretions by marine organisms, and the mechanical disaggregation of skeletal grains. Bioclasts are formed by the accumulation of skeletal fragments of the previously mentioned calcite providing marine organisms.

Carbonate classification

Crucial to this study is the ability to properly classify carbonate rocks based on their lithological features. Mentioned in the description of the Edwards carbonate group are traits specific to the

Fort Terret Formation that can be indicative of specific facies and will ultimately result in the distinctions needed to correlate the outrcrops.

Preliminary analysis of the Fort Terret Formation revealed that a majority of the facies are mudstone and wackestone that were classified based on the Dunham classification system for carbonate rocks. The Dunham model is used to classify carbonate sedimentary rocks based on overall composition percentages of its constituents. Classification varies depending on the size and abundance of framework grains compared to the type of the cement or matrix and the degree of which is present.

Table 1.1 Dunham classification of carbonate rocks (Dunham, 1962)

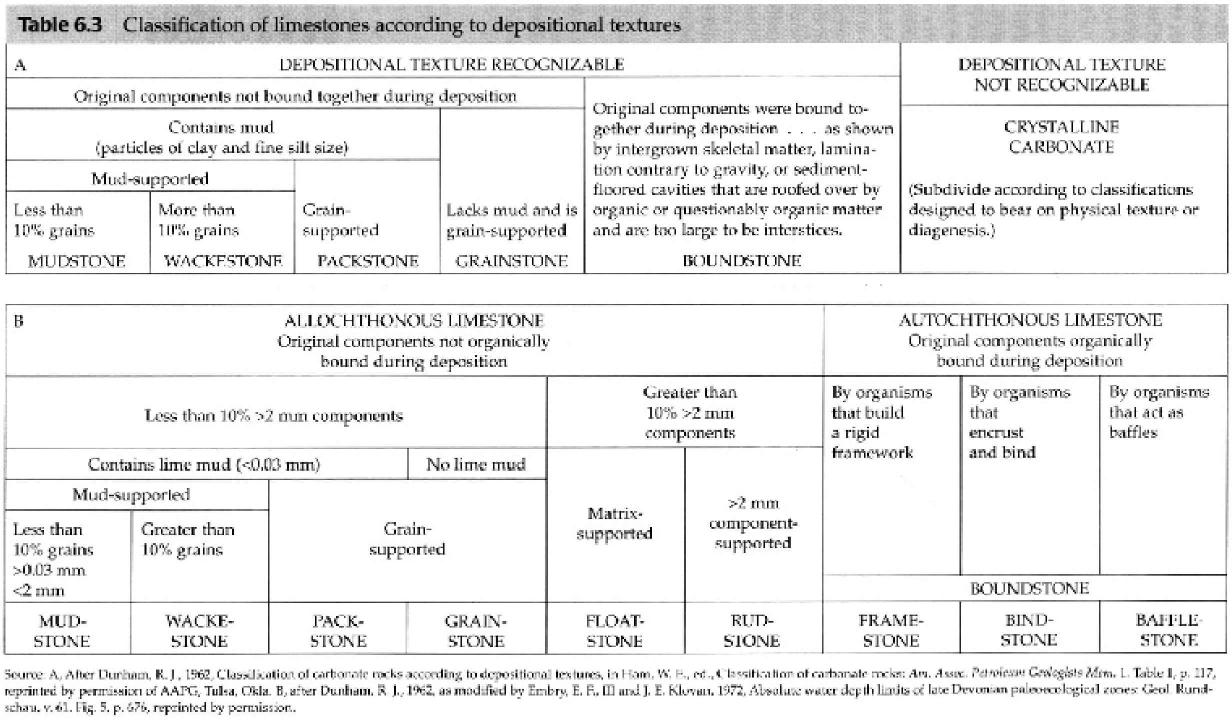


Table 6.3 Classification of limestones according to depositional textures

A					
DEPOSITIONAL TEXTURE RECOGNIZABLE					DEPOSITIONAL TEXTURE NOT RECOGNIZABLE
Original components not bound together during deposition				Original components were bound together during deposition . . . as shown by intergrown skeletal matter, lamination contrary to gravity, or sediment-floored cavities that are roofed over by organic or questionably organic matter and are too large to be interstices.	CRYSTALLINE CARBONATE (Subdivide according to classifications designed to bear on physical texture or diagenesis.)
Contains mud (particles of clay and fine silt size)			Lacks mud and is grain-supported		
Mud-supported		Grain-supported			
Less than 10% grains	More than 10% grains				
MUDSTONE	WACKESTONE	PACKSTONE	GRAINSTONE	BOUNDSTONE	

B								
ALLOCHTHONOUS LIMESTONE Original components not organically bound during deposition						AUTOCHTHONOUS LIMESTONE Original components organically bound during deposition		
Less than 10% >2 mm components				Greater than 10% >2 mm components		By organisms that build a rigid framework	By organisms that encrust and bind	By organisms that act as baffles
Contains lime mud (<0.03 mm)			No lime mud	Matrix-supported	>2 mm component-supported			
Mud-supported		Grain-supported						
Less than 10% grains >0.03 mm <2 mm	Greater than 10% grains					BOUNDSTONE		
MUD-STONE	WACKE-STONE	PACK-STONE	GRAIN-STONE	FLOAT-STONE	RUD-STONE	FRAME-STONE	BIND-STONE	BAFFLE-STONE

Source: A, After Dunham, R. J., 1962, Classification of carbonate rocks according to depositional textures, in Ham, W. E., ed., Classification of carbonate rocks: *Am. Assoc. Petroleum Geologists Mem.* 1, Table I, p. 117, reprinted by permission of AAPG, Tulsa, Okla. B, after Dunham, R. J., 1962, as modified by Embry, E. F., III and J. E. Klovan, 1972, Absolute water depth limits of late Devonian paleoecological zones: Geol. Rundschau, v. 61, Fig. 5, p. 676, reprinted by permission.

Carbonates can further be divided into facies centered on characteristics such inclusions, fossil content, and any other sedimentary structures that can be observed in hand sample or outcrop scale. Examples of some of these lithologic qualifiers will be discussed in further detail throughout the study as examples that are relevant to the study are encountered.

CHAPTER II

METHODS

Data acquisition

All of the samples obtained for the contribution of this project were acquired by hand using standards field methods techniques on site in Mason, TX.

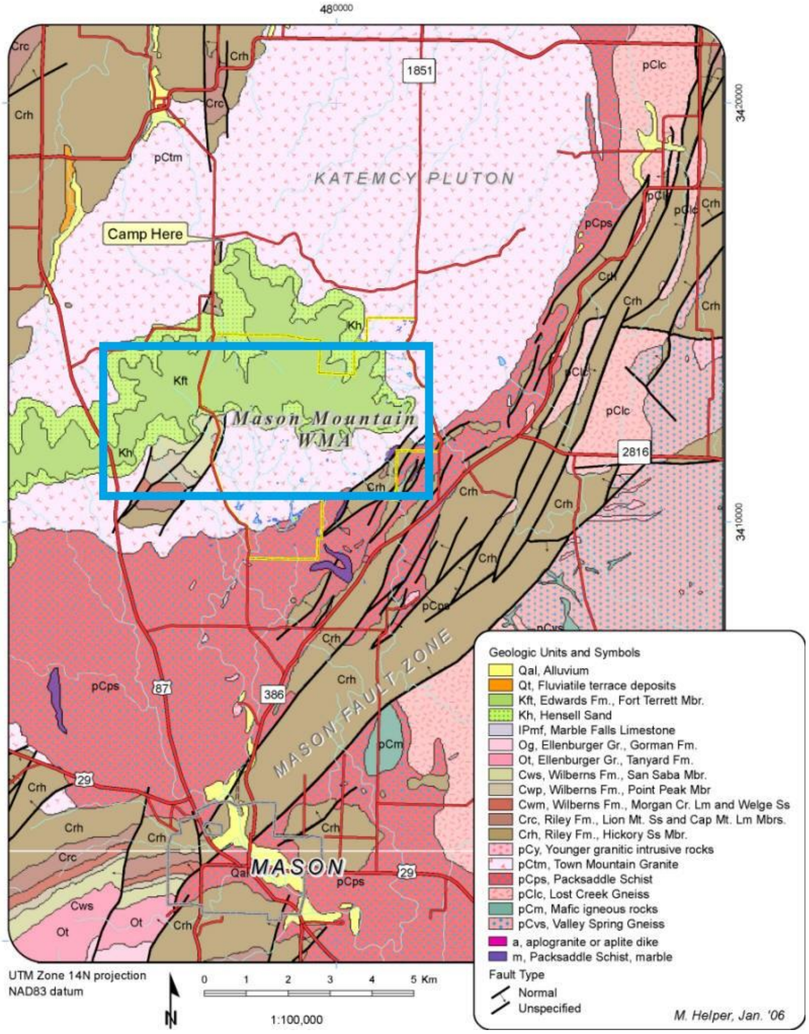


Figure 2.1 Map of study area encompassed in blue (Helper, M. 2006)

Each measured section was recorded using a Jacobs staff to record the heights of each carbonate unit. It is pertinent to acknowledge that complete outcrops found in the area are rare due to extensive soil coverage. This accounted for the absent units within the completed measured sections. Unit height was recorded on the metric scale for consistency with the metric system used in both the siliciclastic grain size and the Dunham classification for the lithologic contents of the units themselves. The strike and dips of key units were taken using a standard Brunton compass in order to record any unusual bedding configurations each station. In order to digitally record images in the field a Canon Rebel XT camera was used to document parts of the study area that could not be removed from the site.

At each unit, a hand sample was taken using a 20oz rock hammer. Approximately 45 hand samples were brought back for further analysis. A 20X21mm hand lens was used to examine the hand samples for any discernible characteristics. A major component for identifying carbonates through hand sample is with Hydrochloric acid (HCl). When HCl comes into contact with carbonate rocks a clear chemical reaction occurs which can be recognized by fizzing around the applied area. If a siliciclastic rock is exposed to HCl no reaction will occur.

GPS

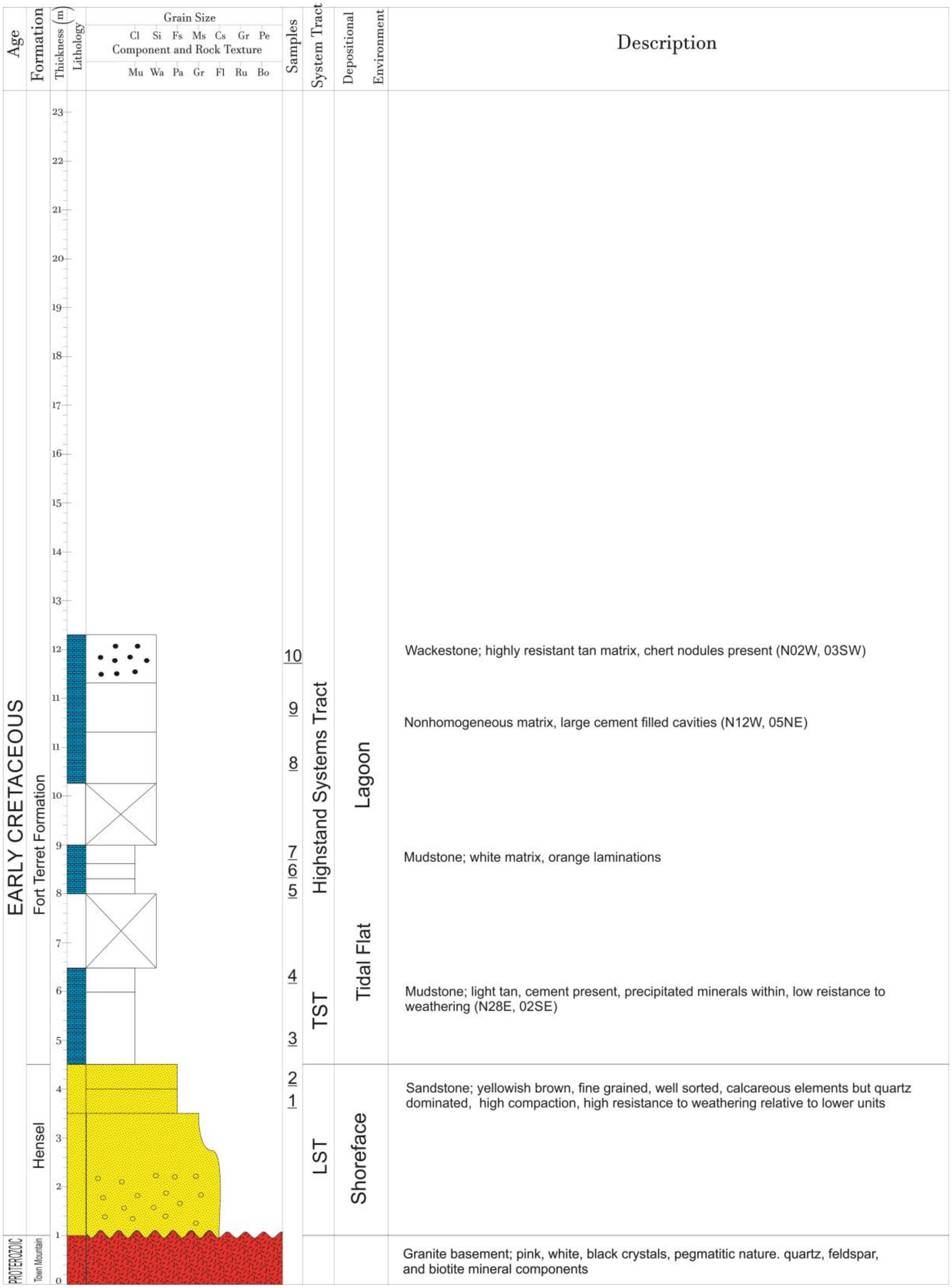
A Garmin 78 handheld GPS unit was utilized to record waypoints for the locations of the outcrops that were used to construct measured sections of the area. This allowed us to view the outcrops as reference points in relationship to one another as well as the rest of the study area. It was necessary to know the orientation of the stations to be able to properly correlate the stratigraphic columns.

The DNRGPS software provided by the Minnesota Department of Natural Resources was used to upload the GPS waypoints onto a computer for expanded purposes. Initially, the waypoints were saved as a .kmz file to be viewed in Google Earth as a satellite images. The images serve as a visual for the layout of the different stations within the MMWMA. The green indicators represent the base of each outcrop and the beginning of the measured station for each station. The red indicator denotes the peak of the outcrop and the coordinates for the final unit in each measured section.

Figure 2.2 Satellite image of study area

Measure section drawing

The measured sections that were observed and recorded in the field needed to be digitized so that they could be properly correlated. For this project Corel DRAW X6 and X8 software was used to illustrate the exact stratigraphic columns for the outcrop of each station. In addition, all figures representing the facies found within the succession were created using the Corel software. Corel allows the user to create columns that display the units of the outcrop to scale in a vertical succession. The width of each unit can signify the classification of both carbonate and siliciclastic constituents. Lithological traits are noted by symbols in each unit and a brief description of significant strata are included on the right portion of the column. There are also elements within the column designated for indicating the depositional environment, system tract, sample number, lithology, formation and age of each individual unit in correlation with the unit's position along the vertical succession. It is crucial to construct these columns so that an in depth interpretation of the facies distribution, both horizontally and vertically, could be conducted. The stratigraphic columns rendered for this project are arguably the most fundamental component of this area of research, primarily in dealing with correlating outcrops present in the study area. Measured sections representing each measured section are included in the figures below.



Wackestone; highly resistant tan matrix, chert nodules present (N02W, 03SW)

Nonhomogeneous matrix, large cement filled cavities (N12W, 05NE)

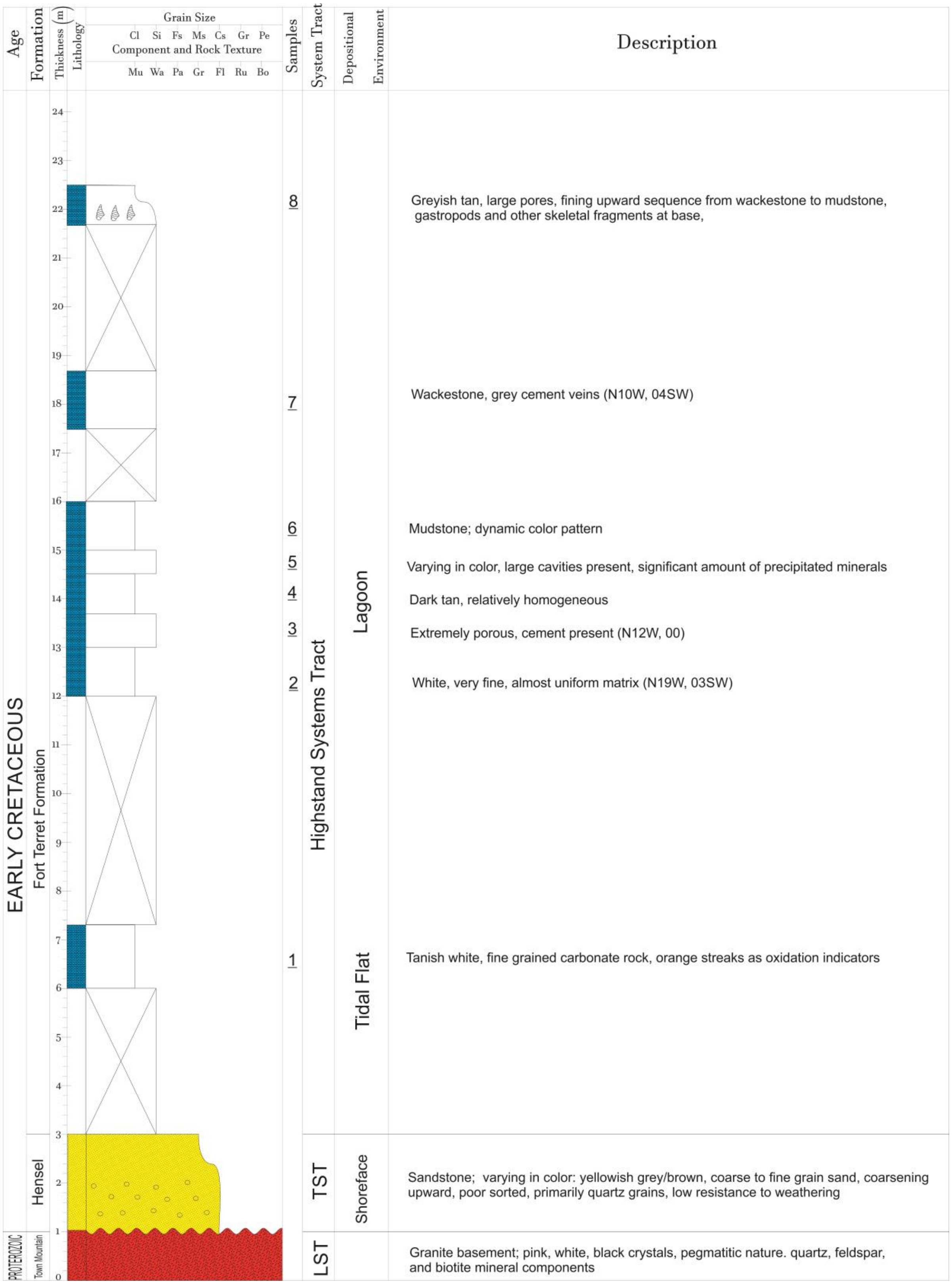
Mudstone; white matrix, orange laminations

Mudstone; light tan, cement present, precipitated minerals within, low reistance to weathering (N28E, 02SE)

Sandstone; yellowish brown, fine grained, well sorted, calcareous elements but quartz dominated, high compaction, high resistance to weathering relative to lower units

Granite basement; pink, white, black crystals, pegmatitic nature. quartz, feldspar, and biotite mineral components

Figure 2.3 Measured section highlighting lithology of station 1.



Greyish tan, large pores, fining upward sequence from wackestone to mudstone, gastropods and other skeletal fragments at base,

Wackestone, grey cement veins (N10W, 04SW)

Mudstone; dynamic color pattern

Varying in color, large cavities present, significant amount of precipitated minerals

Dark tan, relatively homogeneous

Extremely porous, cement present (N12W, 00)

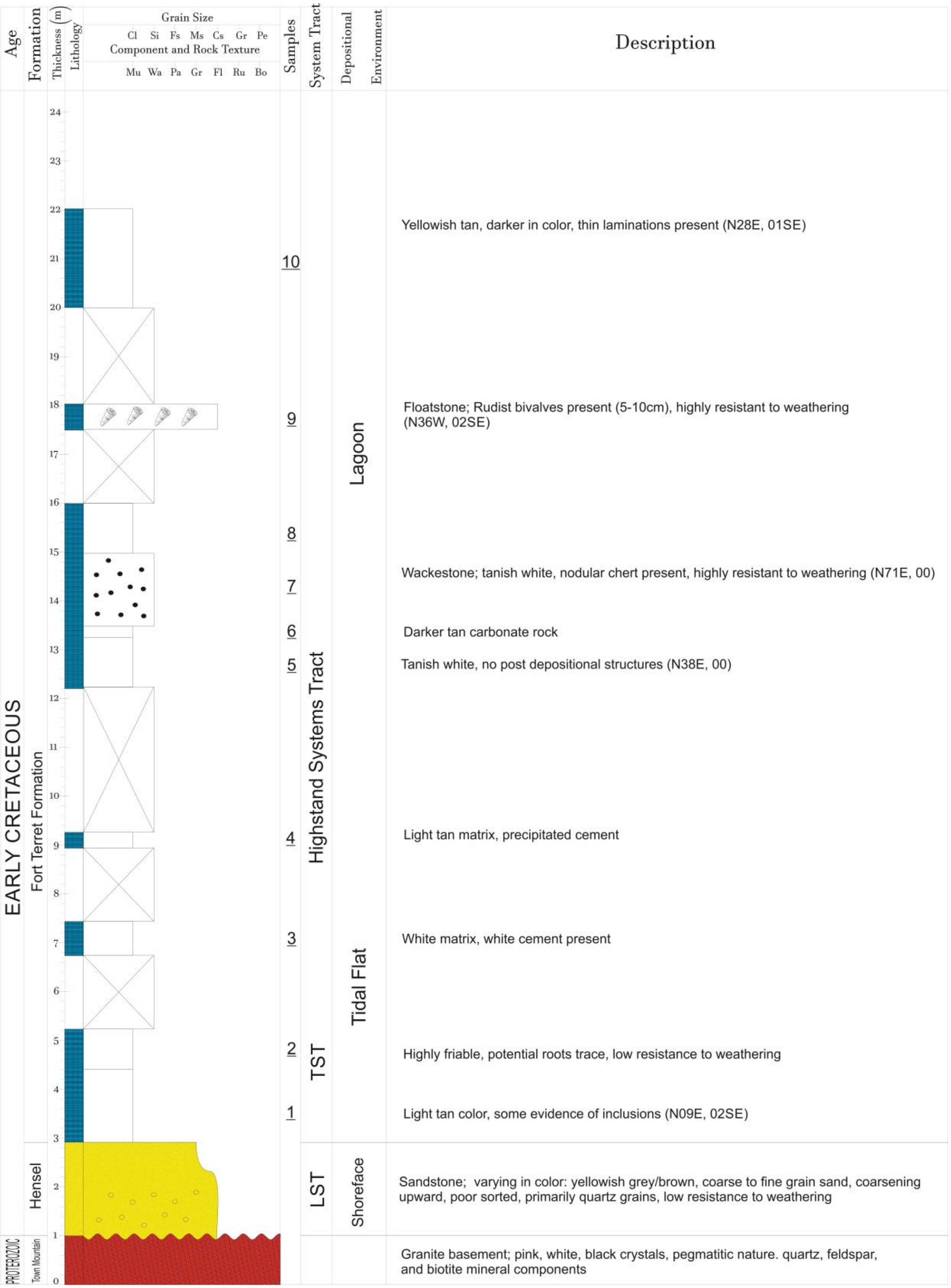
White, very fine, almost uniform matrix (N19W, 03SW)

Tanish white, fine grained carbonate rock, orange streaks as oxidation indicators

Sandstone; varying in color: yellowish grey/brown, coarse to fine grain sand, coarsening upward, poor sorted, primarily quartz grains, low resistance to weathering

Granite basement; pink, white, black crystals, pegmatitic nature. quartz, feldspar, and biotite mineral components

Figure 2.4 Measured section of station 2.



Yellowish tan, darker in color, thin laminations present (N28E, 01SE)

Floatstone; Rudist bivalves present (5-10cm), highly resistant to weathering (N36W, 02SE)

Wackestone; tanish white, nodular chert present, highly resistant to weathering (N71E, 00)

Darker tan carbonate rock

Tanish white, no post depositional structures (N38E, 00)

Light tan matrix, precipitated cement

White matrix, white cement present

Highly friable, potential roots trace, low resistance to weathering

Light tan color, some evidence of inclusions (N09E, 02SE)

Sandstone; varying in color: yellowish grey/brown, coarse to fine grain sand, coarsening upward, poor sorted, primarily quartz grains, low resistance to weathering

Granite basement; pink, white, black crystals, pegmatitic nature. quartz, feldspar, and biotite mineral components

Figure 2.5 Measured section of station 3.

CHAPTER III

RESULTS

Facies classification

This section of the project will be used to distinguish the different facies found within the study area. It is necessary to segregate the units into more general facies so they can be correlated on a larger, schematic scale. Classifying individual facies also allows for a way to further interpret units that are missing in measured section due to soil coverage. The vertical and lateral extent of each unit can be explained with relative precision when they are categorized as part of a larger group.

The units of this study area can be arranged into five different facies: basement Town Mountain granite, Hensel sandstone, mudstone, bioclastic mudstone/wackestone with chert nodules, and Rudist floatstone. It is to be noted that the Town Mountain Granite is not a Cretaceous facies but is described in the facies description as such in order to classify the unit. Throughout the results section certain units will be highlighted within each facies for the purpose of a more in depth analysis. Breaking down the facies more specifically throughout the results section will aid in the formation of a more complete interpretation of the depositional environment and overall sedimentology. A table providing a brief introduction is included below that will be subsequently followed by a more in depth description of each facies.

Table 3.1 Facies classification

Facies	Brief Description
Basement Town Mountain Granite	Pinkinsh red color with black grains, pegmatitic nature with varying crystal size, massive, primarily potassium feldspar, quartz, and biotite mica. Only igneous component in the succession
Hensel sandstone	Lower units are maroon, grey, or brown in color, upper units are typically a yellowish brown. Coarse grained basal units fining upward to very find sand upper units. Dominated by quartz grains, cementation and resistance to weathering varies.
Mudstone	Dullish brown in color, relatively homogeneous throughout, fine grained carbonate rock, lacking in sedimentary structures, fossil content, or variation within units at outcrop scale
Bioclastic mudstone/wackestone	Typically tanish brown in color, most units classified as wackestone on the Dunham scale, precipitated minerals common, nodular chert unit present, Instances of gastropod and bivalve fossils
Rudist floatstone	Darker cream color, highly resistant floatstone. Contains rudist bivalve fossils typically 5 to 10 cm in length. Does not correlate laterally, but previous studies have found this facies at other locations

Basement Town Mountain granite

The Town Mountain granite is the basement constituent that is present at each station. This facies is the only igneous component of the succession. The Town Mountain granite has already been briefly described and as mentioned previously it can be found throughout the study area as exposed cratons of the Llano Uplift. The granite facies is massive throughout all stations and its physical properties vary primarily in the pegmatitic nature of its crystal size as a result of varying cooling rates at each station. The granite is primarily made of potassium feldspar, quartz, and biotite mica. Consequently, the granite is a pinkish red color with black crystals throughout. The vertical extent of the basement at each station is not represented within the illustrated measured sections. It is assumed that the basement extends indefinitely in the downward direction.

Hensel sandstone

The Hensel Sandstone is the first appearance of Cretaceous aged rock units in each station. A noncomformity exists as the boundary between the Paleozoic aged granite and the Cretaceous sandstone. The sandstone has variations in color within each station. The lower portions of the sandstone are multicolored and present shades of maroon, grey, and brown but the upper the upper units of the sandstone are typically a yellowish brown.

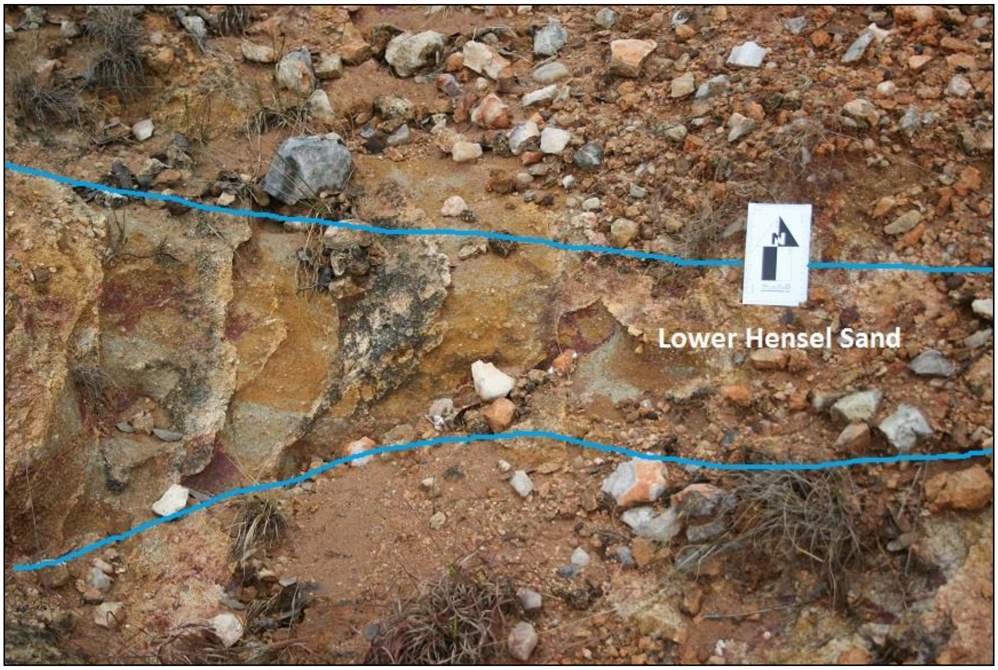


Figure 3.1 Color variations of lower Hensel sand, orientation card for scale.

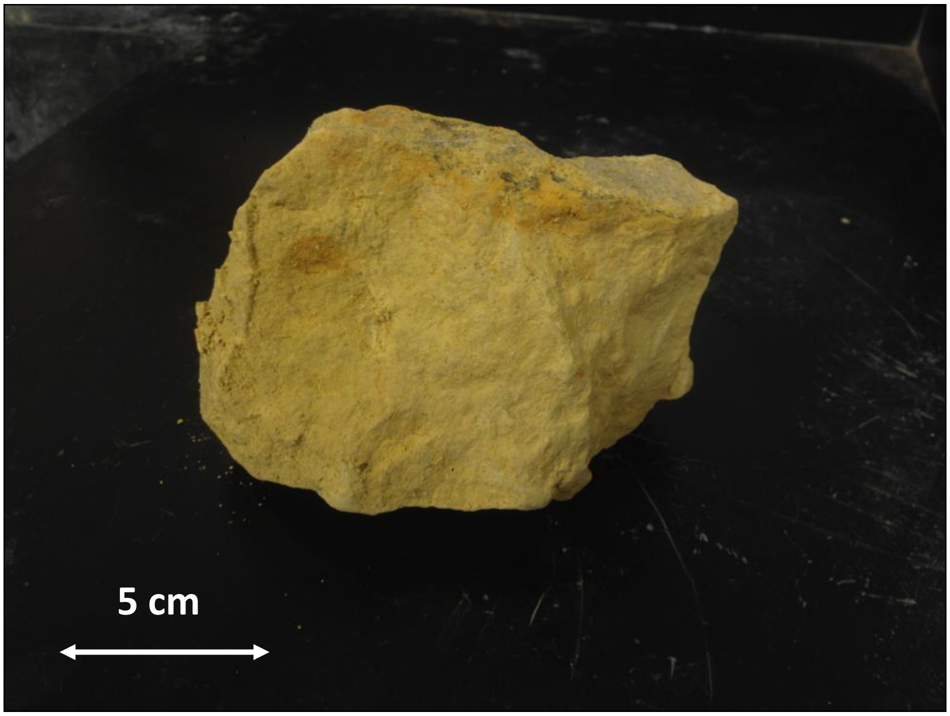


Figure 3.4 Hand sample of upper Hensel sand

The Hensel facies displays a fining upward grain size ranging from moderately sorted coarse grained sand within the basal units to well sorted, very fine sand upper units. These units are dominated by quartz grains but reflect different degrees of cementation and resistance to weathering. Loose packing and low resistance to weathering are present in the basal units while high cementation and a higher level of weathering resistance is present within the upper portions of the sandstone facies. While the Hensel sand is silica rich in nature there are calcareous elements within the sandstone that are deposited adjacent to the first limestone units.

Mudstone

The lower mudstone facies is the first example of carbonate in the Mason successions. This facies is a fine grained carbonate rock that can be generally classified as a mudstone at each station. There is an absence of sedimentary structures, fossil content, or even significant variation between units in the hand sample and outcrop scale. This facies can be described as a dull brownish yellow color that is relatively homogeneous throughout. Some beds within this facies provide the only variations in color from white to orange.

Bioclastic mudstone/wackestone

Distinguishing features for this facies group are much more prevalent in comparsion to its lower facies counterpart. The upper mudstone/wackestone is similar in that it is also a carbonate rock but as a whole it would classify more as a wackestone facies than a mudstone. This is a result of the different grain types that can be found within this facies unit. Carbonate rocks classify as wackestones if they are mud dominated but grains make up more than ten percent of the rock. The Upper mudstone/wackestone facies has higher concentrations of precipitated minerals, increased instances of fossil content, and typically demonstrates higher porosity than the lower carbonate facies.

The bioclastic mudstone/wackestone facies contains nodulated chert intervals. Examples of this chert bedding can be found explicitly in station one and station three, although chert nodule samples were taken from the soil of a missing unit within the station two succession.

Figure 3.5 Chert nodule imbedded within wackestone of station #3. Arrow indicates chert nodule. Marker for scale.

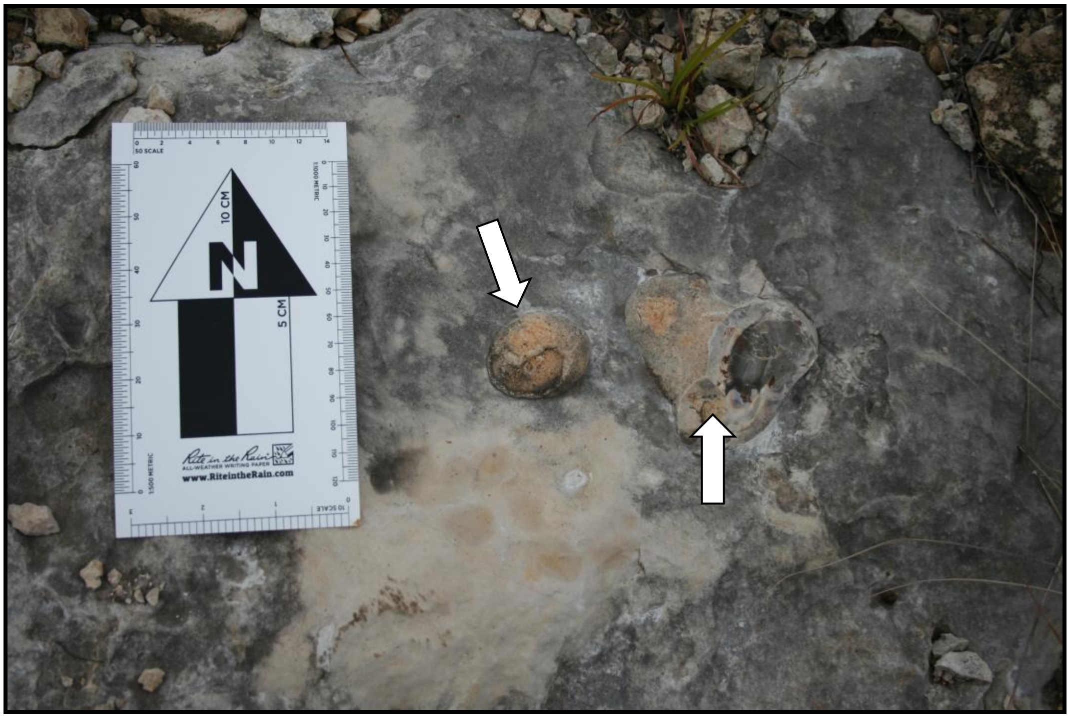


Figure 3.6 Chert nodules exposed at the top of station 3. Arrows indicate chert nodules. Orientation card for scale.

Rudist floatstone

The most unique facies encountered within the succession is the presence of a rudist floatstone unit. The floatstone is a highly resistant limestone that hosts the presence of a large number of Rudist fossils. Rudist bivalves were major reef formers of the cretaceous period (Coogan, 1977) and their presence within the succession provides serious insight to the depositional environment for the carbonates within the Mason area.

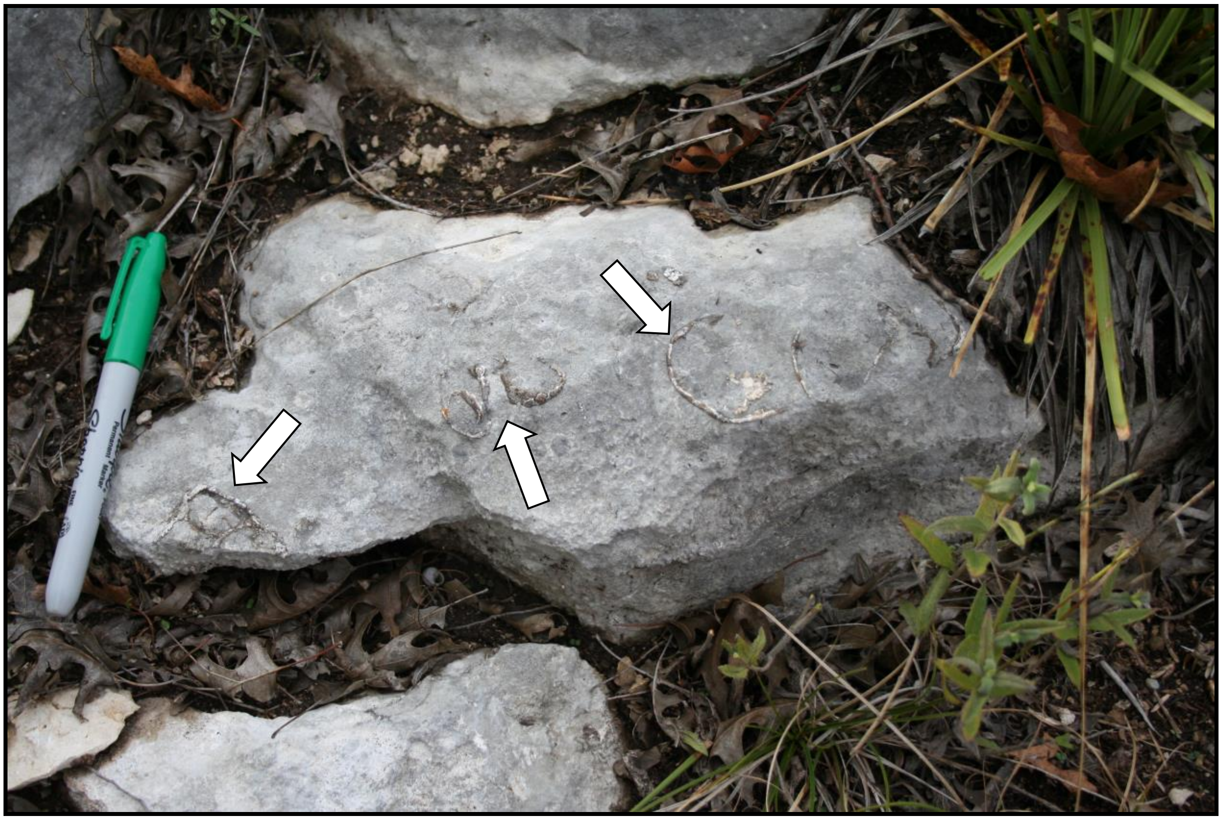


Figure 3.7 Rudist floatstone from station 3. Arrows indicate Rudist fossils. Marker for scale.

The rudists themselves are typically 5 to 10 centimeters in length. The floatstone is an isolated unit within station three encompassed by the upper mudstone/wackestone unit. It does not correlate laterally with the other stations in this study but previous investigations of the study area have yielded findings of this facies at other locations within the MMWMA.

Correlation

The facies within this study are correlated laterally from West to East, from station three to station one. The distance between stations three and two is 1877 meters while the distance between stations two and one is 1217 meters. A schematic correlation was rendered using the uppermost portion of Hensel sandstone facies as the datum. Carbonate rock units are indicated using a blue brick pattern. Missing sections as a result of soil coverage are represented with an X through the column. It is assumed that the granite extends indefinitely in the downward vertical direction. Figure 3.8 below represents the final correlation.

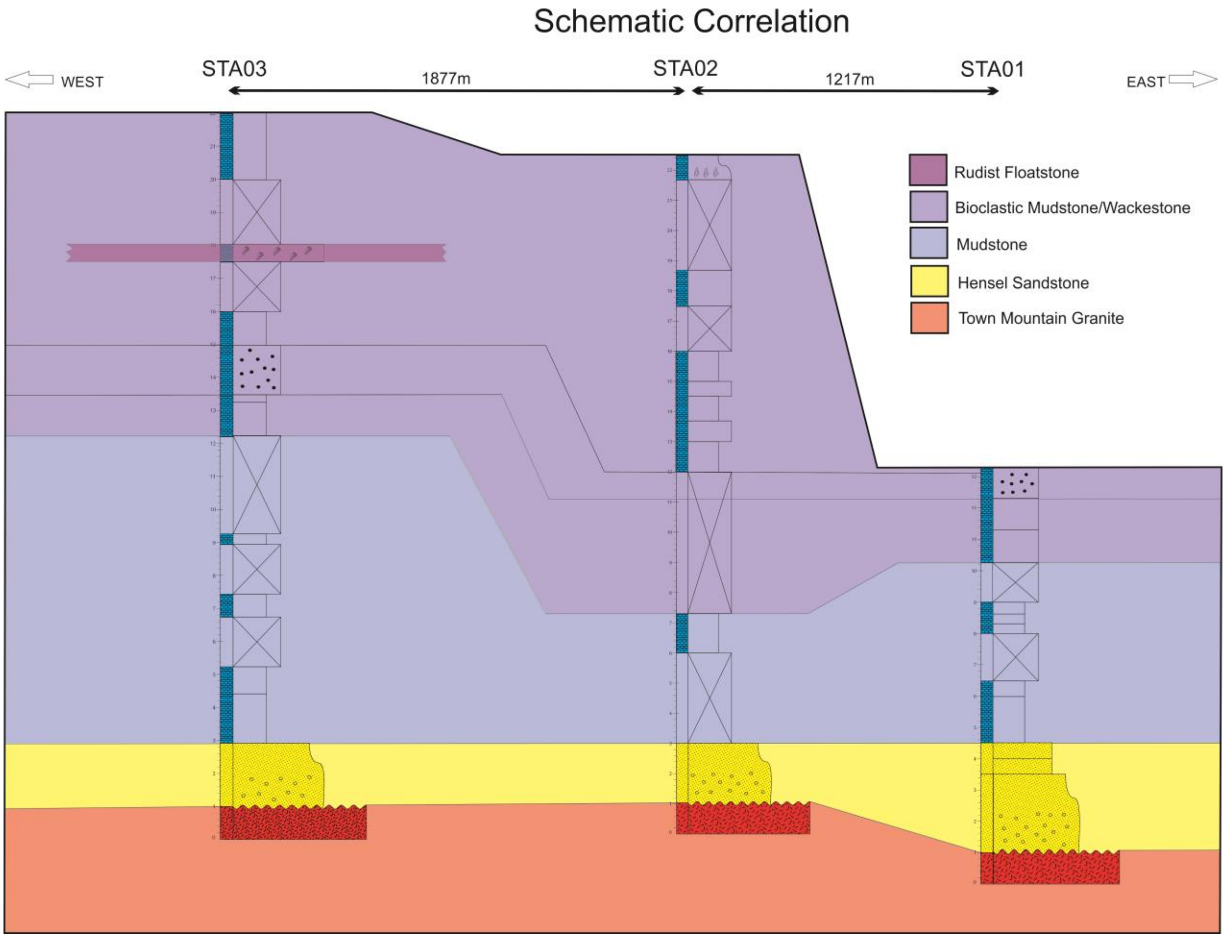


Figure 3.8 Correlation of the carbonate succession

The inferred lateral extent of the aforementioned nodulated chert bed can be seen in the correlation above and is symbolized by black points within the visual representation of the bed. The nonconformity between the Hensel sandstone and the Town Mountain granite is represented by a distorted curved line and the fining upward tendency of the Hensel is shown by having coarse grain illustrations at the base of the lower facies units. There is also a clear representation of the isolated floatstone bed within station three. The general trend of the correlation is that we see an increase in aggregate vertical extension of each facies towards the west.

Discussion

Based on the sedimentology of each facies unit we can interpret certain attributes regarding the formation and environment of individual units within the succession, facies as a whole, and the overall development of the Mason location. For this portion of the study we will only be concerned with the Cretaceous aged facies and therefore any igneous components of the Town Mountain granite will be ignored. In order to address the nature of the succession each facies will be broken down with respect to the order in which they were introduced. Elements of sequence stratigraphy will be utilized to log the progression of the Cretaceous sea in order to evaluate its influence on each facies. In this particular study, we see instances of the lowstand, transgressive, and highstand systems tracts.

In relation to sequence stratigraphy the Hensel sandstone facies was formed as a result of a lowstand system tract as the Cretaceous sea encroached further inland. Prior to inland transgression of sea level the basement igneous rock was exposed. During this time period the exposed portions of the Town Mountain granite were weathered and eroded at the sight of the study area.

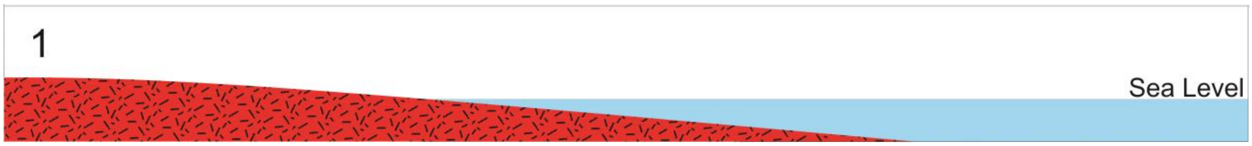


Figure 3.9 Exposed basement granite prior to sea level encroachment.

As the sealevel rose eroded source material which was primarily made up of quartz grains was picked up by the sea and then later deposited. This series of events provides an explanation for the fining upward grain sequence we see within the Hensel sand units. When the sea lifted the source grains from the basement rock into suspension the coarser, heavier grains first settled at the base while the finer, lighter grains that were left in suspension were subsequently deposited once the sea level had risen enough to transition into a lower energy environment. Ultimately, the silica rich nature of the Hensel sand is the primary reason for concluding that the origin of the grains that comprise the sandstone can be traced to the Town Mountain granite.

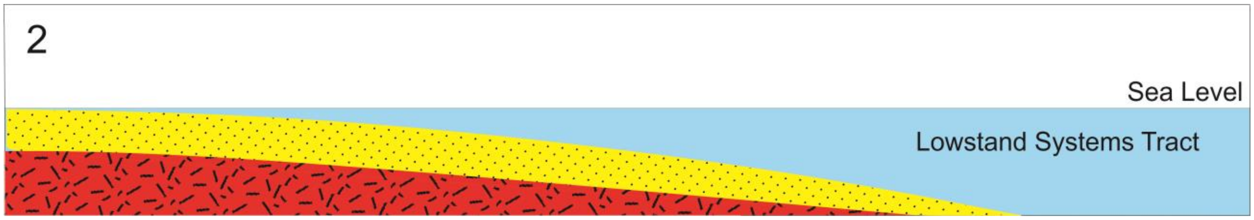


Figure 3.10 Figure depicting deposition of source material during lowstand systems tract.

The appearance of the carbonate mudstone facies marks the first indicator of the transgressive systems tract of sequence stratigraphy in which the Cretaceous sea is close to completing its full advancement within this area of Texas. The uniform nature of the mudstones in this facies are indicators that this environment is consistent with an upper shoreface depositional environment. With each rise in sea level we see a new layer of mudstone deposited above the last while maintaining relative homogeneous composition.

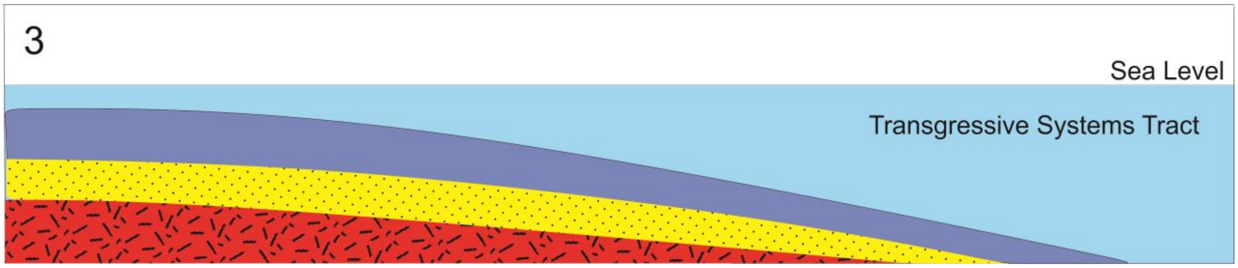


Figure 3.11 Carbonate mudstone formation begins above Hensel sand during transgressive tract.

It can be inferred that these mudstone layers amassed a series of tidal flats in which the advancing sea deposited organic material in low energy environments at the shoreface of the Cretaceous sea. The orange blemishes noted within the mudstone are likely a result of post depositional oxidation events signifying the presence of either iron or magnesium rich elements within the carbonate rock.

The bioclastic mudstone/wackestone facies formed as a result of the highstand systems tract, and it differs from the mudstone in terms of formation and depositional setting. Increased occurrences of beds containing skeletal grains leading to the formation of bioclasts are a result of a low energy carbonate setting in which calcareous organisms could thrive. From this we can predict the paleoclimate conditions that would support the habitat of calcareous organisms as well as carbonate formation. Given what we know about this facies it is reasonable to conclude that this facies developed in a tropical, warm water environment. This leads us to believe that the probable setting for the formation of the bioclastic mudstone/wackestone facies was within a lagoonal depositional environment. This would also support the idea that the mudstone facies developed further inshore. As the sealevel continued to advance a lagoonal environment formed in place of the shoreface boundary, therefore depositing the wackestone facies above the mudstone.

An absence in skeletal fragments within certain beds of the bioclastic mudstone/wackestone facies tends to display increased levels of porosity. The higher porosity is a result of the dissolution of skeletal fragments of marine organisms that are components of the carbonate rock. These pores are regular locations for the mineral precipitation of calcite from the calcite rich pore fluid saturated following the dissolution process.

The formation of the nodular chert unit within this facies can be interpreted as the result of a silica rich solution replacing pore space within the limestone (Siever & Maliva, 1989). It is unclear as to whether the pores originated from the dissolution of bioclasts or a silica rich, non-carbonate mineral such as gypsum or anhydrite.

At the peak of station two we see a fining upward sequence from wackestone to mudstone within one unit. The base of the unit contains a high density of skeletal fragments, mainly gastropods, while the upper portions of the unit is a homogenous, fine grained mudstone. From this we can infer that there could have potentially been a series of flooding events within the bioclastic mudstone/wackestone facies as well as throughout the highstand tract. In this instance, a rapid increase in sea level deposited a layer of fine grained material above the skeletal fragments within the same unit. Events similar to this one provide an explanation for the interbedded mudstone facies that are similar in nature to the mudstone facies within the bioclastic mudstone/wackestone facies.

The Rudist floatstone facies is unique in that it does not possess an extensive lateral correlation as do the other facies. Because we know rudists were major reef formers during the cretaceous period, this lateral discontinuity suggests that this facies developed as a patch reef within a lagoonal depositional environment. At this series of sequence stratigraphy the study area was still undergoing a highstand systems tract.

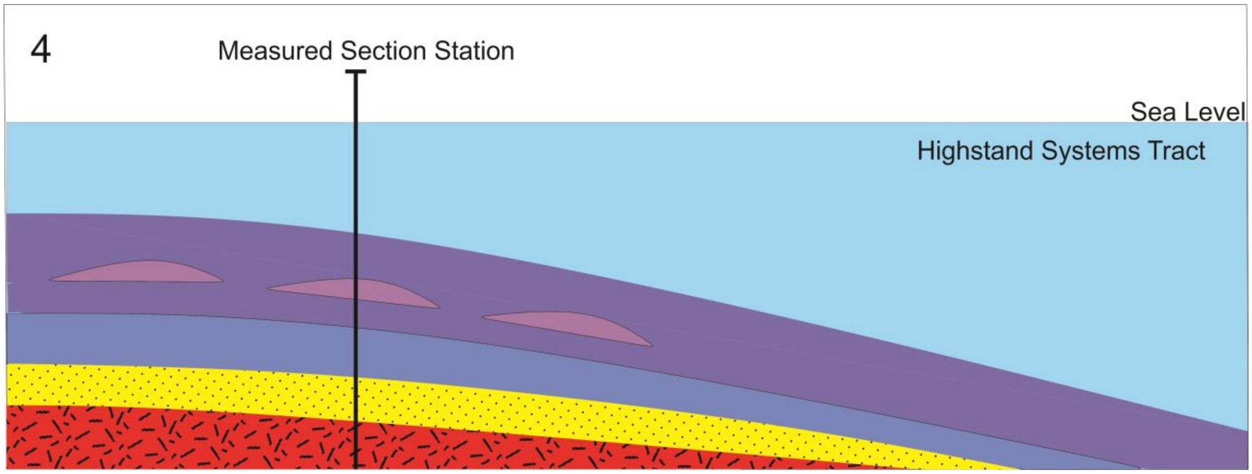


Figure 3.12 Depiction of highstand systems tract and the formation of both the bioclastic mudstone/wackestone and rudist floatstone facies.

Patch reefs are isolated platforms that typically develop in lagoonal settings. The presence of a patch reef also supports previously made claims regarding paleoclimate in that a tropical, warm water environment would be necessary for the formation of patch reefs to occur.

The study area remained in a highstand systems tract, allowing for the continuation of a lagoonal depositional environment for some time. As the sea level rose to its peak, we see that the transitioning in depositional environment became stagnant, allowing for this lagoonal setting to continue to produce members of the bioclastic mudstone/wackestone facies which were subsequently deposited above the patch reefs.

At this point we can see the full vertical relationship between facies based on their depositional progression. This progression can be illustrated on the macro scale as a static representation of the depositional environments as seen in figure 3.13.

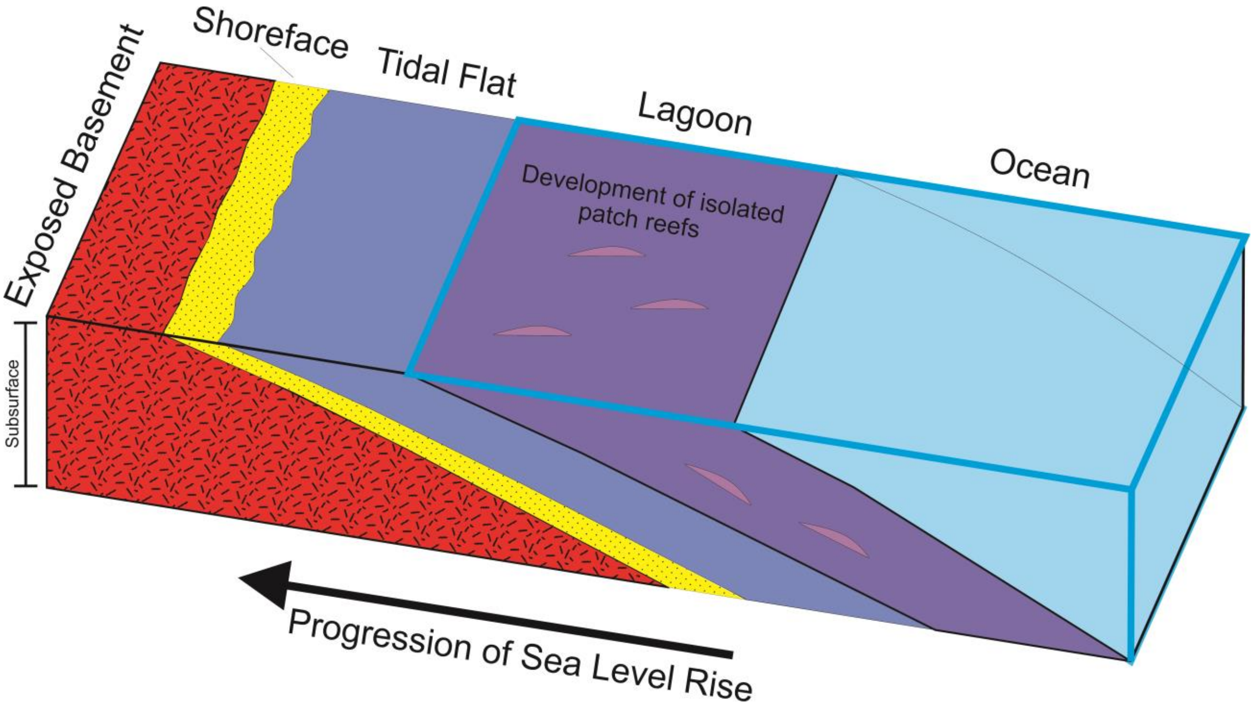


Figure 3.13 Representation of depositional environments in relation to progression of sea level rise.

Leading up to this point we have seen the deposition of each facies relative to their respective systems tracts. It is important to note that there is an exaggerated dipping angle of the facies within figure 3.13 as most of the units recorded in the field had a dip of less than five degrees if there was any dip at all. From the figure it becomes easier to visualize the succession in a three dimensional view.

CHAPTER IV

CONCLUSION

Our initial objectives in this project was to describe the sedimentology of the carbonate rocks within the Mason succession in an effort to properly correlate observed facies so that we could make interpretations about the geologic history of the Mason area leading up to its modern topography. In doing so, we were able to make draw conclusions regarding formation processes, depositional environments, and paleoclimates involved in the creation of the Fort Terret formation carbonate rocks seen in the Mason succession.

By recording the sedimentology we were able to break the succession into five facies including the Precambrian Town Mountain granite which was discovered to be the source material for the overlying Hensel sandstone facies. The carbonate facies of the succession were described as mudstone, bioclastic mudstone/wackestone, and finally the rudist floatstone. In correlating we were able to see variation in the vertical and lateral extent of each facies which provided the insight to the progression of formation of each facies.

Based on the correlations it was concluded that each facies unit was developed under different intervals of eustatic sea level change. These changes in sea level were defined based on the nature of the stratigraphy within the succession. As we have seen, the Hensel sand developed under a lowstand systems tract, the mudstone during the transgressive tract, and finally the bioclastic mudstone/wackestone as well as the rudist floatstone formed during the highstand tract during peak sea level rise.

A combination of our lithological observations in conjunction with the inferred stratigraphy led us to deduce that during the Cretaceous period the Mason location experienced shoreface, tidal flat, and lagoonal depositional environments depending on the stage of sea level advancement. Because of this we can infer that within this interval of time the Mason location more than likely experienced a tropical, warm watered paleoclimate that would allow for carbonate formation within this specific depositional setting to occur.

In conclusion, the carbonate rocks of the Fort Terret formation as seen in the Mason location are an exemplary reflection of the geologic and environmental conditions of central Texas approximately 100 to 110 mya.

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