

ABSTRACT

Regional Reservoir Characterization and Sequence Stratigraphy of the Jean Marie Member of the Redknife Formation, Northern British Columbia

Curtis J. Barclay, M.S.

Thesis Chairperson: Stacy C. Atchley, Ph.D.

The Upper Devonian Jean Marie Member of the Redknife Formation in northern British Columbia is an extensive carbonate shelf complex. Porous stromatoporoid boundstones are the primary gas reservoirs, and are stratigraphically trapped beneath and adjacent to the Upper Redknife Shale Member. This study focuses on characterizing reservoir quality and regional distributions through facies description, reservoir attribute mapping, and delineation of the depositional and/or diagenetic controls on reservoir quality. The study is based upon detailed core description of whole core from 80 wells (1556 m of cumulative length), and wireline logs from 156 wells. The Jean Marie reservoir interval is composed of 17 facies grouped within 5 facies associations. The stromatoporoid boundstone (“reef”) facies association is concentrated within three distinct, north-trending fairways within the eastern, central, and western portion of the study area. These fairways are interpreted to be the product of a westward prograding carbonate shelf that evolved from a ramp to rimmed shelf through time. The highest reservoir quality within the reef complex coincides with fractured facies characterized by grain-supported textures and associated high interparticle porosity. The spatial

distribution of reservoir properties is depicted through cross-sections and maps of facies, grain-supported textures, gross and net porosity thickness, pore-volume thickness, gross interval thickness and fracture density

Regional Reservoir Characterization and Sequence Stratigraphy of the Jean Marie
Member of the Redknife Formation, Northern British Columbia

by

Curtis J. Barclay, B.S.

A Thesis

Approved by the Department of Geology

Steven G. Driese, Ph.D., Chairperson

Submitted to the Graduate Faculty of
Baylor University in Partial Fulfillment of the
Requirements for the Degree
of
Master of Science

Approved by the Thesis Committee

Stacy C. Atchley, Ph.D., Chairperson

Steven G. Driese, Ph.D.

Kenneth T. Wilkins, Ph.D.

Accepted by the Graduate School
August 2012

J. Larry Lyon, Ph.D., Dean

Copyright © 2012 by Curtis J. Barclay

All rights reserved

TABLE OF CONTENTS

List of Figures	vii
List of Tables	ix
Acknowledgments	x
Chapter One	1
Introduction	1
Objectives	1
Geologic Setting	2
Data and Methodology	5
Chapter Two	7
Facies Framework	7
Facies Model Introduction	7
Facies 1 – Laminated Rooted Mudstone (LRM)	7
Facies 2 – <i>Amphipora</i> Floatstone (AF)	9
Facies 3 – Massive Encrusting Thrombolite Boundstone (METB)	9
Facies 4 – Massive Encrusting Stromatoporoid Boundstone (MESB)	10
Facies 5 – Platy Stromatoporoid Boundstone (PSB)	10
Facies 6 – Fine Peloid Grainstone (FPG)	12
Facies 7 – Coral Floatstone Restricted (CFR)	12
Facies 8 – Coral Floatstone Open (CFO)	14
Facies 9 – Skeletal Wackestone Restricted (SWR)	14
Facies 10 – Skeletal Wackestone Open (SWO)	14

Facies 11 – Skeletal Intraclastic Wackestone (SIW)	15
Facies 12 – Rooted Burrowed Mudstone (RBM)	15
Facies 13 – Intraclastic Flaser-Bedded Mudstone (IFM)	15
Facies 14 – Skeletal Rudstone (SR)	17
Facies 15 – Black Laminated Mudstone (BLM)	17
Facies 16 – Rounded and Sorted Skeletal Rudstone (RSSR)	17
Facies 17 – Intrareef Skeletal Debris (RSK)	19
Facies Associations	19
Chapter Three	21
Controls on Reservoir Quality	21
Introduction	21
Reservoir Quality and Facies	22
Reservoir Quality and Facies Associations	22
Textural Classification and Reservoir Quality	23
Fracture Occurrence and Facies	23
Chapter Four	30
Sequence-Stratigraphic Framework	30
Introduction	30
Cycle Hierarchy	30
Sea-Level History	32
Distribution and Stacking Patterns of Parasequences	33
Chapter Five	35
Regional Controls on Reservoir Quality	35

Introduction	35
Facies Association	35
Matrix Texture	37
Fracture Density	38
Porosity	38
Chapter Six	42
Conclusions	42
Appendices	43
Appendix A: Detailed stratigraphic cross sections	44
Appendix B: Core descriptions from UWI starting with 200-A	45
Appendix C: Core descriptions from UWI starting with 200-B	76
Appendix D: Core descriptions from UWI starting with 200-C	97
Appendix E: Core descriptions from UWI starting with 200-D	123
Appendix F: Core descriptions from UWI starting with 202	141
References	145

LIST OF FIGURES

1. Late Devonian lithostratigraphy of northeast British Columbia.	3
2. Paleogeography of the Late Devonian (360Ma) and location of the study area.	4
3. Basemap of study area including wellbores from which Jean Marie core has been extracted, and all other wellbores that are as deep as or deeper than the Jean Marie Member.	6
4. Bar chart of facies proportion of total core described.	9
5. Representative core photographs of facies 1-4.	11
6. Representative core photographs of facies 5-8.	13
7. Representative core photographs of facies 9-12.	16
8. Representative core photographs of facies 13-17.	18
9. Percent facies association of total core meters described.	20
10. Box and whisker plots of pore-meter thickness and maximum daily gas production.	21
11. Box and whisker plots of facies versus porosity and the permeability.	24
12. Box and whisker plots of facies association versus porosity and the permeability.	25
13. Box and whisker plots of matrix texture versus porosity and the permeability.	26
14. Stacked bar chart of matrix textural proportions per facies and facies association.	27
15. Box and whisker plots of facies and facies associations versus fracture density.	28
16. Representative core photographs of commonly fractured facies (facies 3, 4 and 5).	29
17. Composite sea-level curves for the interval of study.	31
18. Dominant facies association map for the Jean Marie.	36
19. Grain-supported textural proportion map for the Jean Marie.	37
20. Average fracture density map for the Jean Marie.	39

21. Gross interval thickness map of Jean Marie density porosity greater than 3%.	40
22. Net pore-meter thickness map of the Jean Marie.	41

LIST OF TABLES

1. Jean Marie gas reserve estimate.	1
2. Facies summary table.	8
3. Facies association characteristics.	19
4. Facies association porosity and permeability summary statistics.	23

ACKNOWLEDGMENTS

This research was made possible through the generous sponsorship of Husky Energy, Calgary, Alberta through the Baylor Applied Petroleum Studies program. In addition, data analysis was accomplished through software donations from Halliburton GeoGraphix® and IHS Energy Accumap®. Anne Young of Husky Energy and Nolan Skains of the Baylor University provided critical technical support related to navigating, trouble shooting, and updating these software programs. I would also like to thank my thesis committee members Dr. Steven Driese and Dr. Kenneth Wilkins for seeing this project through from start to finish and providing excellent editorial advice.

This Late Devonian reservoir characterization project was largely a group effort with many key players. First, I must acknowledge the employees of the Dave Johnson Core Research Centre of Fort Saint John, British Columbia. In particular, I would like to thank the core facility supervisor Ryan Olson for accommodating all our requests; as well as core handlers Rob Story and Deneen Shalay for keeping the core-boxes coming and going at a blistering pace. Furthermore, I must also recognize all the members of the Jean Marie core-research team, who were all vital to the success of this project. To colleagues Jason Mintz and Aislyn Trendell I owe many thanks. Without their keen eyes, core description experience, and good company, our work in British Columbia would have taken twice as long and would have been half as fun. To my research mentor and advisor Dr. Stacy Atchley, I am eternally grateful. The guidance and patience you have shown me throughout this research endeavor was, and will always be, greatly appreciated. Last but certainly not least, my research partner Kelly Jones deserves much

credit. We worked side by side on this project a full year before our paths were stratigraphically differentiated, and every step of the way we trudged forward together. Kelly, thank you for sharing the responsibilities, the work load, the successes, the gorilla costume, and the other various ups and downs of this project. I wish you the best in the future. Finally, thank you Roustabouts Restaurant and Balloon Fantasy (costume rental) of Fort Saint John for providing nourishment and much needed entertainment in the wilds of northern British Columbia.

CHAPTER ONE

Introduction

Objectives

The Jean Marie Member of the Redknife Formation is an extensive gas-charged carbonate shelf complex. This shelf complex is progradational and overlies basinal shale of the Late Devonian Fort Simpson Formation. The Jean Marie extends across northeast British Columbia, northwest Alberta, and the southern Northwest Territories and is estimated to contain 10.6 tcf of in-place gas reserves (Adams et al., 2006) (Table 1).

Table 1. Jean Marie conventional gas reserves in trillion cubic feet (tcf)
(modified from Adams et al., 2006).

Formation	Play Area	GIP (tcf)			Producible	Marketable
		Low	Medium	High		
Jean Marie	Platform	2.657	7.107	12.855	4.617	4.127
Jean Marie	Bank Edge	1.722	3.058	8.865	2.723	2.395

Despite proven gas reserves and significant gas in-place estimates (Table 1), there is very little information published on the Jean Marie Member. Using a small dataset of only 18 core, Wendte (2009a) introduced a facies model and sequence-stratigraphic framework for the Jean Marie in a location just north of the study area. Additionally, Wendte's (2009a, b) studies did not include an examination of the highly productive Jean Marie shelf margin.

The objectives of this study of the Jean Marie Member are to: 1) develop a facies model and depositional framework from the core data set, 2) determine relationships

between facies/facies associations and reservoir quality attributes, 3) generate a sequence-stratigraphic framework to evaluate the depositional history of the Jean Marie, and 4) characterize the spatial distribution of potentially porous and permeable reservoir bodies.

Geologic Setting

The Jean Marie Member was deposited within the Western Canada Sedimentary Basin (WCSB), which contains a northeastward-tapering wedge of Phanerozoic sedimentary rocks. The sedimentary wedge thickens gradually southwestward from a zero edge to a thickness of 3 and 5 km within the basin axis (Price, 1994). The Jean Marie Member was deposited during the early miogeocline platform stage of WCSB formation (Price and Mountjoy, 1970). Upper Devonian strata in western Canada were largely deposited as platform carbonates and equivalent basinal deposits during a second-order (i.e., Kakaskia, *sensu* Sloss 1963) cycle of sea-level change. During this time, the Late Devonian climatic deterioration from warm to cool coincided with the Frasnian–Famennian mass-extinction event (Whalen, 2010). Sea-level rise during the Early and Middle Devonian led to the accumulation of a thick sedimentary succession within the WCSB (Bond, 1991). Second-order sea-level highstand during the Devonian produced a seaway that extended across the Northwest Territories and western Canada, and resulted in clastic and carbonate deposition throughout the WCSB (Corlett, 2011).

The WCSB lithostratigraphic framework for the Devonian of northern British Columbia is summarized in Figure 1. Jean Marie shallow-marine carbonates overlie the deep-water shales of the Fort Simpson Formation, and the Jean Marie is overlain by the low permeability deep-water shales of the Redknife Formation.

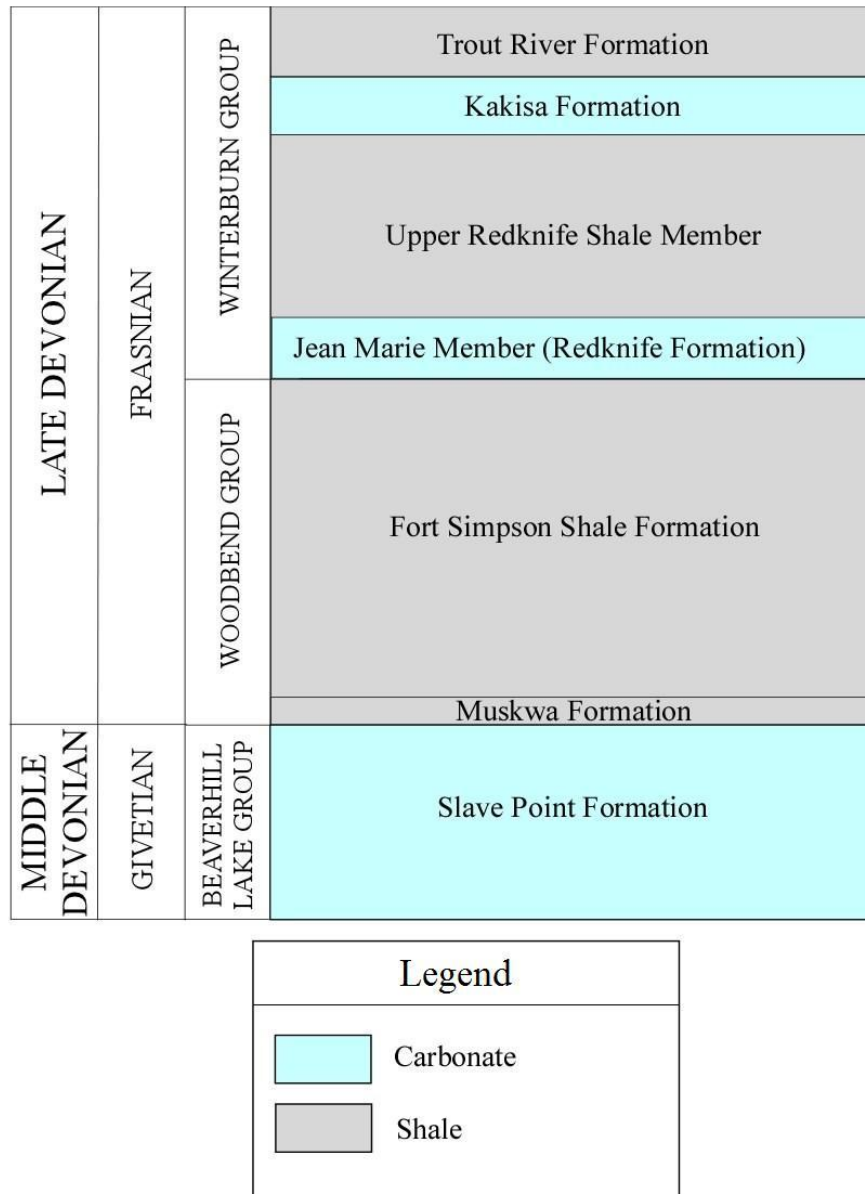


Figure 1. Late Devonian lithostratigraphy of northeast British Columbia. (modified from Wendte 2009b and Mei 2009)

The Jean Marie accumulated as a carbonate platform complex that was attached to the western margin of the North American continent (Figure 2). Figure 2 presents the location of the Jean Marie study area in relation to both global and regional Late Devonian paleogeographic reconstructions.

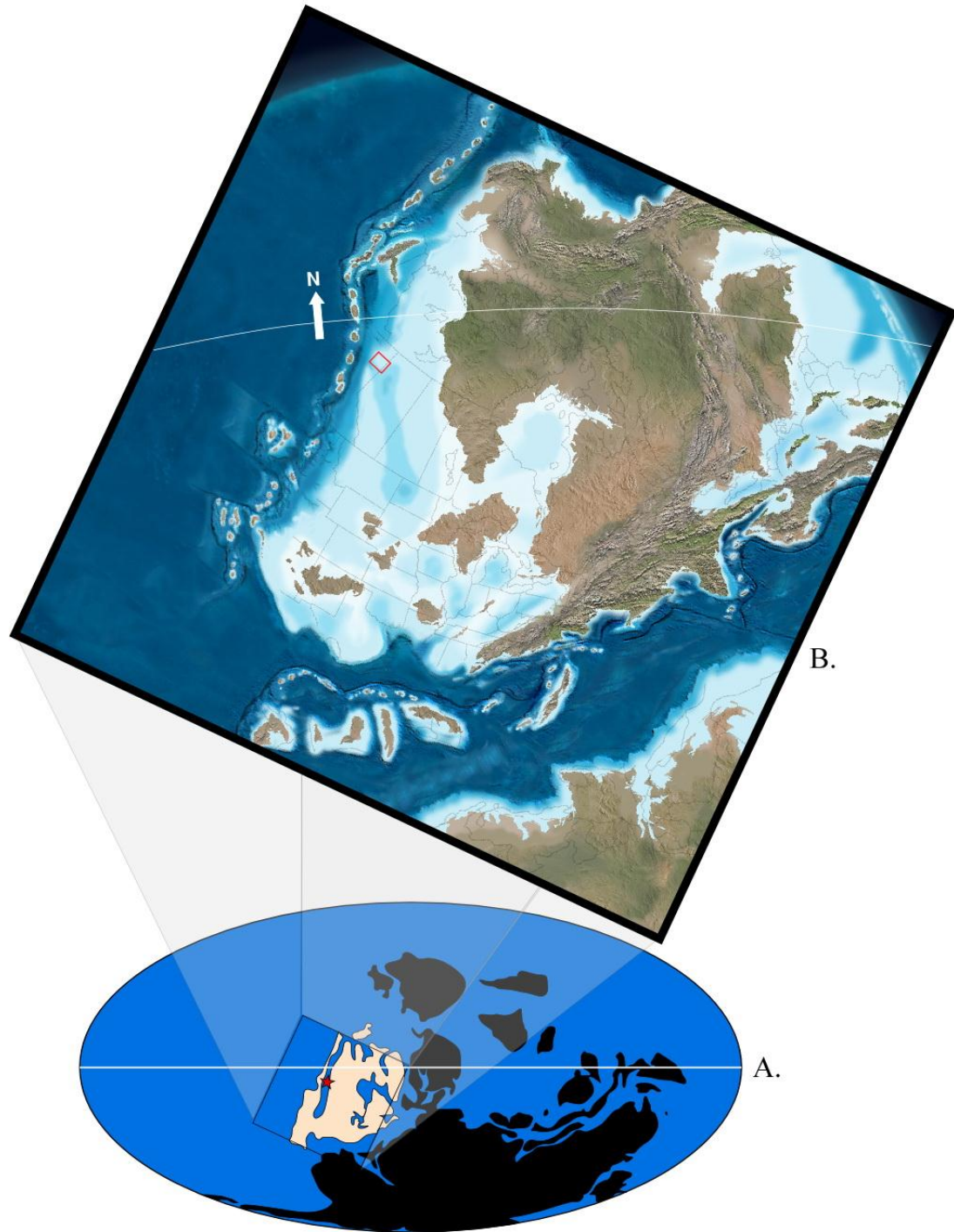


Figure 2. The lower map A) displays a Late Devonian (360Ma) global paleogeographic reconstruction (modified from Scotese 2004), with North America highlighted in gray, and the study area identified by a red star. The upper map B) displays the North American paleogeography during the Late Devonian (360Ma) (modified from Blakey 2010), and the small red box identifies the location of the study area. The white line across the map depicts the Late Devonian paleoequator and its relation to magnetic north (see arrow).

Data and Methodology

This study is based upon detailed description of 1556 m of whole core from 80 vertical wellbores within the study area (Figure 3). Core was described at the Dave Johnson (Charlie Lake) Core Research Facility that is operated by the British Columbia Ministry of Energy and Mines. Detailed core descriptions account for variations in matrix texture, facies, grain type, sedimentary structures, visible porosity type and relative proportion, conspicuous cement type and fracture density. Photographs were taken of all diagnostic features observed within each core. Core description attributes, such as facies designation and matrix texture, are digitized within Microsoft Excel® and merged with all porosity and permeability core analysis data (64 wells). Statistical analysis of core description results were completed within Microsoft Excel® and drafted within ACD Canvas®.

Well log data from 235 vertical wellbores were used for stratigraphic correlation within a cross-section grid for the study area (Figure 3). Stratigraphic correlation was completed within Halliburton Geographix® Xsection™. Following correlation, Jean Marie top and bottom horizon picks were exported into Microsoft Excel® and imported into Surfer 8® where map attributes were computer gridded and contoured. Computer-generated maps were then imported into ACD Canvas 11® where they were modified and refined by hand. Additional attributes (i.e., stratigraphic tops, and porosity value and thickness measurements) that were digitized and used in mapping were collected using raster well logs available within IHS Energy Accumap ® (i.e., for well logs not available within the Geographix database). Logs from a total of 156 vertical wells are included in the study and consist of sonic, density and neutron-density porosity data.

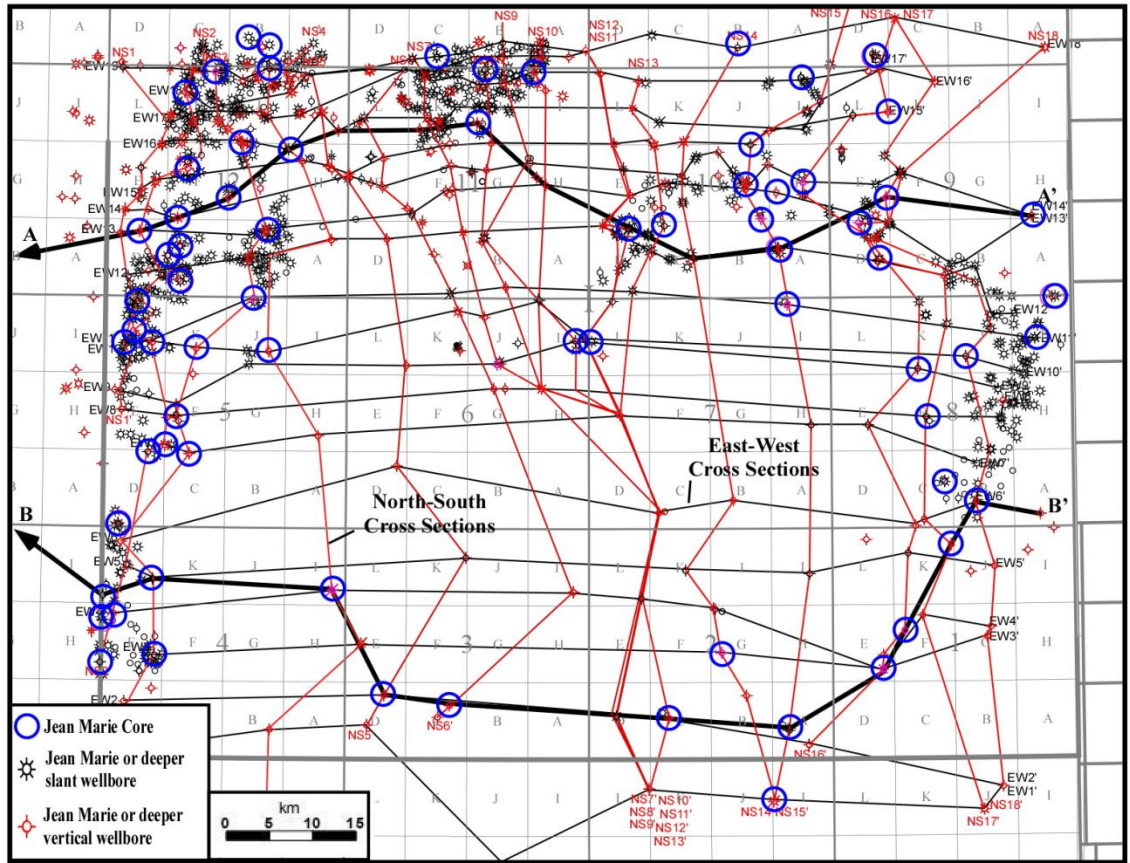


Figure 3. Basemap of study area including wellbores with core and all wellbores as deep as or deeper than the Jean Marie Member. Bold lines (A-A' and B-B') represent detailed stratigraphic cross-sections (Appendix A) used for sequence-stratigraphic interpretations. Red lines are north-south cross-sections and gray lines are east-west counterparts. Blue circles identify wells with Jean Marie core. Original core descriptions and a core description legend are located within Appendices B-F.

CHAPTER TWO

Facies Framework

Facies Model Introduction

Wendte (2009a) described the Jean Marie as a prograding carbonate shelf with a well defined margin that includes a shallow-water interior with abundant coalescing patch reefs. Stratigraphic correlations from the present study indicate that the shelf evolved from a gently sloping carbonate ramp into a high-relief, rimmed shelf (Plate A). From these depositional systems, seventeen total facies are differentiated within the Jean Marie on the basis of variations in texture, grain types, and sedimentary structures (Table 2). The relative proportion of each facies observed within core is shown in Figure 4. The following discussion provides descriptions of the criteria by which facies are differentiated and subsequently interpreted.

Facies 1- Laminated Rooted Mudstone (LRM)

Facies 1 is a black to brown mudstone with few carbonate grains. No diagnostic allochems exist in this facies, although the most common grains include intraclasts and peloids. Common sedimentary structures are millimeter lamina (Figure 5A), root traces (Figure 5A), burrows, mud cracks, flaser bedding, and occasionally the trace fossil *Bergaueria*. Mud cracks and root traces indicate deposition within a shallow tidal flat environment.

Table 2. Facies summary table

Facies	Environment of Deposition	Dominant Texture	Diagnostic Grains	Accessory Grains	Sedimentary Structures
Laminated rooted mudstone (LRM) 1	Tidal Flat	Wackestone	None	Intraclasts, peloids	Root traces, burrows, mm lamina, mud cracks, flaser bedding, Bergaueria
Amphipora floatstone (AF) 2	Shallow subtidal	Wackestone	Amphipora	Brachiopods, intraclasts, gastropods, oncoids, Thamnopora, rugose corals	Thalassinoides
Massive encrusting thrombolite boundstone (METB) 3	Patch or barrier reef crest	Bindstone	Platy stromatoporoids, filamentous cyanobacteria	Rugose and tabulate coral, brachiopods, crinoids, bivalves, Thamnopora	Thrombolitic binding
Massive encrusting stromatoporeid boundstone (MESB) 4	Patch or barrier reef crest	Bindstone, framestone	Massive encrusting stromatoporoids	Rugose and tabulate corals, bulbous and platy stromatoporoids, Renalcis, brachiopods, Thamnopora	Organic binding
Platy stromatoporeid boundstone (PSB) 5	Patch or barrier reef flank, subtidal biostrome	Bindstone	Platy stromatoporoids	Rugose and tabulate corals, Thamnopora, brachiopods, intraclasts, crinoids, cylindrical stromatoporoids, Amphipora	Organic binding, Thalassinoides
Fine peloid skeletal grainstone (FPG) 6	Shoal, intra- and/or inter-reef sediment	Grainstone	Peloids	Bryozoans, brachiopods, gastropods, rugose corals, oncoids	Thalassinoides
Coral floatstone (restricted) (CFR) 7	Intermediate depth subtidal (restricted marine)	Wackestone	Oncoids	Thamnopora, rugose and tabulate corals, platy stromatoporoids, gastropods, brachiopods, crinoids	Thalassinoides
Coral floatstone (open) (CFO) 8	Intermediate depth subtidal (open marine)	Wackestone	Thamnopora, tabulate coral, brachiopods	Rugose coral, crinoids, oncoids, brachiopods, platy stromatoporoids, intraclasts, rare Amphipora	Thalassinoides
Skeletal wackestone (restricted) (SWR) 9	Intermediate depth subtidal (restricted marine)	Wackestone	Oncoids, undifferentiated skeletal grains	Gastropods, <<Thamnopora, <<rugose coral, cylindrical stromatoporoids, Amphipora	Thalassinoides
Skeletal wackestone (open) (SWO) 10	Intermediate depth subtidal (open marine)	Wackestone	Brachiopods and crinoids	Gastropods, intraclasts, platy stromatoporoids, <<Thamnopora	Thalassinoides
Skeletal intraclastic wackestone (SIW) 11	Intermediate to deeper subtidal	Wackestone	Brachiopods, crinoids, intraclasts	Rugose corals, peloids	Crinkly lamina, argillaceous stylolitized lamina
Restricted burrowed mudstone (RBM) 12	Intermediate to deeper subtidal	Mudstone	Peloids	<<Brachiopods, <<bivalves, <<crinoids	Thalassinoides
Intraclastic flaser bedded mudstone (IFM) 13	Deeper subtidal	Mudstone	Terrigenous clay and silt interbedded with cm-thick carbonate layers	Intraclasts, peloids, undifferentiated skeletal grains, crinoids, Thamnopora	Flaser lamina
Skeletal rudstone (SR) 14	Basinal, transgressive lag	Rudstone	Brachiopods, rugose corals, Thamnopora	Gastropods, intraclasts, undifferentiated skeletal grains	None
Black laminated mudstone (BLM) 15	Basinal	Calcareous shale	Terrigenous clay and silt	Rare diminutive brachiopod and crinoid fragments	Millimeter to sub-millimeter lamina
Rounded and sorted skeletal rudstone (RSSR) 16	Shoreface to beach	Packstone to rudstone	Coated grains, abraded and rounded skeletal grains, lithoclasts, Amphipora	None	Weak centimeter-scale horizontal lamina
Intra-reef skeletal debris (RSK) 17	Reef crest and/or slope	Packstone to grainstone	Diverse skeletal (principally stromatoporeid) fragments, intraclasts and lithoclasts	None	None

Facies 2- Amphipora Floatstone (AF)

Facies 2 has abundant *Amphipora* and typically a wackestone texture (Figure 5B). Accessory grains are sparse but include brachiopod, intraclast, gastropod, oncoid, *Thamnopora*, and rugose coral. Trace fossils are rare, but *Thalassinoides* burrows are occasionally observed. The mud-rich texture and limited faunal diversity is suggestive of a low-energy, somewhat restricted shallow-marine environment.

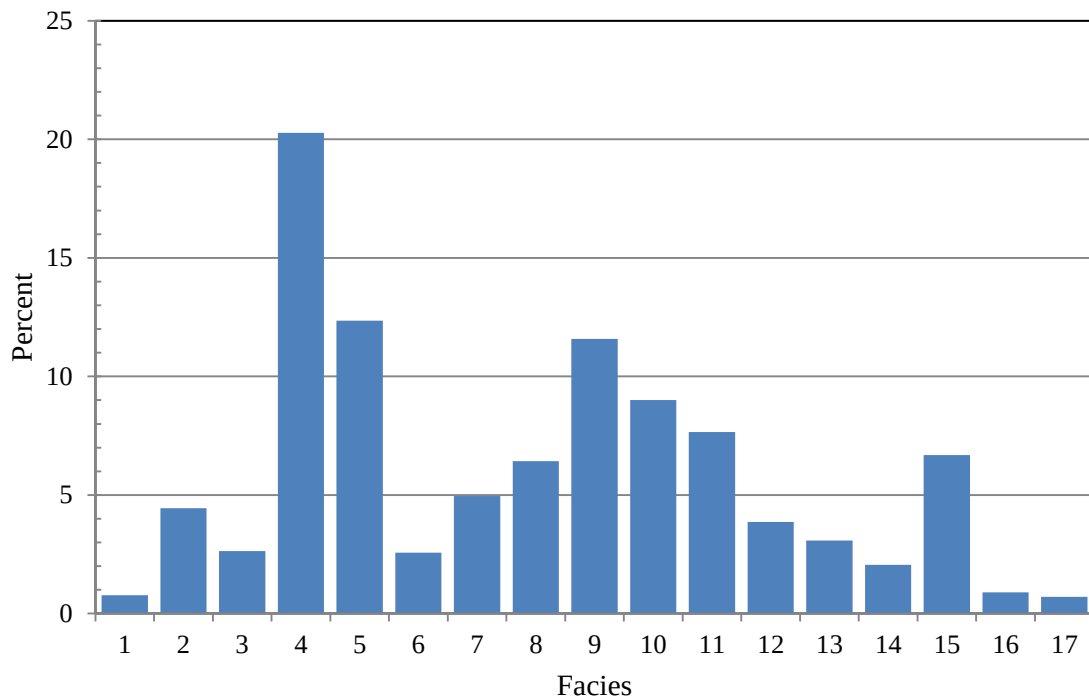


Figure 4. Percent facies occurrence within the total Jean Marie core described.

Facies 3- Massive Encrusting Thrombolite Boundstone (METB)

The key diagnostic attributes of facies 3 are filamentous cyanobacterial binding and lesser platy stromatoporoids (Figure 5C). Accessory fauna are rugose and tabulate coral, brachiopods, crinoid ossicles, bivalves, and *Thamnopora*. The dominant textural classification of facies 3 is bindstone, and the typical matrix texture is wackestone or

packstone. The presence of coral, platy stromatoporoids, and organic binding suggests a patch reef or barrier reef depositional environment.

Facies 4- Massive Encrusting Stromatoporoid Boundstone (MESB)

The most common texture within this facies is framestone and/or boundstone with packstone or grainstone texture between organically bound sediment. Massive encrusting stromatoporoids are the most common framework skeletal component (Figure 5D). Other accessory skeletal grains include rugose and tabulate corals, stromatoporoids (bulbous, platy, and cylindrical), *Renalcis*, brachiopods, *Thamnopora*, and gastropods. Massive encrusting stromatoporoid boundstone facies is the most common "reef" deposit within the Jean Marie. The growth framework habit of binding organisms is suggestive of a high-energy marine, reef environment.

Facies 5- Platy Stromatoporoid Boundstone (PSB)

The dominant texture is boundstone with mudstone or wackestone matrix texture. Only 35% of facies 5 contains packstone to grainstone matrix textures. Distinguishing features include an abundance of platy stromatoporoids and an absence of massive encrusting stromatoporoids (Figure 6A). Platy stromatoporoids are distinguished from massive encrusting stromatoporoids by thickness. Stromatoporoids greater than 2 cm in thickness are considered massive, whereas tabular stromatoporoids ranging from 0.5 to 2 cm are considered platy. Tabular stromatoporoids less than 0.5 cm in thickness are described as wafer (Figure 6A). These varieties of stromatoporoid also have distinctive growth habits. Massive encrusting and platy stromatoporoids occur as colonies in which a framework of three-dimensional plates grew above the seafloor, and

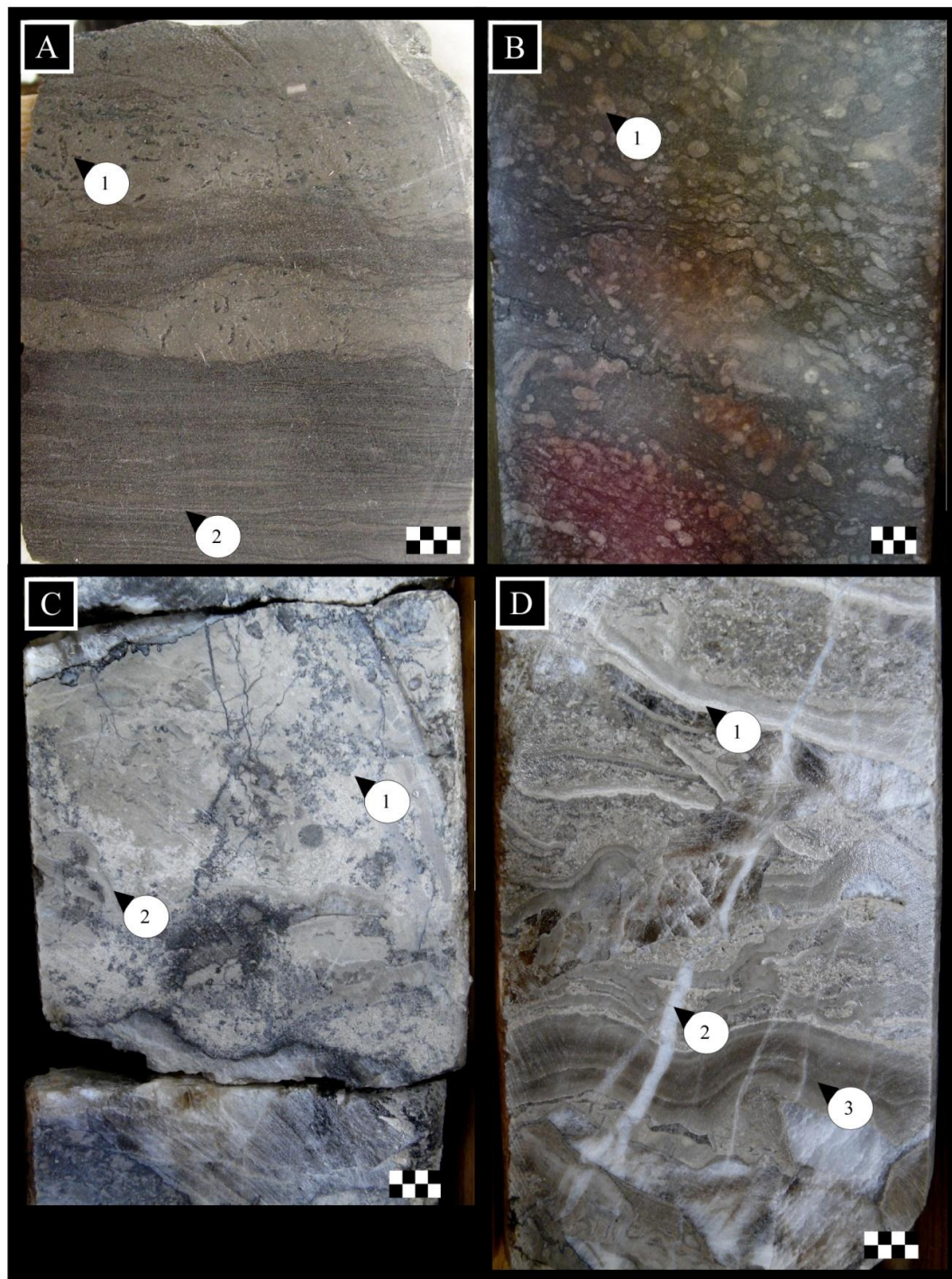


Figure 5. Core photographs of Jean Marie Member facies 1-4. Total length of the scale bar is 1 cm. A) LRM (facies 1) in well 200B032L094I04 at 1698m depth 1) rooting and 2) fine laminations; B) AF (facies 2) in well 200A100I094I11 at 1369m depth, 1) one of many *Amphipora* grains in a wackestone matrix; C) METB (facies 3) in well 200C085I094I10 at 1126m depth, 1) filamentous cyanobacterial thrombolitic binding and 2) platy stromatoporoid; D) MESB (facies 4) in well 200B060C094I12 at 1501m depth, 1) pendant renalcis and platy stromatoporoids with intercalated grainy sediment, 2) calcite-filled fracture, and 3) massive encrusting stromatoporoid.

wafer stromatoporoids grew as thin branching sheets across the seafloor (Wendte, 2009a). Common accessory grains include rugose and tabulate coral (Figure 6A), *Thamnopora*, brachiopods, intraclasts, cylindrical stromatoporoids, *Amphipora*, and crinoids. The muddy texture and constituent grains are suggestive of a middle slope depositional environment. Facies 5 is a common transitional facies between off-bank and on-bank reef crest facies.

Facies 6- Fine Peloid Skeletal Grainstone (FPG)

Facies 6 is characterized by a grainstone texture and abundant fine peloids (Figure 6B). Accessory grains include oncoids and whole or fragments of bryozoa, brachiopod, gastropod, and rugose coral. The facies is almost always observed to be massive, and ripple and trough cross-stratification are rarely observed. Facies 6 is interpreted as a shoal deposit possibly associated with "reefal" buildups of facies 4 and/or 5. Interparticle and moldic porosity is common.

Facies 7- Coral Floatstone Restricted (CFR)

A wackestone texture with large interspersed corals and oncoids is most common (Figure 6C). Regular accessory grains include *Thamnopora*, rugose and tabulate coral (Figure 6C), platy stromatoporoids, gastropods, brachiopods, and crinoid ossicles. *Thalassinoides* burrows are occasionally observed. The mud-supported texture and presence of oncoids and corals suggest deposition within a low-energy, restricted marine environment (Wilson, 1975).

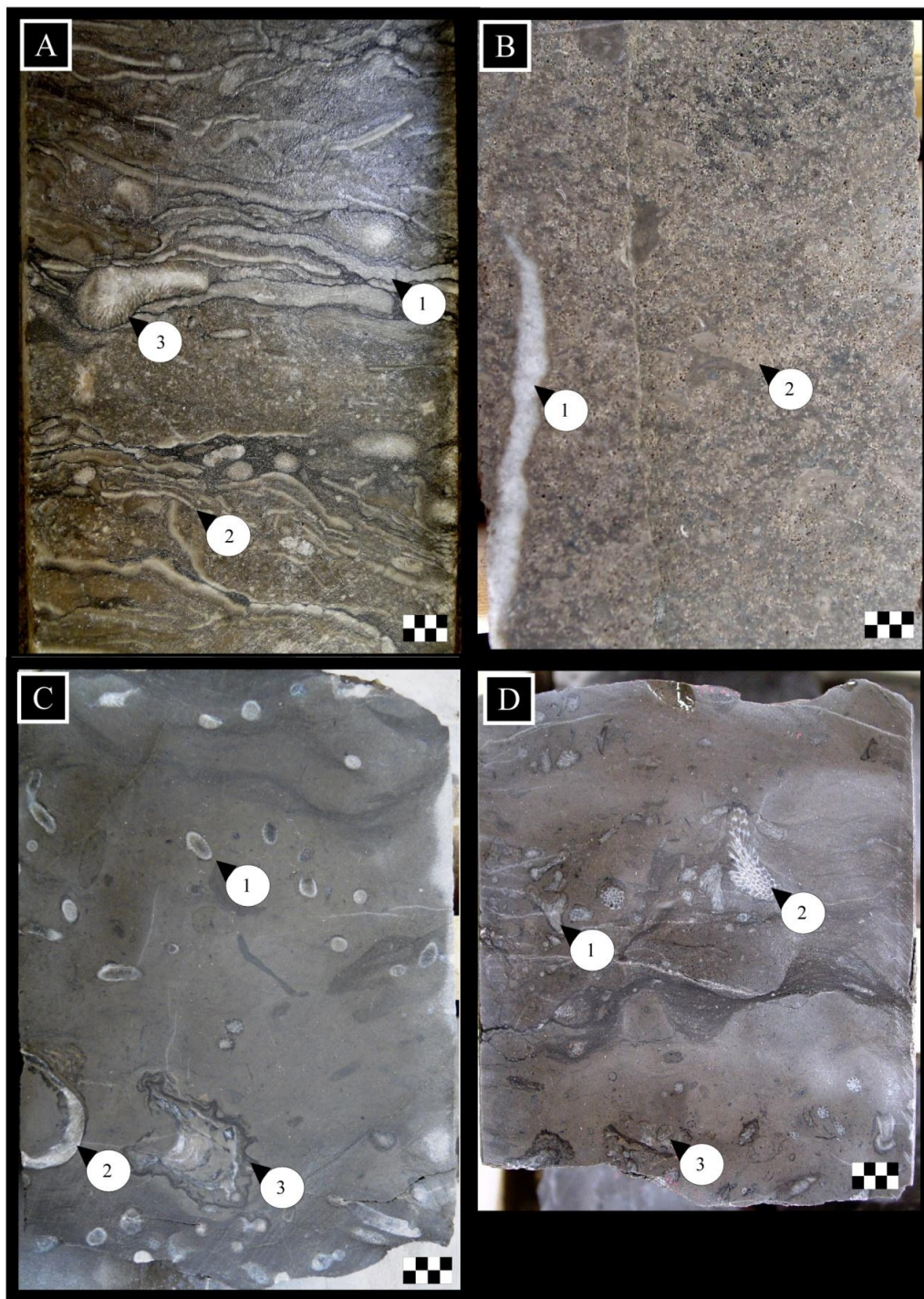


Figure 6. Core photographs of Jean Marie Member facies 5-8. Total length of the scale bar is 1 cm. A) PSB (facies 5) in well 200B008D094I05 at 1697m depth, 1) platy stromatoporoid surrounded by micrite, 2) wafer stromatoporoid and 3) *Thamnopora*; B) FPG (facies 6) in well 200B100H094I12 at 1432m depth, 1) large fracture filled with calcite and 2) interparticle pore space between peloid grains; C) CFR (facies 7) in well 200C029J094I11 at 1323m depth, 1) rugose coral, 2) *Megalodont* bivalve and 3) oncoid; D) CFO (facies 8) in well 200A094D094I10 at 1321m depth, 1) tabulate coral, 2) *Thamnopora* and 3) small brachiopod.

Facies 8- Coral Floatstone Open (CFO)

Facies 8 is similar to facies 7, but is primarily differentiated by an absence of oncoids and relatively higher faunal diversity (Figure 6D). Diagnostic grains include *Thamnopora* (Figure 6D), tabulate coral (Figure 6D), and brachiopods (Figure 6D), and accessory grains include rugose coral, crinoid ossicles, brachiopods, platy stromatoporoids, intraclasts, and *Amphipora*. Facies 8 is interpreted to have accumulated within a low-energy, relatively more open-marine environment (i.e., in comparison with Facies 7). This interpretation is supported by both the mud-rich textures and more diverse associated grain types.

Facies 9- Skeletal Wackestone Restricted (SWR)

Diagnostic grains are oncoids and undifferentiated skeletal grains (Figure 7A), and accessory grains are gastropods, *Thamnopora*, rugose coral, cylindrical stromatoporoids, and *Amphipora*. The trace fossil *Thalassinoides* is occasionally differentiated. Based on its muddy texture and oncoids, facies 9 is interpreted to have accumulated within an environment similar to facies 7.

Facies 10- Skeletal Wackestone Open (SWO)

Facies 10 is similar to facies 9, but is distinguished by the absence of oncoids and higher grain abundance. Oncoids and grain-richness help distinguish restricted intermediate depth subtidal environments from open-marine depositional environments, in the same manner that facies 7 and 8 are distinguished. Diagnostic allochems of facies 10 are brachiopods and crinoid ossicles (Figure 7B), with accessory grains including gastropods, intraclasts, platy stromatoporoids, and *Thamnopora*. Allochems are

suspended in a mud-rich, wackestone matrix indicative of a low-energy, subtidal depositional environment. The assortment of grains and the absence of oncoids indicates a more open-marine environment than facies 9.

Facies 11- Skeletal Intraclastic Wackestone (SIW)

The distinguishing feature of facies 11 is its mudstone to wackestone texture, and crinkly and argillaceous stylolitized lamina (Figure 7C). Diagnostic grains include brachiopods, crinoid ossicles, and intraclasts (Figure 7C). Less common accessory grains are rugose corals and peloids. Grain types and the argillaceous mudstone to wackestone textures suggest that facies 11 likely accumulated within an intermediate to deeper subtidal environment.

Facies 12- Restricted Burrowed Mudstone (RBM)

Facies 12 is characteristically a peloid mudstone that lacks large grains (Figure 7D). Brachiopods, bivalves, and crinoid ossicles are occasionally observed as accessory grains. Sedimentary structures include *Thalassinoides* burrows (Figure 7D) and crinkly lamina. Argillaceous mudstone texture and low faunal diversity within facies 12 indicate deposition within an intermediate to deeper subtidal environment.

Facies 13- Intraclastic Flaser-Bedded Mudstone (IFM)

Alternating mud and carbonate layers as “flaser” lamina are diagnostic (Figure 8A). Lamina are comprised of terrigenous clay and silt drapes across centimeter-thick carbonate layers. Accessory grains may include intraclasts, peloids, crinoid ossicles, *Thamnopora*, and undifferentiated skeletal grains. Flaser bedding is diagnostic of

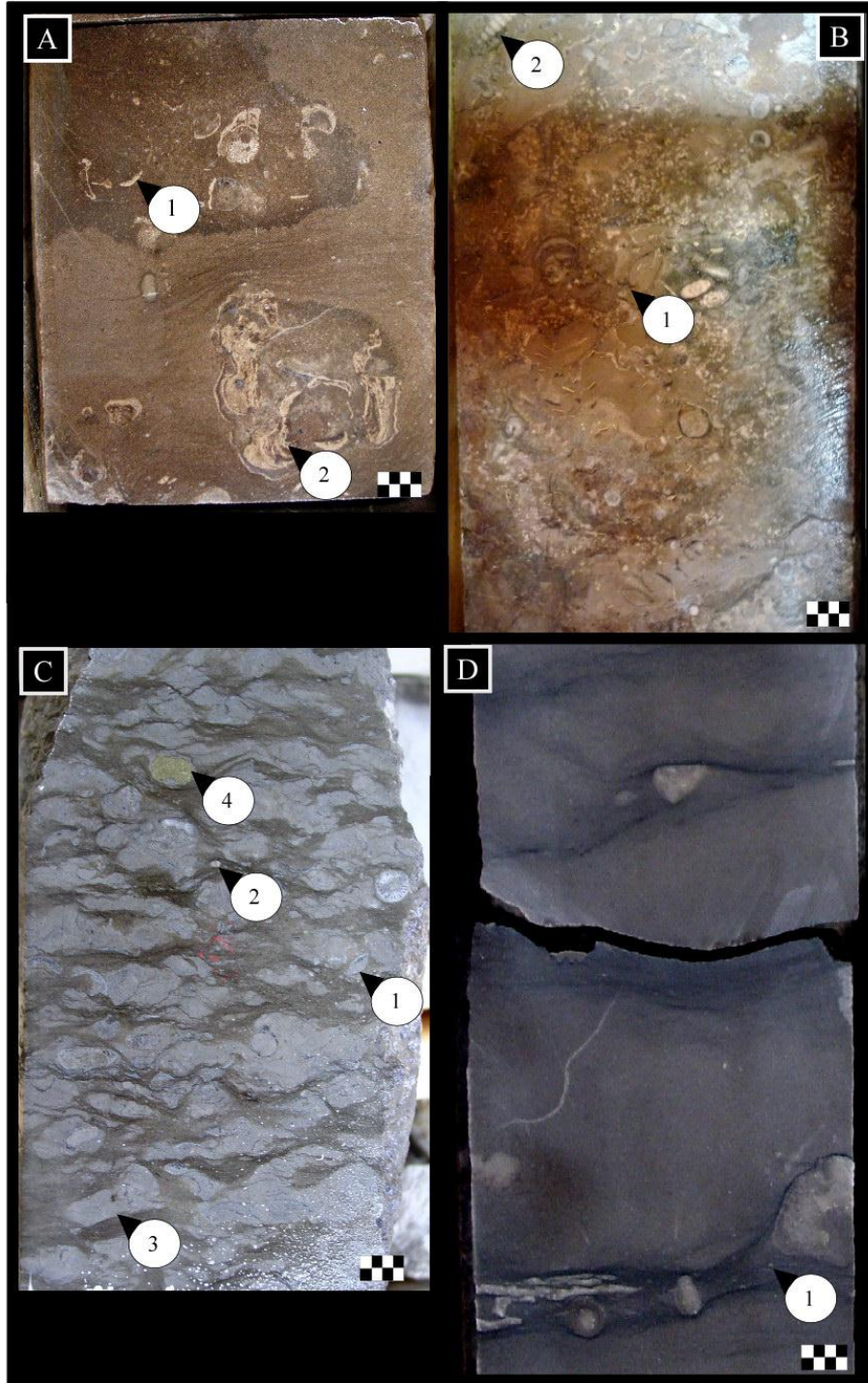


Figure 7. Core photographs of Jean Marie Member facies 9-12. Total length of the scale bar is 1 cm. A) SWR (facies 9) in well 200A094D094I10 at 1312m depth, 1) undifferentiated skeletal grain and 2) oncoid; B) SWO (facies 10) in well 200A055H094I10 at 1153m depth, 1) brachiopod and other undifferentiated skeletal grains and 2) crinoid stem; C) SIW (facies 11) in well 200A094D094I10 at 1324m depth, 1) brachiopod surrounded by crinkly argillaceous lamina, 2) crinoid ossicle, 3) intraclast and 4) pyrite replacement; D) RBM (facies 12) in well 200B085D094I12 at 1509m depth, 1) peloid.

depositional environments with intermittent and/or alternating flow (Reineck and Wunderlich, 1968). The mud-rich nature and low faunal diversity suggest accumulation within a deeper subtidal depositional environment.

Facies 14- Skeletal Rudstone (SR)

Facies 14 is a coarse-grained rudstone composed of brachiopods, rugose corals, and *Thamnopora* (Figure 8B) along with less common gastropods, intraclasts, and undifferentiated skeletal grains. Facies 14 is commonly located at the base of parasequence 1 (Appendix A) and has a rudstone texture. This may infer a relatively high-energy environment and/or a basinal storm or transgressive lag.

Facies 15- Black Laminated Mudstone (BLM)

Facies 15 is a calcareous shale composed of terrigenous clay and silt (Figure 8C) that includes rare, diminutive brachiopod and crinoid ossicles. Millimeter to sub-millimeter lamina are common throughout (Figure 8C). This facies is commonly recovered as rubble in core (Figure 8C). The argillaceous mudstone texture, marine biota and millimeter lamina suggest a low-energy, restricted marine environment (likely basinal).

Facies 16- Rounded and Sorted Skeletal Rudstone (RSSR)

Diagnostic attributes are a packstone to rudstone texture, coated grains, abraded and rounded skeletal grains, lithoclasts, and *Amphipora* (Figure 8D). Horizontal lamina are rarely present. Coated and abraded skeletal grains suggest sediment accumulation within shallow, agitated conditions (Srivastava, 2006).

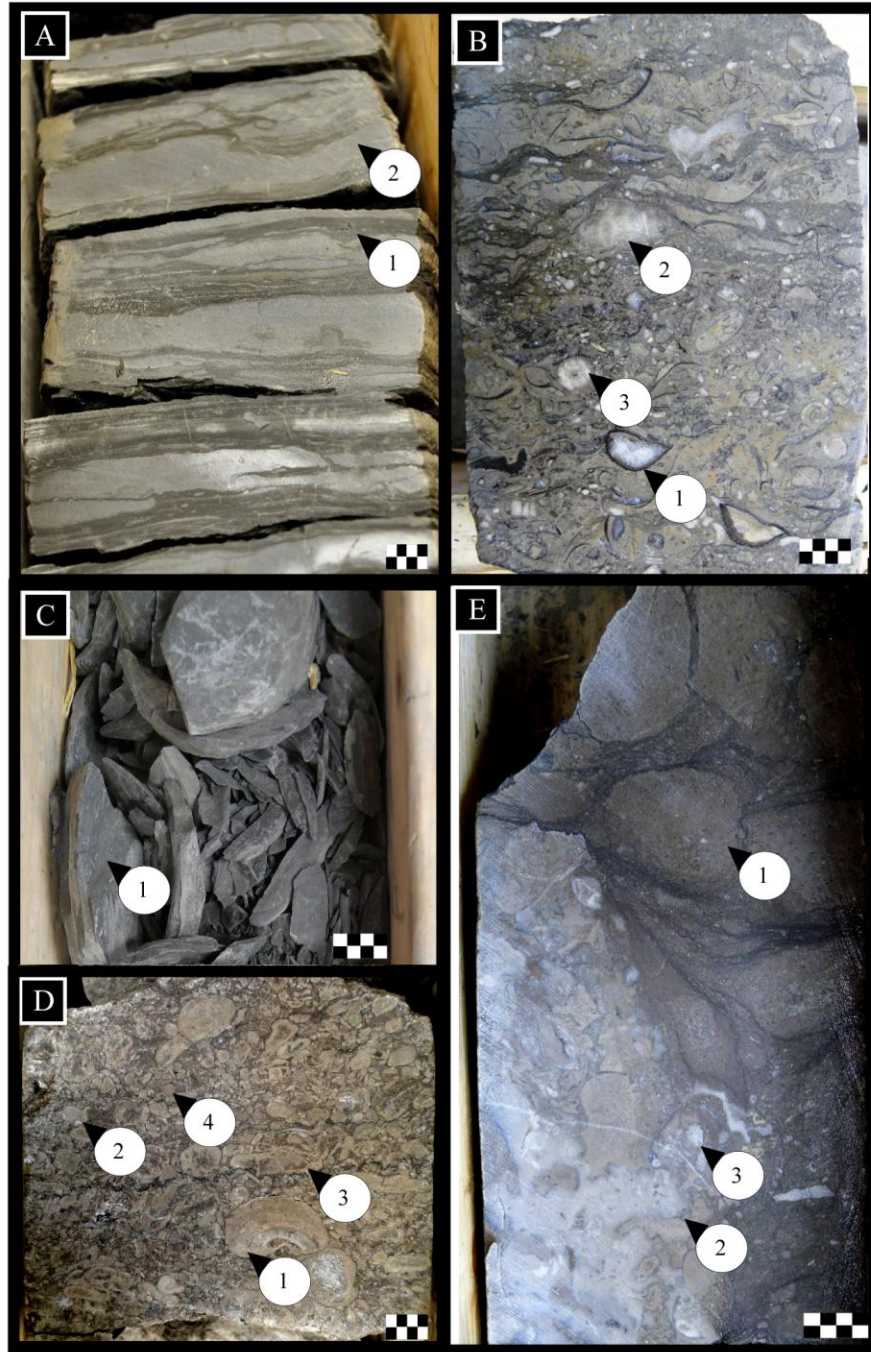


Figure 8. Core photographs of Jean Marie Member facies 13-17 found within the Jean Marie Member. Total length of the scale bar is 1 cm. A) IFM (facies 13) in well 200C045F094I08 at 1276m depth, 1) terrigenous clay lens and 2) carbonate lens; B) SR (facies 14) in well 200B031E094I09 at 1140m depth, 1) calcite filled brachiopod, 2) colonial rugose coral bioclast and 3) crinoid ossicle; C) BLM (facies 15) in well 200D047I094I08 at 1177m depth, 1) rubbled calcareous shale with mm scale lamina; D) RSSR (facies 16) in well 200D089E094I04 at 1794m depth, 1) coated skeletal grain, 2) round and abraded skeletal grain 3) lithoclast and 4) *Amphipora*; E) RSK (facies 17) in well 200B008D094I05 at 1677m depth, 1) stromatoporoid fragments within a lithoclast, 2) lithoclast and 3) undifferentiated skeletal grain.

Facies 17- Intrareef Skeletal Debris (RSK)

Facies 17 is commonly a packstone to grainstone texture with diverse skeletal grains including most commonly stromatoporoid fragments, and less commonly intraclasts and angular lithoclasts (Figure 8E). Based on the high proportion of stromatoporoid and lithoclast reef fragments, facies 17 is interpreted as reworked reef debris.

Facies Associations

Facies are grouped into five associations on the basis of sedimentological attributes and environmental similarity (Table 2). Figure 9 summarizes the proportion of each facies association observed in core.

Table 3. Facies associations, their constituent facies and likely environment(s) of deposition.

Facies Association	Depositional Environment	Associated Facies
1	Low-energy subtidal to intertidal	1, 2
2	Low-energy subtidal	7, 8, 9, 10, 12
3	Platform top or margin buildup	3, 4, 5, 17
4	Platform top shoal	6, 16
5	Deeper-marine, subtidal to basinal	11, 13, 14, 15

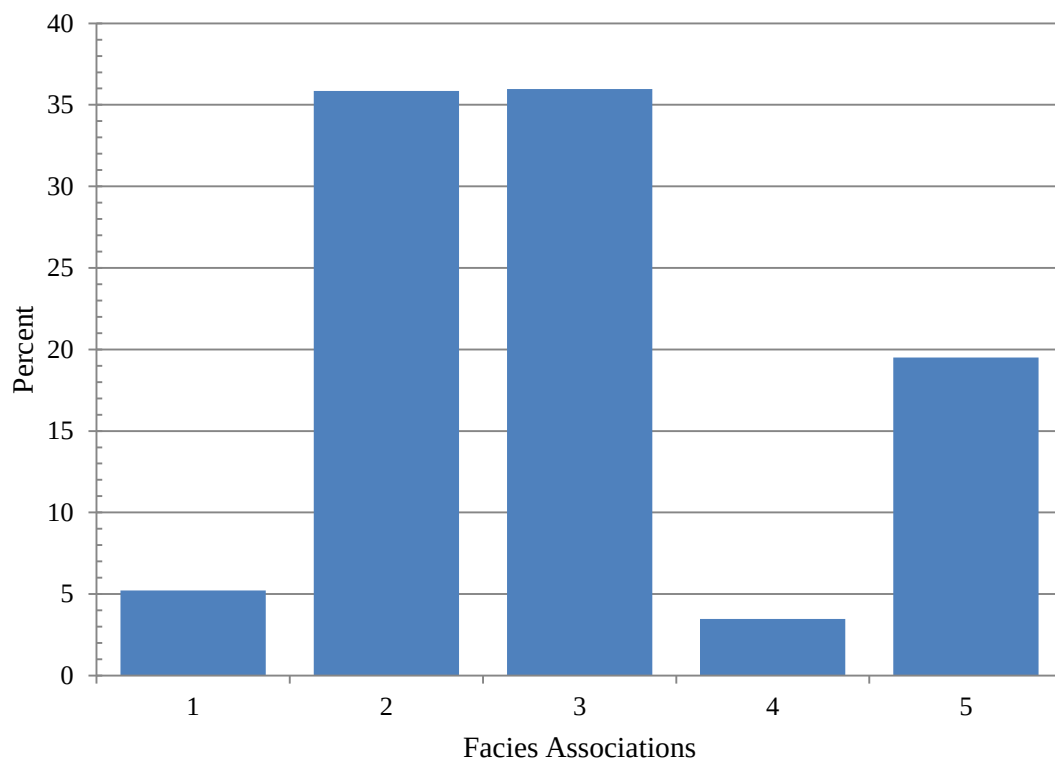


Figure 9. Proportion of facies associations observed in core.

CHAPTER THREE

Controls on Reservoir Quality

Introduction

Trends of porosity and permeability and rates of gas production closely correlate within the Jean Marie Member (Figure 10). The following discussions present results from the evaluation of whether reservoir quality (porosity, permeability and fracture density), and hence gas production, is predictably related to facies and/or facies associations.

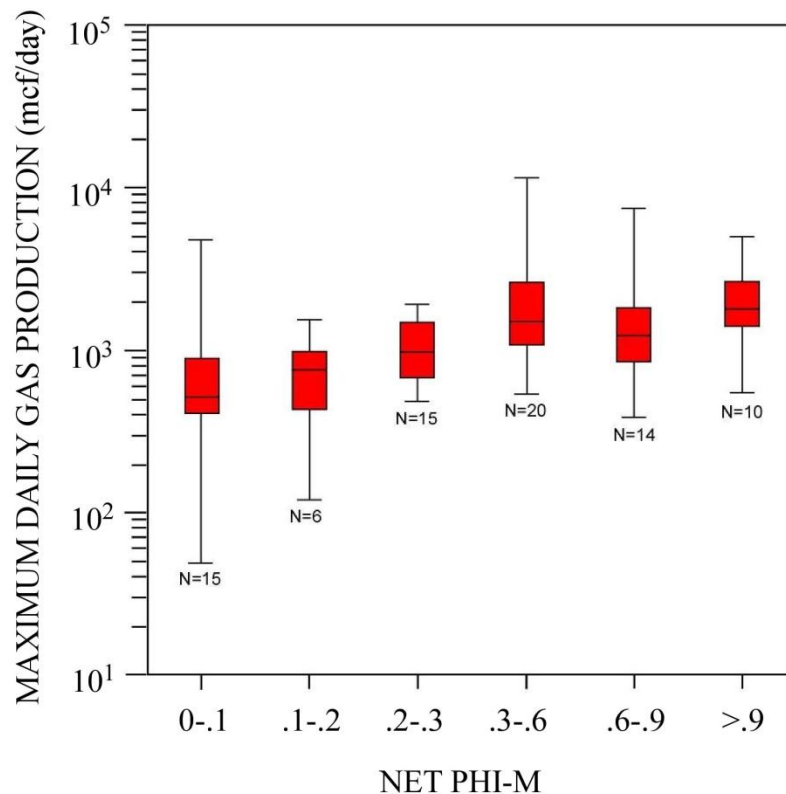


Figure 10. Box and whisker plot comparing net pore-meter thickness to maximum daily gas production. Pore-meter thickness in this study is defined as the interval thickness where density porosity exceeds neutron porosity on well logs when calibrated to a "limestone" matrix, i.e., "gas-effect", multiplied by median porosity across the "gas effect" interval.

Reservoir Quality and Facies

Reservoir quality is commonly facies-specific, because facies represent recurring, homogenous rock properties that are distinguishable from other, interstratified rock. Primary depositional attributes characteristic of facies, and/or facies-specific diagenetic fabrics commonly control variability in reservoir quality. The following discussion presents an evaluation of whether (or not) reservoir quality is predictably related to depositional facies.

Figure 11 provides a "box and whisker plot" that compares facies with core-observed porosity and permeability. Explicit trends in the porosity of individual facies displayed in Figure 11A suggest that depositional facies is a control on reservoir porosity. High energy depositional facies 4, 6, 16, and 17 have the highest mean porosity values with all above 5% (Figure 11A). Three of these facies have low sample population (N), i.e., facies 6, 16 and 17, because they have a naturally low abundance within the Jean Marie. Permeability trends are similar to porosity with the exception of facies 1, 12 and 15 (compare Figures 11A and 11B). Anomalously high permeability values within facies 1, 12 and 15 may be related to comparatively low sample populations. In general, facies with higher values of porosity and permeability coincide with higher-energy environments of deposition.

Reservoir Quality and Facies Associations

Facies associations were also compared with porosity and permeability trends (Figure 12). Facies associations 3 and 4 have the highest range of porosity and permeability, as well as the highest mean and median values (Table 4). Median, rather

than mean values are a more reliable representation of permeability inasmuch as permeability occurs within a logarithmic range.

Table 4. Facies association porosity and permeability summary statistics.

Facies Association	Mean Porosity (decimal fraction)	Median Porosity (decimal fraction)	Mean Permeability (mD)	Median Permeability (mD)
1	0.038	0.033	2.27	0.17
2	0.040	0.034	1.42	0.20
3	0.048	0.044	3.30	0.43
4	0.057	0.064	11.43	1.18
5	0.028	0.028	3.32	0.03

Textural Classification and Reservoir Quality

Grain-supported matrix textures, produced by current-winnowing of carbonate mud, have the highest proportion of interparticle pore types, and accordingly, the highest measureable porosity and permeability (Figure 13). Facies associations 3 and 4 accumulated within high-energy depositional environments, and are grain-rich and have the highest porosity and permeability (Figure 14).

Fracture Occurrence and Facies

Fracture density data were also collected during core description and results are summarized in Figure 15. Despite the fact that the majority of fractures are calcite-filled (Figures 5D, 16A, 16B, and 16C), there is a strong correlation between fracture density and depositional environment. Facies association 3, i.e., the reef framework association (facies 3, 4 and 5), has the highest fracture density (Figure 15B). No clear correlation is observed between the occurrence of calcite cement and facies or facies association.

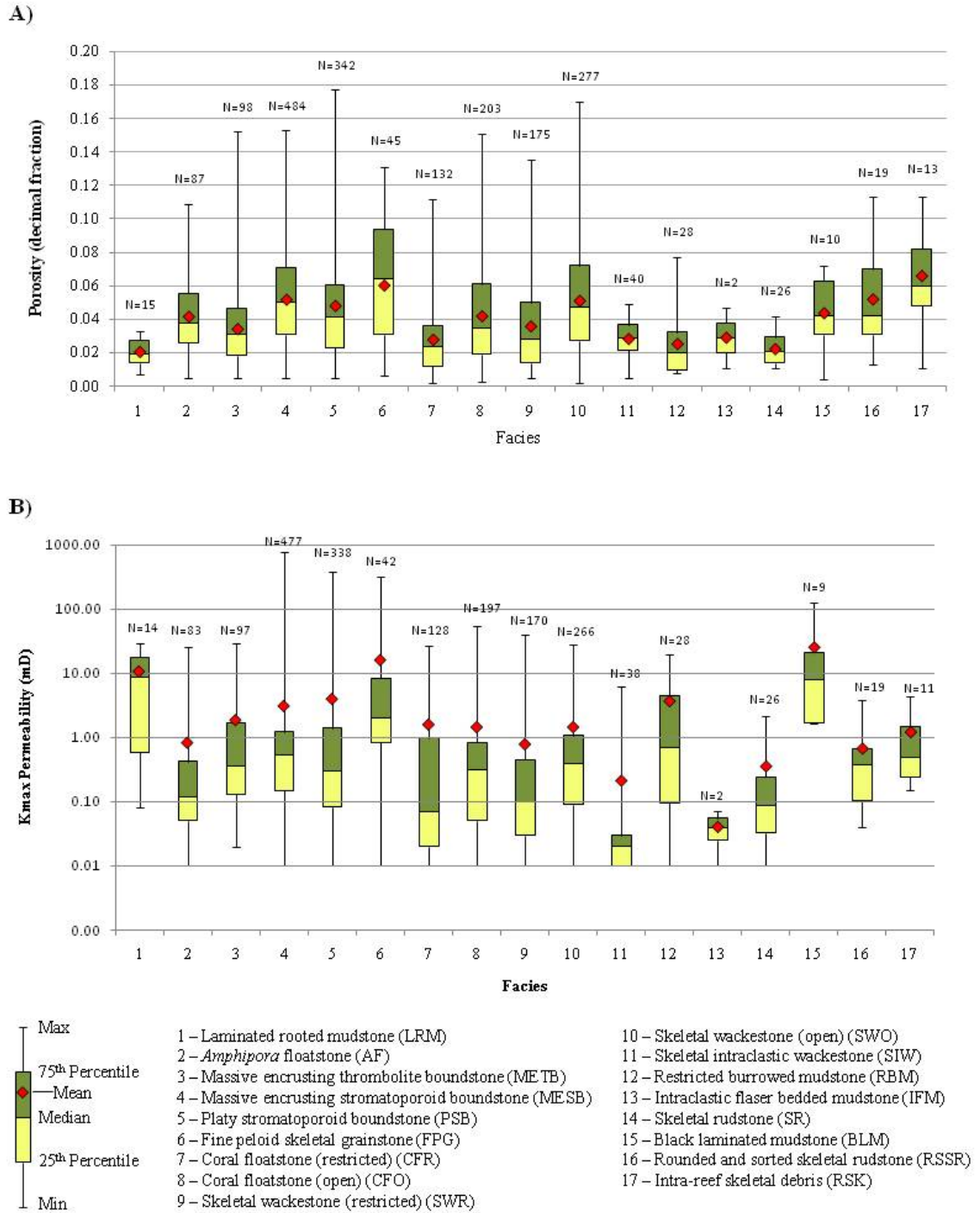
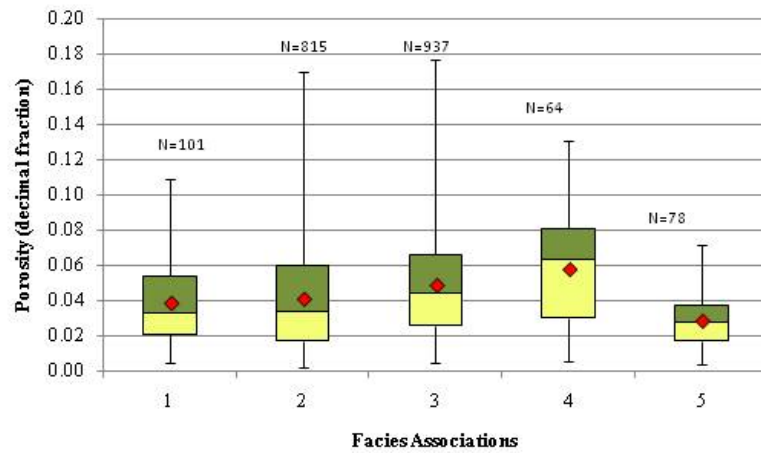
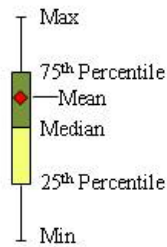
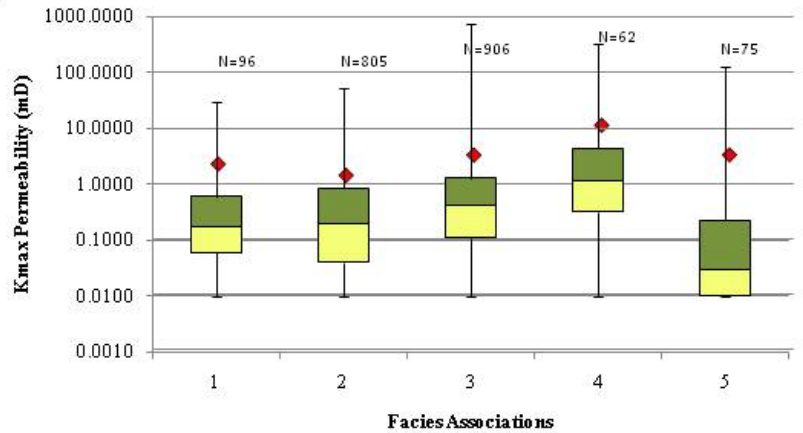


Figure 11. Box and whisker plots that compare facies to both porosity A) and Kmax permeability B). Data are from the analytical analysis of whole core samples. N = sample size.

A)



B)



- 1 – LRM, AF
 2 – CFO, CFR, SWO, SWR, RBM
 3 – MESB, METB, PSB, RSK
 4 – FPG, RSSR
 5 – BLM, IFM, SIW, SR

Facies

- | | |
|---|--|
| 1 – Laminated rooted mudstone (LRM) | 10 – Skeletal wackestone (open) (SWO) |
| 2 – <i>Amphipora</i> floatstone (AF) | 11 – Skeletal intraclastic wackestone (SIW) |
| 3 – Massive encrusting thrombolite boundstone (METB) | 12 – Restricted burrowed mudstone (RBM) |
| 4 – Massive encrusting stromatoporoid boundstone (MESB) | 13 – Intraclastic flaser bedded mudstone (IFM) |
| 5 – Platy stromatoporoid boundstone (PSB) | 14 – Skeletal rudstone (SR) |
| 6 – Fine peloid skeletal grainstone (FPG) | 15 – Black laminated mudstone (BLM) |
| 7 – Coral floatstone (restricted) (CFR) | 16 – Rounded and sorted skeletal rudstone (RSSR) |
| 8 – Coral floatstone (open) (CFO) | 17 – Intra-reef skeletal debris (RSK) |
| 9 – Skeletal wackestone (restricted) (SWR) | |

Figure 12. Box and whisker plots that compare facies association to both porosity A) and Kmax permeability B). Data are from the analytical analysis of whole core samples. N = sample size.

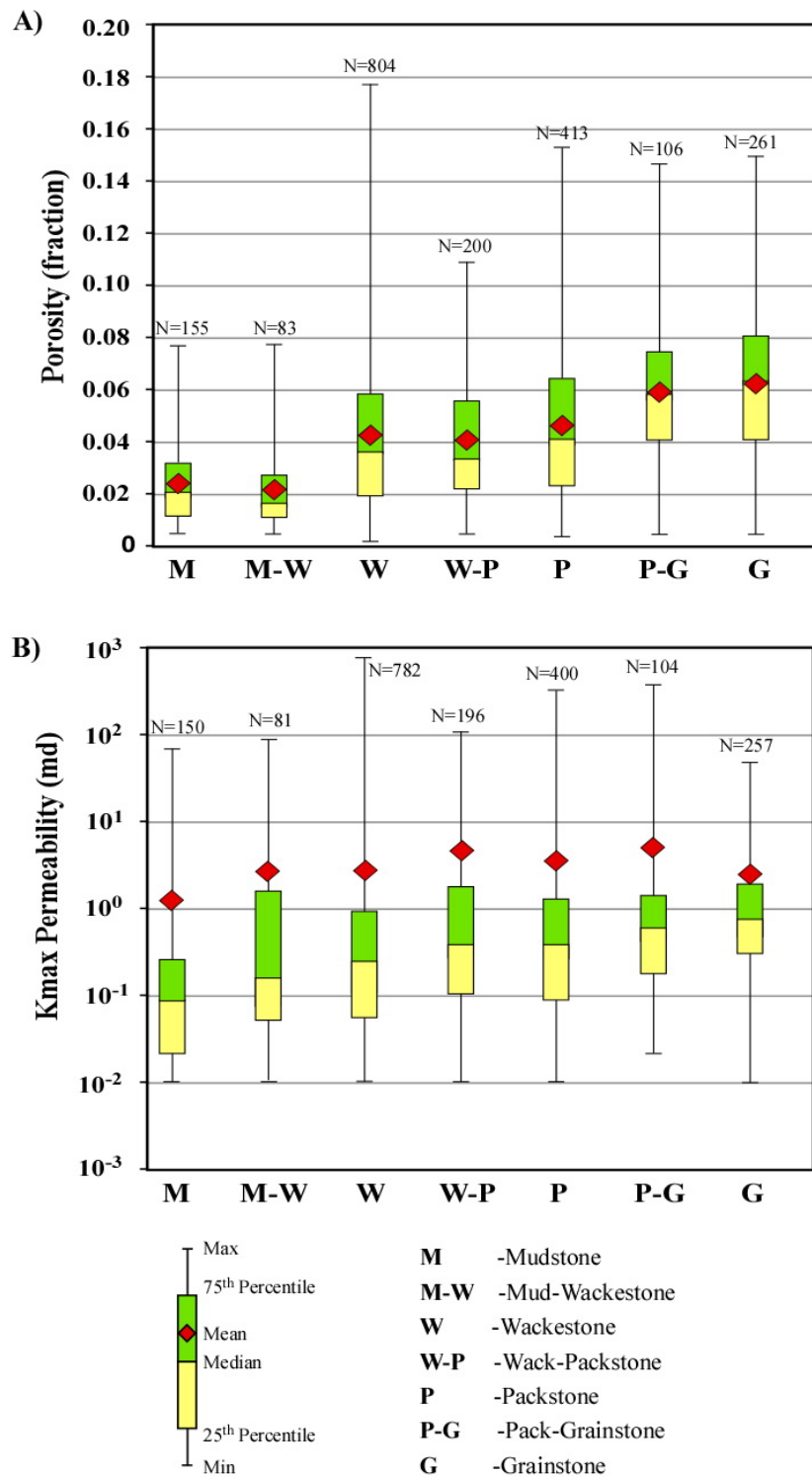


Figure 13. Box and whisker plots that compare matrix texture to porosity A) and permeability B). Data are from the analytical analysis of whole core samples. N = sample size.

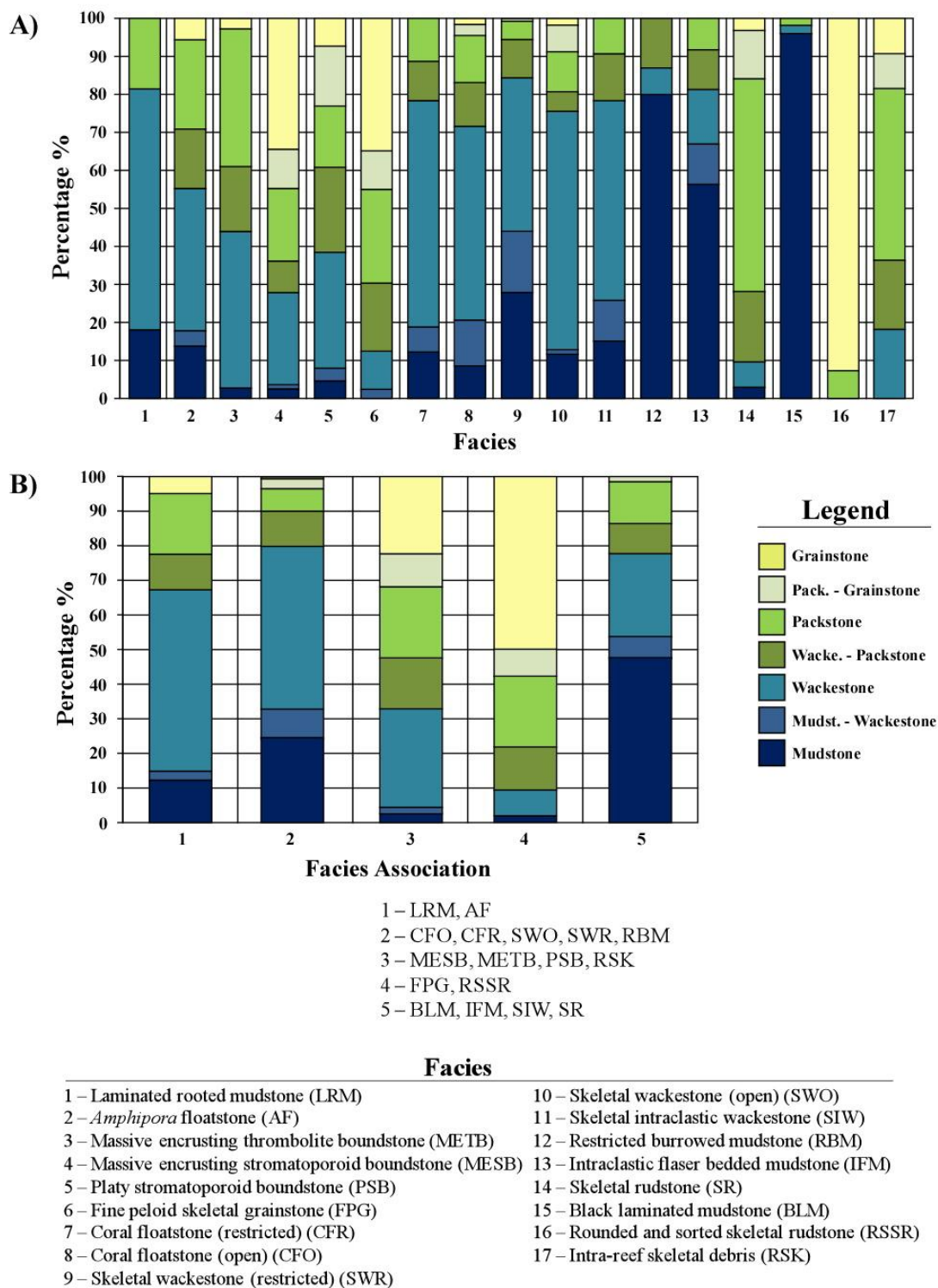


Figure 14. Stacked bar chart of textural proportions by facies A) and facies association B).

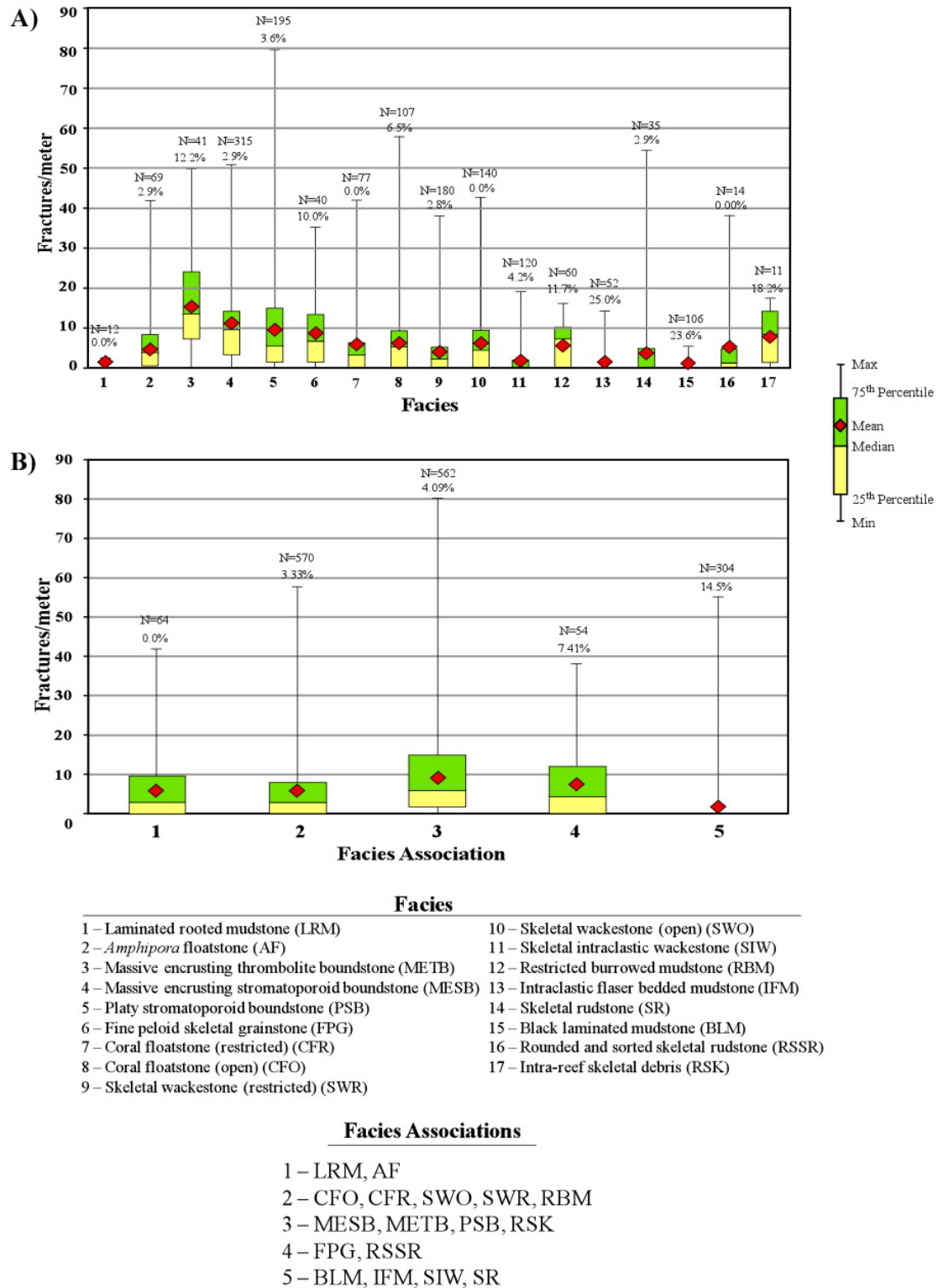


Figure 15. Box and whisker plots that compare facies A) and facies association B) to fracture density. N = sample size. % = percent rubble.

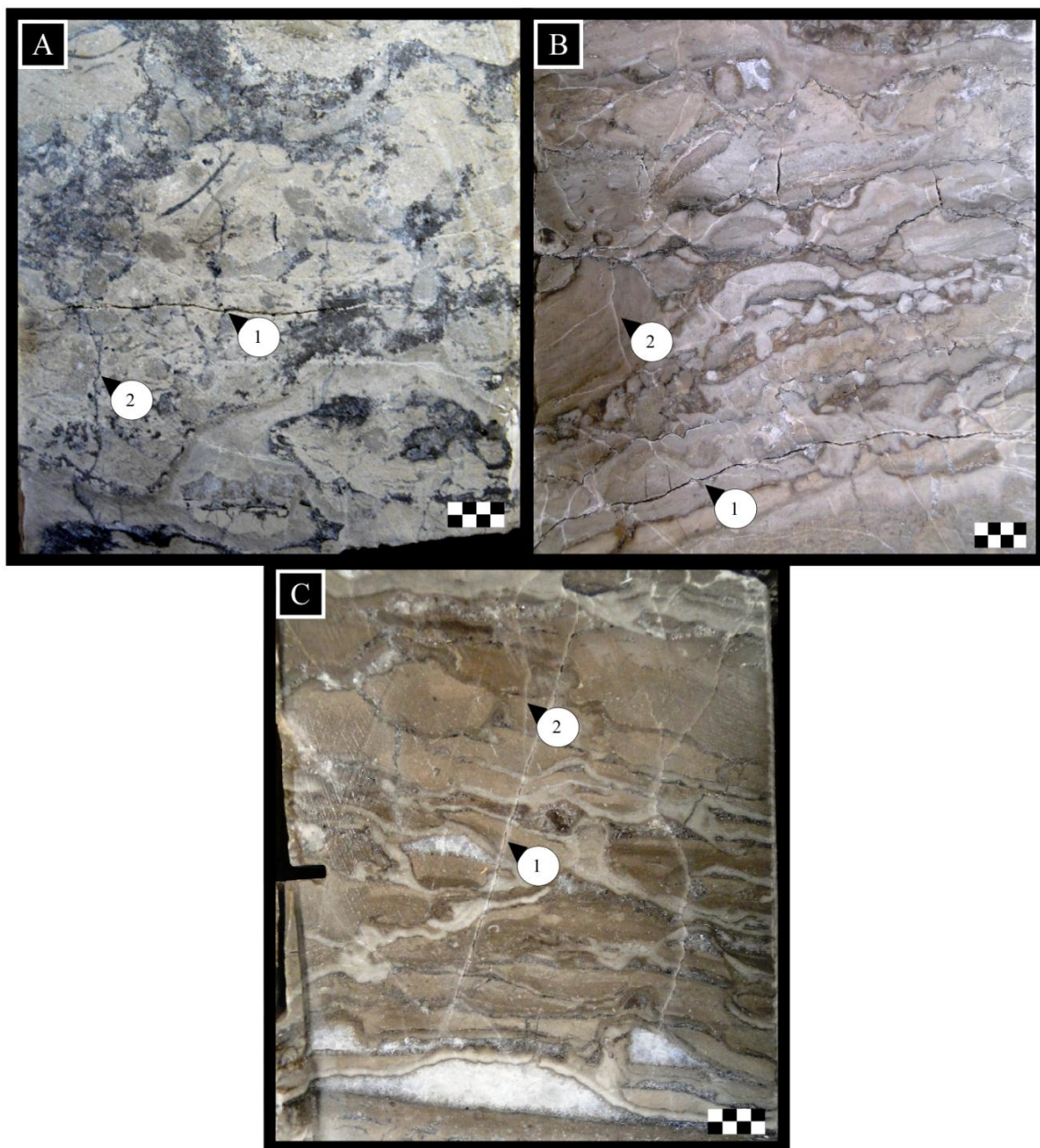


Figure 16. Core photographs of Jean Marie Member facies association 3. Total length of the scale bar is 1 cm. A) METB (facies 3) in well at 200A021H094J01 at 1851m depth. 1) open fracture and 2) calcite filled fracture; B) MESB (facies 4) in well 200D037L094I09 at 967m depth. 1) open fracture and 2) calcite-filled fracture; C) PSB (facies 5) in well 200B086G094I06 at 1490m depth. 1) open fracture and 2) calcite-filled fracture.

CHAPTER FOUR

Sequence-Stratigraphic Framework

Introduction

Deposition of Upper Devonian carbonate strata within the WCSB was influenced by cyclic changes in climate and tectonics (uplift and/or subsidence). As a result, the associated composite effects of relative and/or absolute changes in sea-level produced a nested hierarchy of depositional cycles (i.e., second-order cycles identified by Plint et al. 1992, third-order cycles identified by Johnson 1985, and fourth-order cycles identified by MacNeil 2006). A cycle's "order" refers to its periodicity within a hierarchy of cyclic deposition, which is consistent with terminology outlined by Plint et al. (1992). The Jean Marie Member is the product of such a cyclic hierarchy, and deciphering its nature assists in the prediction of the spatial and temporal distribution of facies associations, and therefore, reservoir bodies.

Cycle Hierarchy

Devonian strata of the WCSB occur within the Kaskaskia cratonic sequence of North America (*sensu* Sloss, 1963). In western Canada, the Kaskaskia sequence is a prolific hydrocarbon system in which reserves are primarily associated with large, reefal stratigraphic traps of Devonian age (Potma et al, 2001). This continental-scale second-order sequence is the product of both tectonic and eustatic changes (Pittman, 1978). Figure 17 summarizes the second-, third- and fourth-order cyclic hierarchy that has been previously documented for the Late Devonian of the WCSB, including the interval of study.

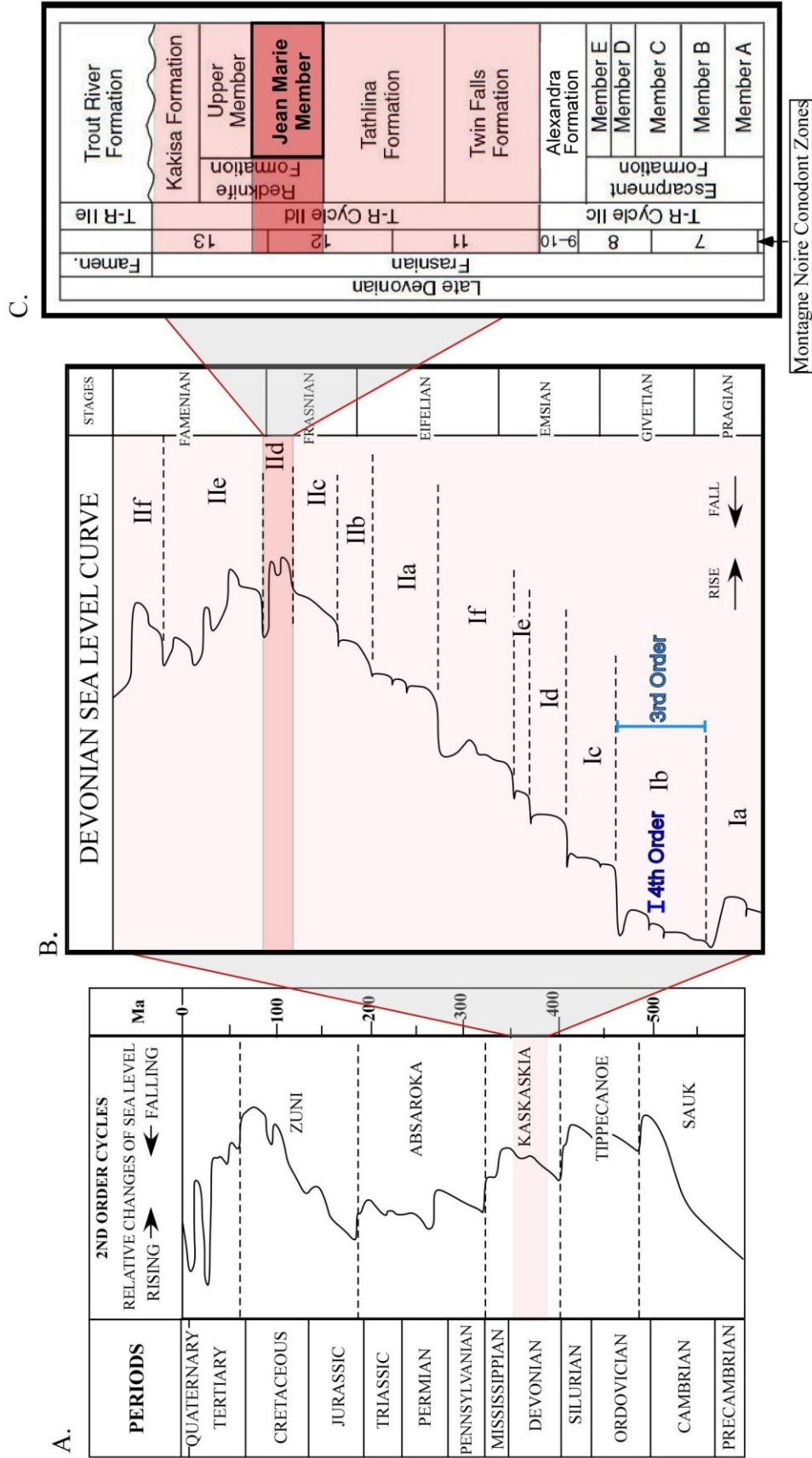


Figure 17. The hierarchy of sea level changes from A) second-order cycles (modified from Plint 1992), third-order cycles (Ia-IIf) and superimposed fourth-order cycles (modified from Johnson 1985). The sea level curve of B) highlights the long-period, second-order Kaskaskia transgression, as well as the third-order Jean Marie "T-R cycle IId" of Johnson (1985). C) Lithostratigraphic correlation chart summarizing the units within the study region that coincide with "T-R cycle IId". Conodont biozones are after Klapper (1985).

Within this cyclic hierarchy, MacNeil (2006) uses the conodont biostratigraphic framework of Klapper (1988) to correlate the third-order "T-R cycles" of Johnson (1985) with Late Devonian lithostratigraphic units of western Canada. From this, MacNeil (2006) indicates that the Jean Marie Member belongs within zone 12, and therefore, the third-order T-R cycle IId of Johnson (1985) (Figure 17C). Using similar biostratigraphic criteria, however, Wendte (2009a) places the Jean Marie Member within zone 13 (Figure 17C). From these constraints, Jean Marie Member is likely a fourth-order depositional cycle within the longer-period, third-order "T-R cycle IId" (Figure 17 B, C).

Sea-level History

Devonian sea level within the WCSB was dominated by second-order Kaskaskia transgression punctuated by higher-frequency shallowing and deepening events (Johnson 1985; Hallam 1999) (Figure 17B). During the second-order transgression, carbonate platforms associated with the Woodbend and Beaverhill Groups backstep across western Alberta (Potma et al., 2001). In the Late Frasnian, however, deceleration of second-order sea-level rise and concurrent third-order cyclicity resulted in progradation of the Jean Marie Member (Winterburn Group) and its equivalent the Nisku Formation in Alberta (Potma et al., 2001).

Within the Jean Marie Member, the presence of recurring meter-scale shallowing-upward facies successions indicate the occurrence of even higher-frequency depositional cycles, i.e., similar in scale and perhaps frequency to the fifth-order cycles of Goldhammer et al. (1990). The shallowing-upward facies successions are bounded by marine flooding surfaces, and therefore, are classified as parasequences (Van Wagoner, 1995). Within the study area, the Jean Marie Member is composed of five meter-scale,

shallowing-upward parasequences (Appendix A). The following discussion summarizes the depositional character and distinguishing features of each parasequence, as well as interrelated facies association distributions. Comparisons will be made between parasequences identified in this study and similar cycles identified by Wendte (2009a) in his study of the Jean Marie.

Distribution and Stacking Patterns of Parasequences

Parasequences 1-5 are progradationally stacked, and are displayed on two regional, east-west, dip-oriented stratigraphic cross sections (Appendix A). Parasequence 1 is the lowermost portion of the Jean Marie and overlies the Fort Simpson Shale. The base of parasequence 1 consists of low-energy, subtidal and occasionally deeper subtidal storm and transgressive lag deposits of facies associations 2 and 5. The parasequence commonly shallows upward into reef and reef flank deposits of facies association 3. Laterally, parasequence 1 gradually downlaps within the central portion of the study area and lacks a discrete reef-framework platform margin. These observations are consistent with a low-relief carbonate ramp (e.g., Ahr, 1973). In a study of the Jean Marie to the north, Wendte (2009a) provides the same interpretation within his first parasequence-scale "T-R cycle" and states that, "the lower stratigraphic interval consists of a thin basal skeletal lag deposit and overlying open-marine limestone ramp deposits." Parasequence 2 similarly downlaps within the central portion of the study area (to the west of parasequence 1), and shallows upward from subtidal (e.g., facies associations 2 and 5) to reefal deposits (facies associations 3). Based upon similar criteria as parasequence 1, parasequence 2 is also interpreted as having accumulated during the ramp phase of the Jean Marie shelf complex, although thicker deposits and more abrupt downlap along the

southern cross section (B-B', of Appendix A) suggest a stratal evolution towards a differentiated shelf margin. Parasequence 2 differs slightly from the succession described by Wendte (2009a). Within his intermediate "T-R cycle", possibly equivalent with parasequence 2, Wendte documented a symmetrical transgressive and subsequent regressive facies succession.

Parasequence 3 extends across the study area and thickens to the west, where it reaches a maximum thickness of 26 m at the terminal reef margin (northern cross-section A-A', of Appendix A). Parasequence 3 is the first parasequence of the rimmed shelf phase of the Jean Marie. Parasequences 3, 4, and 5 comprise the Jean Marie rimmed shelf phase and are all similar in facies distributions and associated stacking trends. Within parasequences 3, 4, and 5, reef facies associations 3 and 4 are present only along the western platform margin. Across the corresponding shelf interior, subtidal deposits of facies association 2 are identified. Following the terminal progradation of parasequence 5, the Jean Marie shelf complex was transgressed and the basinal Upper Redknife Shale Member deposited.

CHAPTER FIVE

Regional Controls on Reservoir Quality

Introduction

Facies distributions within parasequences 1-5 control the exploration-scale distribution of reservoir bodies. Reservoir bodies are preferentially associated with shallow reef depositional environments (i.e., facies association 3). Although the spatial distribution of reservoir bodies is predictably related to the progradational nature of the Jean Marie shelf system, the relative quality of these bodies is related to the spatial variability of depositional texture and fracture density. Strategies of exploration should take into account all of these attributes.

Facies Association

Figure 18 depicts the distribution of dominant facies association across the study area. Conspicuously, the distribution of facies association 3 (platform top or margin buildup) spatially coincides with the distribution of grain-supported matrix textures (Figure 19), high fracture density (Figure 20), highest gross interval thickness where density porosity (i.e., porosity identified using borehole bulk density logs) exceeds 3% (Figure 21), and highest pore volume (Figure 22). Facies association 3 occurs within three north-south trending fairways that were produced in response to westward progradation of the carbonate shelf through time. The fairways located in the central and eastern portion of the study area (Figure 18) are likely associated with parasequences 1 and 2 (Appendix A). Because parasequences 1 and 2 accumulated as ramp carbonates,

wave energy, and associated stromatoporoid reefal buildups, were concentrated within shallower-water areas located along the eastern portion of the study area. Succeeding

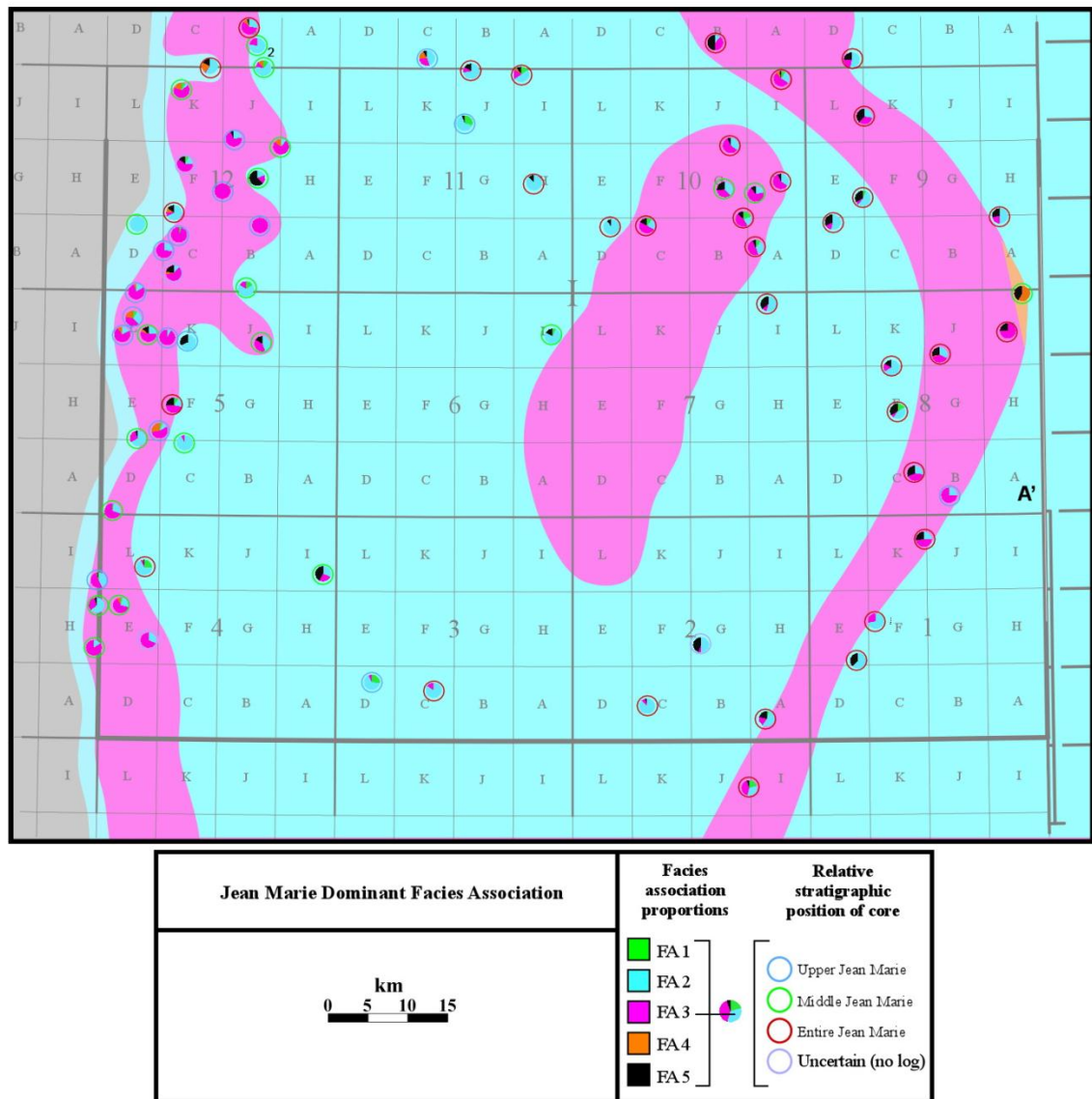


Figure 18. Core observed dominant facies associations within the Jean Marie. The bold east-west black lines labeled (A-A') and (B-B') are detailed stratigraphic cross sections provided in Appendix A. Pie diagrams for wells with Jean Marie core indicate the percent facies association.

progradation of parasequences 3-5 culminate in a rimmed shelf margin and a thick, north-trending succession of facies association 3 along the western edge of the map area (Figure 18).

Matrix Texture

The distribution of grain-supported rock textures closely coincides with the distribution of facies association 3 (compare Figures 18 and 19). The close relationship between matrix texture and facies association is demonstrated within Figure 14.

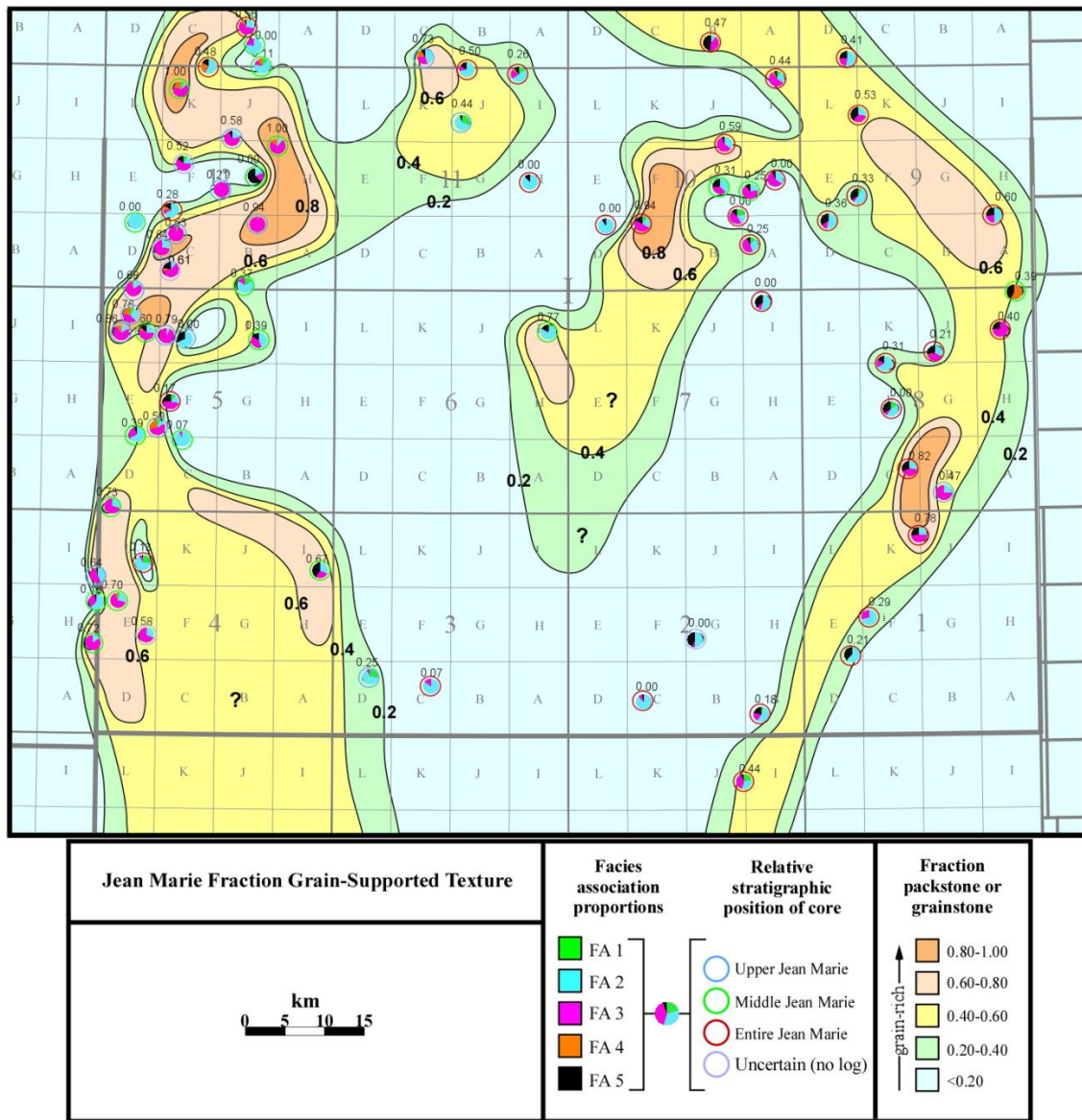


Figure 19. Core observed fraction of grain-supported texture within the Jean Marie. The number above each core location is the decimal fraction of packstone/grainstone textures. Pie diagrams for wells with Jean Marie core indicate the percent facies association.

High-energy conditions associated with stromatoporoid reef accumulation winnowed away carbonate mud and concentrated coarser-grained sediment within growth framework pore space.

Fracture Density

The distribution of highly fractured rocks also corresponds with the distribution of facies association 3 (compare Figures 18 and 20). This correlation is likely owing to the occurrence of large primary pore networks between rigid, but brittle intergrown stromatoporoid growth framework skeletal elements (Figure 5D). Fracture networks and open-growth framework porosity is commonly occluded with coarsely-crystalline, clear sparry calcite cement (Figure 5D).

Porosity

Gross interval porosity thickness and net pore-volume thickness both coincide with facies association, texture and fracture distributions across the study area (compare Figures 18, 19, 20, 21 and 22). Figures 12 and 13 establish the close correlation between porosity, facies association and matrix texture. Facies associations 3 and 4 are characterized by grain-dominated matrix textures (Figure 14) and associated interparticle porosity.

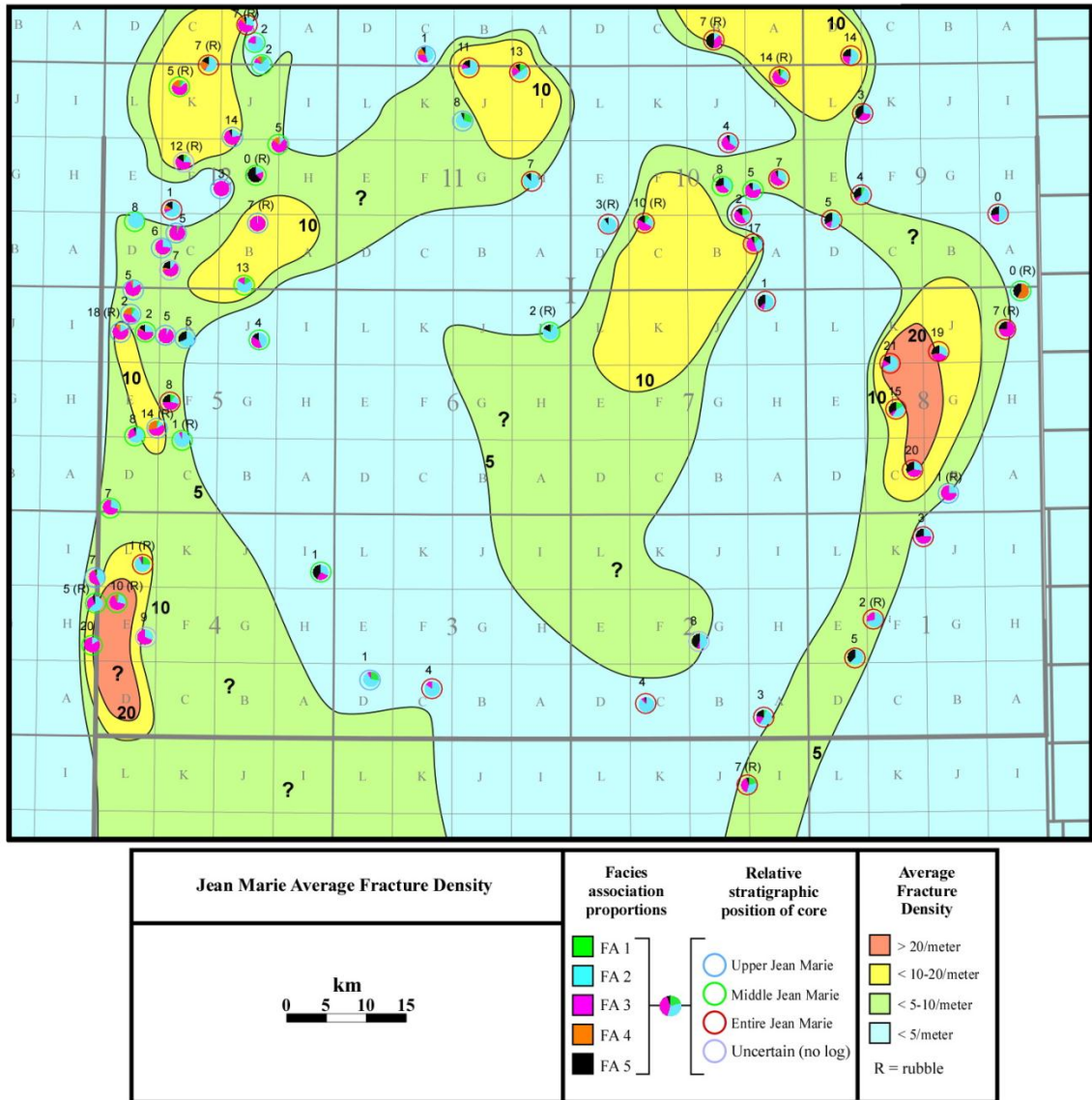


Figure 20. Core observed average fracture density within the Jean Marie. Pie diagrams from wells with Jean Marie core indicate the percent facies association. Numbers above pie diagrams are fractures per meter, and the notation "(R)" refers to core recovery as rubble.

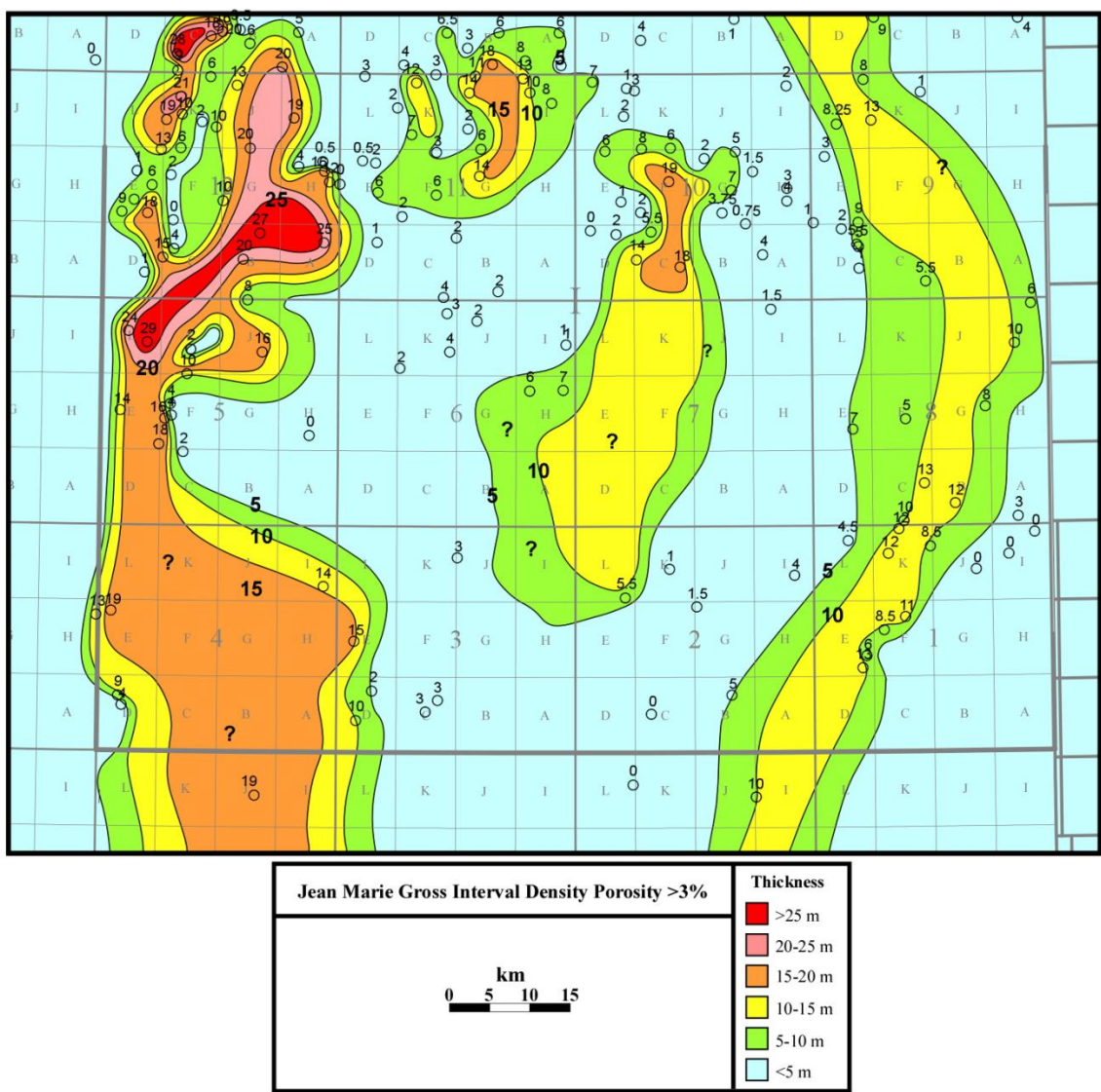


Figure 21. Jean Marie gross interval thickness where density porosity exceeds 3%.

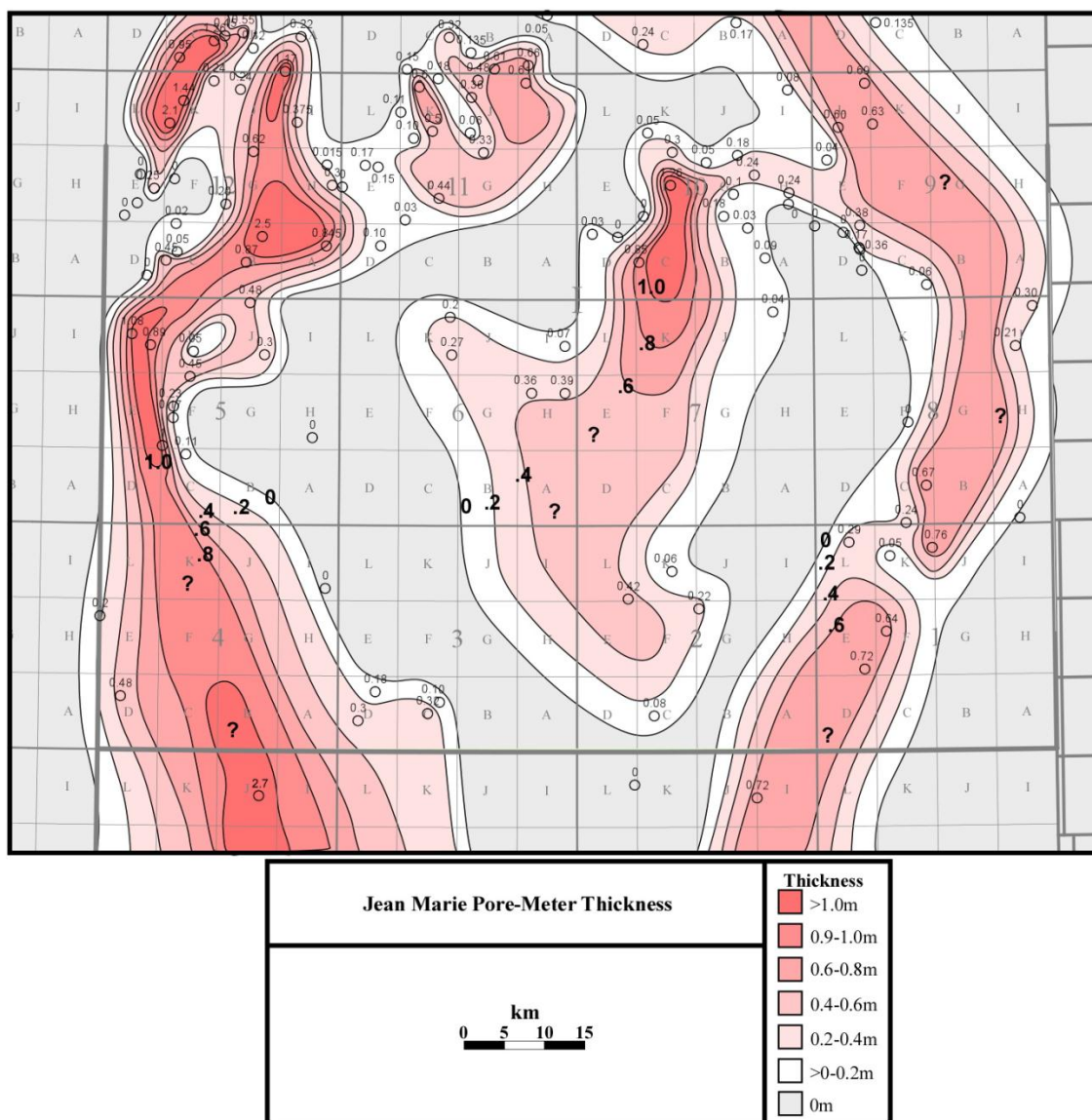


Figure 22. Jean Marie pore-meter thickness within gas-saturated reservoir intervals as indicated by density porosity exceeding neutron porosity on well logs calibrated to a "limestone" matrix, i.e., calcite mineralogy.

CHAPTER SIX

Conclusions

1. The Jean Marie Member of the Redknife Formation is composed of 17 facies deposited within a shallow epeiric sea. Facies accumulated within intertidal, subtidal, and reefal environments, and are grouped in five facies associations on the basis of sedimentological attributes and environments of deposition.
2. Reservoir quality correlates closely with facies association and texture. Porosity and permeability increase with increasingly grain-supported textures. The highest porosity and permeability is associated with the most grain-rich examples of facies association 3.
3. The Jean Marie Member is composed of 5 shallowing-upward, progradational parasequences that potentially partition the Jean Marie into discrete flow units. Due to a lack of closely-spaced well control, this possibility could not be confirmed.
4. The Jean Marie evolved from a low-relief carbonate ramp (parasequences 1-2) into a high-relief rimmed shelf complex (parasequences 3-5).
5. Three north-south fairways of high reservoir quality occur within the study area and coincide with the following mapped reservoir attributes including: dominant facies association 3, dominant grain-supported matrix texture, high fracture density, and porosity. The alignment and distribution of the fairways reflects shelf progradation through time. The eastern and central fairways developed in the early carbonate ramp phase of the Jean Marie, and the westernmost fairway within the terminal margin of a rimmed shelf.

APPENDICES

APPENDIX A

Detailed Stratigraphic Cross Sections

This file is available in BEARdocs (<http://beardocs.baylor.edu>)

under the file name Curtis_Barclay_AppendixA

APPENDIX B

Core Descriptions from UWI starting with 200-A

JEAN MARIE / KAKISA CORE LEGEND

GRAINS

- PELOIDS  INTRACLAST
- OOLIDS  LITHOCLAST
- ⊕ ONCOIDS SK SKELETAL UNDIFF
- Y AMPHIPORA G GASTROPOD
- ~ WAFER STROMS  THROMBOLITE / CYANOBACTERIAL BINDING
- ≡ PLATY STROMS  BULBOSUS STROM
- ≡ MASSIVE ENCRUSTING STROMS  STROM. FRAGMENTS
- ⌈ CYLINDRICAL STROMS  FORAMINIFER
WT SERPULID WORM TUBES
- ⊗_{TH} THAMNOPORA  SYRINGOPORA
- ⊗_R RUGOSECORAL  OST OSTRACOD
- ⊗_T TABULATE CORAL  BRYOZOAN
- Y BRACHIOPOD  MEGALODONT
- ⊙ CRINOID  BIVALVE
- ≡ RENALCIS
- AM AMMONITE WT = WORM TUBE (CALCAREOUS)

SED. STRUCTURES

POROSITY

- ~ FLASER
- ~ CURRENT RIPPLE BP INTERPARTICLE
- ~ WAVE RIPPLE WP INTRAPARTICLE
- ~ TROUGH XBED MD MOLDIC
- GEOPETAL V MUDCRACK V VUGGY
- TG GRADED  PLANAR F FRACTURE
HORIZONTAL
- ~ SCOUR GF GROWTH FRAMEWORK
- ~ HARDGROUND  BC INTERCRYSTALLINE
SERRATE
STYLOLITE
WISPY
STYLOLITE
- U BURROW F FENESTRAL
- ~ CRINKLY LAMINA
- = mm HORIZONTAL LAMINA
- ≡ DIGITATE STROMATOLITE  DUMAL STROMATOLITE

Project/Location: JEAN MARIE
A-2-G-94-I-10
Date: 5/16/2011

Logged By: ATCHLEY
Page 1 of 1

Length	Texture				Facies	Grains	Sed. Struct.	Visible Porosity		Fracture		Stylolite		Photo	Sample	Comments
	M	W	P	G				Rel. Abun.	Type(s)	Freq.	Cement	Freq.	Type			
1185						CORE TOP										
					IFM			-		0						
					BLM			-		0						
					SW(CO)	SK		-		0					5-16-11-12.5A	
					BLM			-		0						
					BLM			-		0						
					IFM	SK		-		0					5-16-11-11.5A	
1190								-		0						
					SIW	SK		-		0						
								-		0						
								-		0					5-16-11-10.5A	
					BLM			-		0						
								-		0					5-16-11-9.5A	
					AF	SK		-		1	C				5-16-11-8.5A	CORE - 0.5m = LOG DEPTH
								-		2						
								-		2					5-16-11-7.5A	
1200					SW(R)	SK		-		2	C					
								-		0					5-16-11-6.5A	
					PSB	SK		-		0					5-16-11-5.5A	
								-		0						
					MESB	SK		-		27	C				5-16-11-3.5A	
					SW(R)	SK		-		0					5-16-11-2.5A	
					SIW	SK		-		0					5-16-11-1.5A	
1210						CORE BOTTOM										

Core diameter = 8.5cm

Metric Units (2.5cm = 3m)

CORE DEPTH - 2m = LOG DEPTH

Project/Location: JEAN MARIE
00-A-009-F-094-I-12
 Date: 7-23-10

Logged By: ATCHLEY
 Page 1 of 2

Length	Texture					Facies	Grains	Sed. Struct.	Visible Porosity		Fracture		Stylolite		Photo	Sample	Comments
	M	W	P	G	B				Rel. Abun.	Type(s)	Freq.	Cement	Freq.	Type			
1524											3	C					
1525							DITTO				3	C	7				LIGHTER COLOR
1526							DITTO				1		6				
1527						SWCR					1		13			7-23-10-20SA	
1528											3		12			7-23-10-19SA	
1529						PSB	SK				3		9				
1530						SW	SK				4	C	3			7-23-10-18SA	
1531						PSB	SK						6				
1532						AF	SK									7-23-10-17SA	
1533							SK				3	C				7-23-10-16SA	
1534						SWCR	SK										
1535							SK									7-23-10-15SA	
1536							SK				4	C					Throughgoing solution-enlarged fracture
1537						SLW	SK						30			7-23-10-14SA	
1538																	
1539																	
1540						RBM											VIRTUALLY DEVOID OF FOSSILES
1541																7-23-10-13SA	
1542																	
1543																7-23-10-12SA	
1544																	
1545						IFAL											
1546						BLM										7-23-10-11SA	
1547																	
1548						IFM										7-23-10-10SA	
1549						BLM											

Core diameter = 9cm

CORE BASE

Metric Units (2.5cm = 3m)

CORE + 0.5m = LOG DEPTH

Date: 7-23-10

Logged By: ATCHLEY

Page 2 of 2[illegible]

Core diameter = 9 cm

Metric Units (2.5cm = 3m)

Logged By: ATCHLEY
Page 1 of 1

Core diameter = 10 cm

CORE DEPTH - 1 M = LOG DEPTH

Logged By: JSM

Page 1 of 1

Length	Texture				Facies	Grains	Sed. Struct.	Visible Porosity		Fracture		Stylolite		Photo	Sample	Comments
	M	W	P	B				Rel. Abun.	Type(s)	Freq.	Cement	Freq.	Type			
1850					MESB	⊗ _{Th} ≈ γ _{Qn}			BP	25	C					To me 13 mm of a Therapsid bone affected dominated by these
1851					MESB	⊗ _{Th} ≈			BP	25	C					
1852					MESB	↑										
1853						≈ 4 ∞ ⊗ _{Th}			BP	20	C					
1854						≈ 2 ∞ □ _o				20	C					
1855						≈ 2 ∞ □ _o				30	C					
1856						≈ 2 ∞ ⊗ _{Th}			BP	30	C					
1857						≈ 2 ∞ ⊗ _{Th}			BP	20	C					
1858						≈ 2 ∞ ⊗ _{Th}			BP	35	C					
1859					MESB	≈ 2 ∞ ⊗ _{Th}			BP	20	C					
1860					MESB	≈ 2 ∞ ⊗ _{Th}			BP	7	C					
1861					MESB	≈ 2 ∞ ⊗ _{Th}			BP	25	C					
1862					MESB	≈ 2 ∞ ⊗ _{Th}			BP	5	C					
1863					MESB	≈ 2 ∞ ⊗ _{Th}			BP	15	C					
1864					MESB	≈ 2 ∞ ⊗ _{Th}			BP	7	C					
1865					MESB	≈ 2 ∞ ⊗ _{Th}			BP	15	C					
1866					BBM				BP	15	C					
1867									BP	15	C					

Base of cone = 1867.9 (0.3 m not recovered)

Metric Units (2.5cm = 3m)

core depth = log depth (Based on resistivity change at RBM to PSB transition)

Project/Location: JEAN MARIE
00-A-023-I-094-I-04-U Logged By: ATCHLEY
 Date: 7-26-2010 Page 1 of 1

Length	Texture M W P G B	Facies	Grains	Sed. Struct.	Visible Porosity Rel. Abund. Type(s)	Fracture Freq. Cement	Stylolite Freq. Type	Photo	Sample	Comments
5310'										
5320'										
5330'										
5340'										
5350'										
5360'										
5370'										
5380'										

Core diameter = 9 cm CORE BASE Imperial Units (1" = 10')

Project/Location: JM A-29-C/94-I-12

Logged By: AISLIN TRENDELL

Date: 5-17-2011

Page 1 of 1

Length	Texture				Facies	Grains	Sed. Struct.	Visible Porosity		Fracture		Stylolite		Photo	Sample	Comments
	M	W	P	G				Rel. Abun.	Type(s)	Freq.	Cement	Freq.	Type			
1490																
1492m																
					RGM		UT			1	C			5-17-11-17AT		
										1	C					
1495										0	C			5-17-11-16AT		
					SW					1	C					
										1	C			5-17-11-15AT		
										19	C					
					PSB					0				5-17-11-14AT		
														5-17-11-13AT		
1500m					MESB					1	C			5-17-11-12AT		
					FPA					0				5-17-11-10AT ← 200m 5-17-11-11AT		
										4	C			5-17-11-9AT		
										25	C					
					MESB					4	C			5-17-11-8AT		
										9	C			5-17-11-6AT ← 5-17-11-7AT 200m		
										17	C			5-17-11-5AT		
1505										3	C			5-17-11-4AT		
					FPA					6	C			5-17-11-3AT		
										5	C					
					MESB					12	C			5-17-11-1AT		
										21	C					
										1	C			5-17-11-2AT		
1510.0																MISSING
1511																

Core diameter = 10cm

Metric Units (2.5cm = 3m)

* NO WELL LOG AVAILABLE

Project/Location: A-32-E-94-I-4

Logged By: JSM

Date: 5/16/11

Page 1 of 1

[illegible]

Core diameter = Slabbed 8.5 cm

Metric Units (2.5cm = 3m)

Depth shift unknown (no log available)

Jean Marie

Project/Location: a-3L-K/94-I-5

Logged By: Curtis Barclay

Date: 5-16-2011

Page 1 of 1

Length	Texture					Facies	Grains	Sed. Struct.	Visible Porosity		Fracture		Stylolite		Photo	Sample	Comments
	M	W	P	G	B				Rel. Abun.	Type(s)	Freq.	Cement	Freq.	Type			
1520						STW	□ □ _{TH}		-		0				5-16-11 7CB		
1521						STW R & M			-		R						
1522						BLM	↑ ↑ _{10%}		-		R						
1523						BLM			-		R						
1524						BLM			-		R				5-16-11 6CB		
1525						BLM	↓		-		R						rubie
1526						BLM					3	C			5-16-11 5CB		
1527						RBM	• ⊕		-		0						
1528						RBM	• ⊕		-		0						
1529						RBM	• ⊕		-	VP	0				5-16-11 4CB		
1530						RBM	•		-	F	1						
1531						RBM	•		-		0						very few grains
1532						RBM	•		-		0						
1533						RBM	• ⊕		-		0				5-16-11 3CB		
1534						RBM	□ •		-		4	C					is STW (34cm)
1535						CFR	⊕ R □ R3		-		0						
1536						SWO/SW	□ SK • ⊕		-	F	13	C					
1537						SWO/SW	□ SK •		-	F	26	C			5-16-11 2CB		23 cm of crinoid lamina broken up (Rubeel)
1538						SWO/SW	□ SK • ⊕		-	F	10	C			5-16-11 1CB		
1539						SWO/SW	□ SK •		-	F	7	C					
1540						SWO/SW	□ SK •		-	F	8	C					15 cm of 1 cm (broken up) - crinkly lamina
1541						SWO/SW	□ SK •		-		9	C					

Core diameter = 8.5 cm

Metric Units (2.5cm = 3m)

Depth Shift: Core depth - 1 meter = log depth

Logged By: JSM

Date: 7/23/10

Page 1 of 1

[illegible]

Core diameter = 9.5 (cone is busted up pretty bad cannot trust depths)

Metric Units (2.5cm = 3m)

Project/Location: Jean Marie
00/A-40-K/094-I-05/2
Date: 5-17-2011

Logged By: Curtis Barclay
Page 1 of 1

Length	Texture				Facies	Grains	Sed. Struct.	Visible Porosity		Fracture		Stylolite		Photo	Sample	Comments
	M	W	P	G				Rel. Abun.	Type(s)	Freq.	Comment	Freq.	Type			
1539					RBM	none				0				5-17-2011	5CJB	some laminations mostly mud
1540					MESB					2	C					
1541					MESB					7	C			5-17-2011	4CJB	grainy
1542					MESB					9	C					moving to less large GF pores starting to look grainy
1543					MESB					7	C					
1544					MESB					13	C					high fractures
1545					MESB					5	C					
1546					MESB					5	C					lots of shams again and fractures
1547					MESB					1	C			5-17-2011	3CJB	low amount of shams but same facies
1548					MESB					2	C					see a change to less shams than top and less fractures
1549					MESB					4	C					large GF pores and all filled with calcite
1550					MESB					6	C			5-17-2011	2CJB	(change in same 2 grains)
1551					MESB					3	C					same 2
1552					MESB					5	C			5-17-2011	1CJB	Gravel fragments of filled with calcite

553 Bottom

Core diameter = 8.5cm

Metric Units (2.5cm = 3m)

Depth Shift = (unknown)

Project/Location: Jean Marie 001A - CH - L094-1-09/10

Logged By: KELLY JONES

Date: 05/16/2011

Page 1 of 1

Length	Texture				Facies	Grains	Sed. Struct.	Visible Porosity		Fracture		Stylolite		Photo	Sample	Comments
	M	W	P	G				Rel. Abun.	Type(s)	Freq.	Cement	Freq.	Type			
10960					SWR	JSR				1	C					
						OR				6	C					
										1	C					
					PSB				F _{Mo}	3	C					some fractures have no fill
										1	C					some fractures have no fill
										4	C					
10966					MESB	JSR				8	C					05/16/11-19KS 05/16/11-18KS
1097										5	C					05/16/11-14KS 05/16/11-13KS
1098					PSB					3	C					05/16/11-12KS 05/16/11-11KS
					SWR					3	C					05/16/11-10KS
1100					SWR					1	C					
1101					SWR					0						
1102					SIW					2	C					05/16/11-9KS 05/16/11-8KS
1103					SIW					0						05/16/11-7KS 05/16/11-6KS
					SIW					0						05/16/11-5KS 05/16/11-4KS
1105					IFM	node				0						05/16/11-3KS 05/16/11-2KS
1106						none				0						Grades into IFM
1107					BUM	none				0						05/16/11-1KS
1108						none				0						
1109																

Core diameter = 8.5

Metric Units (2.5cm = 3m)

core depth = log depth

Project/Location: Im A-43-L/94-I-5

Logged By: AISLIN TRENDEN

Date: 5.16.2011

Page 1 of 2

Length	Texture					Facies	Grains	Sed. Struct.	Visible Porosity		Fracture		Stylolite		Photo	Sample	Comments
	M	W	P	G	B				Rel. Abun.	Type(s)	Freq.	Comment	Freq.	Type			
						PSB	See above for details				2	C					
											4	C				5-16-11-10-AT	
						MESB			GF, BC, WP		0	X					
1550											0	X				5-16-11-15-AT	
											1	C					
						PSB			GF WP		0	X				5-16-11-14-AT	
											0	X				5-16-11-13-AT	
											2	C					
						SWR					2	C					
											1	C				5-16-11-12-AT	
																5-16-11-11-AT	
											2	C					* MAT
						MESB			GF WP		1	C				5-16-11-10-AT	
											1	C				5-16-11-8-AT	
1560						CFO					1	C				5-16-11-9-AT	
						MESB			GF		0	X				5-16-11-7-AT	
											0	X				5-16-11-6-AT	
											2	C					
											0	X					
						SWR					3	C					
											5	C				5-16-11-5-AT	
											1	C				5-16-11-4-AT	
						MESB			GF		5	C				5-16-11-3-AT	
											1	C					
											2	C					
1570						SW			0.5-1% WP		2	C				5-16-11-2-AT @ 1419.5m	
											1	C				5-16-11-1-AT @ 1420m	
											1	C					
592																	MISSING

Core diameter = 10cm

CORE BOTTOM

Metric Units (2.5cm = 3m)

* CORE DEPTH = WELL LOG DEPTH

Project/Location: Jm A-43-L/94-I-5

Date: 5.16.2011

Logged By: AISLYN TRENDEN

Page 2 of 2[illegible]

Core diameter = 10 cm

Metric Units (2.5cm = 3m)

* CORE DEPTH = WELL-LOG DEPTH

Date: 5/16/2011

Logged By: ATCMLEY

Page 1 of 1[illegible]

Core diameter = 8.5 cm

Metric Units (2.5cm = 3m)

CORE DEPTH = LOG DEPTH?

Project/Location: Jean Marie
a-47-D/94-I-3
Date: 5-17-2011

Logged By: Curtis Barclay (CJB)
Page 1 of 1

Length	Texture				Facies	Grains	Sed. Struct.	Visible Porosity		Fracture		Stylolite		Photo	Sample	Comments
	M	W	P	G				Rel. Abun.	Type(s)	Freq.	Cement	Freq.	Type			
1717					SWO	SK = B @ R @ T				0						[wackestone matrix very muddy with occasional large grains]
1718					SWO	SK = B @ T G				3				5-17-11 11 CJB		
1719					SWO CFO	SK = B				6						
1720					CFO	@ T ~ @ R SK				0						
1721					CFO	@ T SK G □				0						one aneal
1722					CFO	@ TH @ A @ T @ SK				6				5-17-11 10 CJB		very similar to SWO but with some large carys
1723					SWO	SK G @ T				2						
1724					SWO	SK G @ T				2						
1725					SWO	SK G @ T				1				5-17-11 9 CJB		some BP pores
1726					SWO	SK G ~				0						very little pore space
1727					PSB	~ @ TH				2	C					last of the PSB (still low porosity)
1728					PSB	~ @ T				1	C					some areas look like MESB but mostly PSB
1729					PSB	~ @ TH @ R SK				0				5-17-11 10 CJB		very muddy wackestone matrix
1730					MESB CFO	~ @ A R				2	C			5-17-11 7 CJB		very short interval of MESB
1731					CFO	@ TH □ @ T SK				3	C					few large open fractures
1732					CFO	@ TH □ @ T SK				2	C			5-17-11 6 CJB		some open pore fractures (few)
1733					CFO	@ TH □ @ T SK				0						
1734					SIW	SK @ T ~				0						

Core diameter = 9.5 cm

Metric Units (2.5cm = 3m)

Depth shift = (unknown)

Project/Location: 00/A-049-F/044-1-05/0 J.M.

Logged By: JSM

Date: 5/17/11

Page 1 of 2

Length	Texture				Facies	Grains	Sed. Struct.	Visible Porosity		Fracture		Stylolite		Photo	Sample	Comments
	M	W	P	G				Rel. Abun.	Type(s)	Freq.	Cement	Freq.	Type			
1599					↑	~ ~ ~				25	C			← 5-17-11-18-JM		oolitic, bubble grains
1600					↑	~ ~ ~				10	C					oolitic matrix
1601					↑	~ ~ ~		BP		6	C			← 5-17-11-17-JM ← 5-17-11-16-JM		columnar, irregular pockets of peloidal highly porous
1602					↑	~ ~ ~		BP		5	C			← 5-17-11-15-JM		
1603					CF(R)	~ ~ ~		BP		0				← 5-17-11-14-JM ← 5-17-11-13-JM		
1604					↑	~ ~ ~				5	C			← 5-17-11-11-JM		
1605					↑	~ ~ ~				4	C			← 5-17-11-12-JM		
1606					↑	~ ~ ~				5	C			← 5-17-11-10-JM		
1607					↑	~ ~ ~				10	C					
1608					↑	~ ~ ~		N		3	C			← 5-17-11-9-JM		Dark carbonate
1609					PSB	~ ~ ~		N	N	6	C			← 5-17-11-8-JM		
1610					↑	~ ~ ~				7	C			← 5-17-11-7-JM		Skagnum very small reduction in body fossil density
1611					↑	~ ~ ~		N		6	C			← 5-17-11-6-JM		Dark carbonate - planar bedded
1612					↑	~ ~ ~				5	C					Grained, stony, irregular - laminar texture. Branches small
1613					↑	~ ~ ~				5	C					many & somewhat laminar texture
1614					↑	~ ~ ~				10	C			← 5-17-11-5-JM		
1615					↑	~ ~ ~		N		8	C					
1616					↑	~ ~ ~				6	C					
1617					↑	~ ~ ~				5	C					
1618					↑	~ ~ ~		N		6	C					Branches in matrix between grains
1619					IFM	~ ~ ~				5	C					
1620					SIW	~ ~ ~		N		10	C			NAME=4 ← 5-17-11-3-JM		Ignorant of place of pyrite
1621					IFM	~ ~ ~										carbonate volume upwards clay decreases Branches along bedding decreases with
1622					IFM	~ ~ ~		N								
1623					IFM	~ ~ ~								← 5-17-11-2-JM		Dark, Branches are separated by clay, teal, wavy planes
1624					IFM	~ ~ ~		N						← 5-17-11-1-JM		Branches are separated by clay, teal, wavy planes

Core diameter = 7.5cm slabs

Metric Units (2.5cm = 3m)

Logged By: JSM

Page 2 of 2[illegible]

Metric Units (2.5cm = 3m)

Log depth $\approx$ core depth

Project/Location: 00/A-055-H/C94-1-10/0 JM

Logged By: JSM

Date: 5/17/11 : 5/18/11

Page 1 of 1

Length	Texture				Facies	Grains	Sed. Struct.	Visible Porosity		Fracture		Stylolite		Photo	Sample	Comments
	M	W	P	G				Rel. Abun.	Type(s)	Freq.	Cement	Freq.	Type			
Top core																
1141						SW(6) @h Y									ES-18-11-20-JM	
						SW(6) @h Y									ES-18-11-19-JM	
1142						SW(6) @h Y									ES-18-11-18-JM	fine grainy
						SW(6) @h Y									ES-18-11-17-JM	
1143						SW(6) @h Y									ES-18-11-16-JM	
1144						SW(6) @h Y									ES-18-11-15-JM	
1145						SW(6) @h Y									ES-18-11-14-JM	
1146						SW(6) @h Y									ES-18-11-13-JM	Dark imbedded
1147						SW(6) @h Y									ES-18-11-12-JM	
1148						SW(6) @h Y									ES-18-11-11-JM	
1149						SW(6) @h Y									ES-18-11-10-JM	
1150						SW(6) @h Y									ES-18-11-9-JM	
1151						SW(6) @h Y									ES-18-11-8-JM	
1152						SW(6) @h Y									ES-18-11-7-JM	
1153						SW(6) @h Y									ES-18-11-6-JM	
1154						SW(6) @h Y									ES-18-11-5-JM	
1155						SW(6) @h Y									ES-18-11-4-JM	
1156						SW(6) @h Y									ES-18-11-3-JM	
1157						SW(6) @h Y									ES-18-11-2-JM	
Base of core 1156.5																

Core diameter = 7 cm slab

Metric Units (2.5cm = 3m)

core depth - 1.25 m = 105 depth

Project/Location: JEAN MARIE
A-56-L-094-I-05
Date: 5-17-2011

Logged By: ATCHLEY
Page 1 of 2

Length	Texture				Facies	Grains	Sed. Struct.	Visible Porosity		Fracture		Sylolite		Photo	Sample	Comments
	M	W	P	G				Rel. Abun.	Type(s)	Freq.	Cement	Freq.	Type			
1555					SWR	SK			?	0				5-17-11-315A		FDR S.W. (O) INTERVAL WELL LOG SHOWS HIGH ϕ ... NO MACRO ϕ APPARENT, MUST BE MICRO ϕ ?
										0				5-17-11-305A		
										0						
1560					AF	+		WP	3					5-17-11-295A		
					MESB	+		WP	4					5-17-11-275A		
					AF	+		WP	3					5-17-11-285A		
						+		T	3							
					SWR	+		BP	1		C			5-17-11-265A		
						+			0					5-17-11-255A		HIGH ENERGY...
1565					BSSR	+		BP	0					5-17-11-245A		COARSE AND WELL SORTED, WIDE
									0							VARIETY OF GRAIN TYPES... PRIMARY & STRUTIA TOPORDI
					MESB	+		WP	0					5-17-11-235A		
					EPG	+		BP	3		0			5-17-11-225A		
						+			4		C			5-17-11-215A		
						+			0					5-17-11-205A		
1570					MESB	+			0					5-17-11-185A		
						+			0					5-17-11-175A		
						+		BP	0							
						+			1		C					
1575						+		AF	0					5-17-11-165A		
					EPG	+		BP	0					5-17-11-155A		
1577					MESB	+		BP	0					5-17-11-145A		

CORE 1
↑
CORE 2
↓

Core diameter = 10 CM

Metric Units (2.5cm = 3m)

CORE DEPTH = LOG DEPTH?? ... UNSURE

Logged By: ATCHLEY
Page 2 of 2

[illegible]

Metric Units (2.5cm = 3m)

Project/Location: San marie A-02-C/094-1-08

Logged By: Kelly Jones

Date:

Page 1 of 1

Length	Texture					Facies	Grains	Sed. Struct.	Visible Porosity		Fracture		Stylolite		Photo	Sample	Comments
	M	W	P	G	B				Rel. Abun.	Type(s)	Freq.	Cement	Freq.	Type			
1314						PSB	~2 OR				F	38	C			05-18-11-20KS 05-17-11-19KS	Open fractures
1315							OR					43	C				Open fractures
1316						SWO	G ~				F	28	C				
1317						CFW	OR					16	C			05-17-11-18KS	
1318						SWO						21	C			05-17-11-17KS	
1319							~2					9	C				open fractures
1320							OR				F	27	C				
1321						PSB	OR				mo	31	C			05-17-11-16KS	
1322												31	C			05-17-11-15KS	
1323						MESB	~2				F	22	C			05-17-11-14KS	open fractures
1324							~2					33	C			05-17-11-13KS 05-17-11-12KS 05-17-11-11KS	Open fractures
1325						PSB	OR				F	17	C			05-17-11-10KS 05-17-11-9KS	present
1326						CFW	OR					8				05-17-11-8KS 05-17-11-7KS	
1327							OR					0					
1328						STW	G					0				05-17-11-6KS 05-17-11-5KS 05-17-11-4KS	
1329												0				05-17-11-3KS	
1330						IFW						0				05-17-11-2KS	
1331						BUN						0					
1332												0				05-17-11-1KS	

Core diameter = 10.0cm

core depth 1314 - well log depth 1315 = 1m. depth shift

Metric Units (2.5cm = 3m)

Logged By: Curtis Barclay (CJB)
Page 1 of 1

Length	Texture					Facies	Grains	Sed. Struct.	Visible Porosity		Fracture		Stylolite		Photo	Sample	Comments
	M	W	P	G	B				Rel. Abun.	Type(s)	Freq.	Cement	Freq.	Type			
1494						SWR AF	~ SK ~ SK			F	2 C/O 3 C			5-18-11: 7CSB 5-19-11: 6-CSB			dark muddy AF fades into SWR
1495						MESB	~ ~ ~ ~			M	0						
1496						MESB	~ ~ ~ ~			M	0						Gets muddy (mud?) no fractures
1497						MESB	~ ~ ~ ~			BP	4 C						"
1498						MESB	~ ~ ~ ~			BP	5 C						low porosity again
1499						MESB	~ ~ ~ ~			BP	2 C						large geopetal fill
1500						MESB	~ ~ ~ ~			BP	6 C						a few large GF pores but filled w/ calcite very low ϕ
1501						MESB	~ ~ ~ ~			BP	6 C						low porosity
1502						MESB	~ ~ ~ ~			BP	5 C			5-18-11 5CSB			
1503						PSB	~ ~ ~ ~			BP	6 C						large calcite fracture fill
1504						PSB	~ ~ ~ ~			BP	11 C						very low ϕ large fracture filled with calcite
1505						PSB	~ ~ ~ ~				2 C						very low ϕ
1506						PSB	~ ~ ~ ~			BP	8 C			5-18-11 4CSB			half muddy a half green PSB
1507						PSB	~ ~ ~ ~			BP	13 C						some fracture ϕ and a few ϕ
1508						PSB	~ ~ ~ ~			BP	4 C						return to PSB normal more calcite fill
1509						PSB	~ ~ ~ ~			F	10 C			5-18-2011 3CSB			massive calcite fill (fracture) (fault?)
1510						PSB	~ ~ ~ ~			BP	2 C						still fairly low porosity
1511						PSB	~ ~ ~ ~			BP	7 C			5-18-2011 2CSB			muddy section (20cm) mostly packstone
1512						PSB	~ ~ ~ ~			BP	3 C			5-18-2011 1CSB			half rubble very grainy throughout large calcite fill (fracture)

1513-
Bottom

* Core diameter = 9.5 cm

Metric Units (2.5cm = 3m)

Depth correction = (unknown)

Project/Location: JEAN MARIE
A-93-K-94-I-12
Date: 5-16-11

Logged By: ATCHLEY
Page 1 of 2

Length	Texture				Facies	Grains	Sed. Struct.	Visible Porosity		Fracture		Stylolite		Photo	Sample	Comments
	M	W	P	G				Rel. Abun.	Type(s)	Freq.	Comment	Freq.	Type			
								-		16						SEE ABOVE
					RBM	SK (RARE)		-		7						
								-		9						
1460					SIW (R)	SK		-		R					5-17-11-55A	
								-		R	5-17-11-65A					
1465																
1470																
1475								-		0						
					SIW	SK		-		0					5-17-11-45A	
								-		0						
								-		0					5-17-11-35A	
								-		0					5-17-11-25A	
1480					BLM			-		0						
					IFM			-		0					5-17-11-15A	
1482								-		0						

CORE 1
↑
CORE 2
↑

↓
CORE 3

Core diameter = 10 cm
CORE DEPTH = LOG DEPTH?
CORE BASE
Metric Units (2.5cm = 3m)

Metric Units (2.5cm = 3m)

Project/Location: JEAN MARIE
00-A-094-D-094-J-10-D

Logged By: ATCHLEY

Date: 7-21-2010

Page 1 of 1

Thickness	Texture M W P G B	Facies	Sed. Struct.	Photo	Sample	Comments
1307						CORE TOP
1308		BLM				
1309		IFM			7-22-10-145A	HIGHLY FISSILE
1310		CF			7-22-10-135A	
1311		CF				CLIM REPLACEMENT PYRITE NODULE
1312		CF			7-22-10-125A	
1313		SK			7-22-10-115A	
1314		SK				
1315		SK SWCR				
1316		SK				
1317		SK			7-22-10-95A	
1318		SK			7-22-10-105A	
1319		SK				
1320		SK				
1321		CF				
1322		CF			7-22-10-85A	
1323		SW				
1324		SW			7-22-10-75A	
1325		SW			7-22-10-65A	
1326		SW			7-22-10-45A	
1327						
1328						
1329						
1330						
1331						
1332						
1333						
1334						
1335						
1336						
1337						
1338						
1339						
1340						
1341						
1342						
1343						
1344						
1345						
1346						
1347						
1348						
1349						
1350						
1351						
1352						
1353						
1354						
1355						
1356						
1357						
1358						
1359						
1360						
1361						
1362						
1363						
1364						
1365						
1366						
1367						
1368						
1369						
1370						
1371						
1372						
1373						
1374						
1375						
1376						
1377						
1378						
1379						
1380						
1381						
1382						
1383						
1384						
1385						
1386						
1387						
1388						
1389						
1390						
1391						
1392						
1393						
1394						
1395						
1396						
1397						
1398						
1399						
1400						
1401						
1402						
1403						
1404						
1405						
1406						
1407						
1408						
1409						
1410						
1411						
1412						
1413						
1414						
1415						
1416						
1417						
1418						
1419						
1420						
1421						
1422						
1423						
1424						
1425						
1426						
1427						
1428						
1429						
1430						
1431						
1432						
1433						
1434						
1435						
1436						
1437						
1438						
1439						
1440						
1441						
1442						
1443						
1444						
1445						
1446						
1447						
1448						
1449						
1450						
1451						
1452						
1453						
1454						
1455						
1456						
1457						
1458						
1459						
1460						
1461						
1462						
1463						
1464						
1465						
1466						
1467						
1468						
1469						
1470						
1471						
1472						
1473						
1474						
1475						
1476						
1477						
1478						
1479						
1480						
1481						
1482						
1483						
1484						
1485						
1486						
1487						
1488						
1489						
1490						
1491						
1492						
1493						
1494						
1495						
1496						
1497						
1498						
1499						
1500						
1501						
1502						
1503						
1504						
1505						
1506						
1507						
1508						
1509						
1510						
1511						
1512						
1513						
1514						
1515						
1516						
1517						
1518						
1519						
1520						
1521						
1522						
1523						
1524						
1525						
1526						
1527						
1528						
1529						
1530						
1531						
1532						
1533						
1534						
1535						
1536						
1537						
1538						
1539						
1540						
1541						
1542						
1543						
1544						
1545						
1546						
1547						
1548						
1549						
1550						
1551						
1552						
1553						
1554						
1555						
1556						
1557						
1558						
1559						
1560						
1561						
1562						
1563						
1564						
1565						
1566						
1567						
1568						
1569						
1570						
1571						
1572						
1573						
1574						
1575						
1576						
1577						
1578						
1579						
1580						
1581						
1582						
1583						
1584						
1585						
1586						
1587						
1588						
1589						
1590						
1591						
1592						
1593						
1594						
1595						
1596						
1597						
1598						
1599						
1600						
1601						
1602						
1603						
1604						
1605						
1606						
1607						
1608						
1609						
1610						
1611						
1612						

Date: 5/19/2011

Page 1 of 1

Metric Units (2.5cm = 3m)

$$\text{CORE} + 0.75 \text{ m} = \text{LOG DEPTH}$$

Logged By: *Anislyn Trendell*

Date: 5.17.2011

Page 1 of 1

[illegible]

Core diameter = 10 cm

CORE BOTTOM

Metric Units (2.5cm = 3m)

* CORE - 1m = WELL LOG

Project/Location: Jean Marie OCHA-1W-1/044-1-110 Logged By: Kelly Jones
Date: 05/17/11 Page 1 of 1

Length	Texture				Facies	Grains	Sed. Struct.	Visible Porosity		Fracture		Stylolite		Photo	Sample	Comments
	M	W	P	G				Rel. Abun.	Type(s)	Freq.	Cement	Freq.	Type			
1366						ψ				3	C					
						AF	⊗ _{th}			3	C				05-17-11-36KJ	
1370							⊗ _{th}			6	C				05-17-11-35KJ	
							⊗ _{th}			9	C					
							⊗ _{th}			11	C				05-17-11-33KJ	
						SWO				12	C					
										24	C				05-17-11-33KJ	
						FPB	•			11	C				05-17-11-32KJ	
							⊗ _{th}			12	C					
						SWO				19	C					
										13	C				05-17-11-31KJ	
						SWR	Y			11	C				05-17-11-30KJ	
							⊗ _{th}			13	C					
1380						MEB	Y			F	24	C			05-17-11-29KJ	⊗
							⊗ _{th}			GF	20	C			05-17-11-28KJ	
							Y			5	C				05-17-11-27KJ	
						PSB	~00R			12	C				05-17-11-25KJ	
						T	00R			4	C				05-17-24KJ	
						SWO	YG			14	C					
1385										3	C				05-17-11-23KJ	
1386						SLW	⊗ _{th}			5	C				05-17-11-22KJ	
1387							Y			0					05-17-11-21KJ	

Core diameter = 10.0cm

Metric Units (2.5cm = 3m)

Core depth - 1 = log depth at 1381.5

APPENDIX C

Core Descriptions from UWI starting with 200-B

JEAN MARIE

Project/Location: 00-B-07-H-094-I-09-0

Logged By: ATCHLEY

Date: 7-21-2010

Page 1 of 1

Thickness	Texture M W P G B	Facies	Sed. Struct.	Photo	Sample	Comments
1084						CORE TOP
1085					7-21-10-15A	
1086						
1087		BLM			7-21-10-25A	FISSILE SHALE
1088						
1089					7-21-10-35A	← CORE-7m = LOG DEPTH ← PYRITE ← PYRITE
1090						
1091					7-21-10-45A	
1092						
1093					7-21-10-55A	
1094					7-21-10-65A	CLASTS AS ROUNDED NODULES
1095						
1096		PSB			7-21-10-75A	
1097					7-21-10-85A	
1098					7-21-10-95A	
1099						
1100					7-21-10-105A	LARGE GROWTH FRAMEWORK PORE FILLED W/ ENCRUSTING RUGOSE CORAL IN TURN W/ WP F FILLED WITH CLEAR, COARSE CALCITE CEMENT
1101					7-21-10-125A	
1101.35					7-21-10-135A	← CURRENT RIPPLE W/ IN

CORE-6.35m = CORE DIAMETER = 6.5 cm
LOG DEPTH

Metric Units (2.5cm = 3m)

Project/Location: JEAN MARIE
B-B-D-94-I-5
Date: 5/17/2011

Logged By: ATCHLEY
Page 1 of 2

Length	Texture				Facies	Grains	Sed. Struct.	Visible Porosity		Fracture		Stylolite		Photo	Sample	Comments
	M	W	P	G				Rel. Abun.	Type(s)	Freq.	Cement	Freq.	Type			
									BP	2	C			5-18-11-13SA		
									BP	7	C			5-18-11-12SA		
									BP	40	C					
									BP	45	C			5-18-11-11SA		
1685					MESB				BP	40	C					ABUNDANT CALCITE FILLING PRIMARY GROWTH FRAMEWORK PORE SPACE
									BP	18	C					
									BP	22	C			5-18-11-10SA		
									BP	16	C			5-18-11-9SA		
										7	C			5-18-11-8SA		
1690										3				5-18-11-7SA		
										1						
										6	C					
										0				5-18-11-6SA		
										0						
1695					PSB					0						
										0						
										0						
										0				5-18-11-5SA		
					MESB					0				5-18-11-4SA		
1700					SW(O)					3	C					
									BP	3	C			5-18-11-3SA		← CORE - 0.5m = LOG DEPTH
										3	C					
										0				5-18-11-2SA		
1705					SW(R)					3	C					
										0				5-18-11-1SA		
1707					CORE BASE											

Core diameter = 10 cm

Metric Units (2.5cm = 3m)

CORE DEPTH - (0.5 TO 1.25m) = LOG DEPTH

Logged By: ATCHLEY
Page 2 of 2

[illegible]

Core diameter = 10 cm

Metric Units (2.5cm = 3m)

Project/Location: Jean Marie 0013-013-D/094-1-160 Logged By:

Date: 05-17-2011

Page 1 of 1

Length	Texture					Facies	Grains	Sed. Struct.	Visible Porosity		Fracture		Stylolite		Photo	Sample	Comments
	M	W	P	G	B				Rel. Abun.	Type(s)	Freq.	Cement	Freq.	Type			
1067																	
1067						BLM					R					05-18-11-15KS	
						SUR	VSK				20	C				05-18-11-14KS	Very dark
																05-18-11-13KS	
1070						PSB	VSK		Ma		38	C				05-18-11-12KS	
											42	C					
											20	C				05-18-11-11KS	highly stylolized clasts
											20	C					Partly Rubble
						SUR	G				12	C					
											1	C					
1075											4	C				05-18-11-10KS	clast with grain stone texture
1075											5	C				05-18-11-9KS	
						MSB	G				14	C					
											18	C				05-18-11-8KS	
						SUR	G				8	C				05-18-11-7KS	
											9	C				05-18-11-6KS	
1080											3	C				05-18-11-5KS	
											0					05-18-11-4KS	
						SIW	G				0					05-18-11-3KS	
											0					05-18-11-2KS	
1084						IFW					0					05-18-11-1KS	

Core diameter = 10cm

Metric Units (2.5cm = 3m)

Core depth = well log depth

Project/Location: 00-B-020-L-094-I-04-0

Logged By: ATCHLEY

Date: 7-26-10

Page 2 of 2

GROWTH FRAMIE
WORK & FILLED
W/ COARSE
SPARRY CALCITE

← METAPETAL W/IN
LARGE GROWTH
FRAMEWORK
CANY FILL.
TERMINAL FILL
IS MASSIVE, CLEAR
SPARRY CALCITE

Core diameter = 10 cm

Metric Units (2.5cm = 3m)

CORE DEPTH $\approx$ LOG DEPTH

JEAN MARIE

Project/Location: CO-B-020-L-094-I-04-0 Logged By: ATCHLEY

Date: 7-26-10 Page 2 of 2

Length	Texture					Facies	Grains	Sed. Struct.	Visible Porosity		Fracture		Stylolite		Photo	Sample	Comments
	M	W	P	G	B				Rel. Abun.	Type(s)	Freq.	Cement	Freq.	Type			
1774																	
1775						AF	GM						24			7-26-10-445A	"ARGILLACEOUS" MATERIAL CONCENTRATED ALONG WISPY STYLOLITES
1776							G									7-26-10-435A	
1777						SWCR	SK										
1778							Y									7-26-10-425A	
1779							CM										
1780																7-26-10-415A	
1781						PSB											DARK, MUDDIER THAN BELOW
1782																	ARTICULATED CRINOID COLUMNALS
1783						SR	SK									7-26-10-395A	
1784																	
1785						CF										7-26-10-385A	
1786						MEIB	SK										CYANOBACTERIAL BINDINGS
1787						FPG										7-26-10-375A	
1788						PSB										7-26-10-365A	
1789						EPG										7-26-10-355A	
1790						SR										7-26-10-345A	
1791						PSB											
1792						MESB										7-26-10-335A	

Core diameter = 10 cm

Metric Units (2.5cm = 3m)

Project/Location: JM B-028 - 2/094-1-08
 Date: 5-18-2011

Logged By: Aislyn Treadwell
 Page 1 of 1

Length	Texture M W P G B	Facies	Grains	Sed. Struct.	Visible Porosity Rel. Abun. Type(s)	Fracture Freq. Cement	Stylolite Freq. Type	Photo	Sample	Comments
1225m										
		BLM				0			5-18-11-17AT	
		SWR/BLM interbedded				4	c/o		5-18-11-16AT	*2
		SWR	Blue windiff							
		SWO	Depositional abundance			18	c/o			
			OR, OR			20	c/o		5-18-11-15AT	
1230						6	c/o		5-18-11-14AT	
						16	c/o		5-18-11-13AT	
		PSB				29	c/o		5-18-11-12AT	
						68	c/o			
						106	c/o			
									5-18-11-11AT	
1235						0			5-18-11-10AT	
						15	c		5-18-11-9AT	
						11	c		5-18-11-8AT	
						2			5-18-11-6AT	
						0			5-18-11-5AT	
						0			5-18-11-4AT	
1240						0			5-18-11-3AT	
						0			5-18-11-1AT	
						0			5-18-11-2AT	
1243										MISSING CORE

Core diameter = 6.5cm.

Metric Units (2.5cm = 3m)

* CORE - 0.5m = WELL LOG @ depth 1239.5
 *2 CORE = WELL LOG @ Depth 1226.

Logged By: JS m

Date: 7-27/10

Page 1 of 1

Length	Texture				Facies	Grains	Sed. Struct.	Visible Porosity		Fracture		Stylolite		Photo	Sample	Comments
	M	W	P	G				Rel. Abun.	Type(s)	Freq.	Comment	Freq.	Type			

Core diameter = 8 cm

Metric Units (2.5cm = 3m)

JEAN MARIE
 Project/Location: 00-B-32-L-94-I-04-0 Logged By: ATCHLEY
 Date: 7-28-2010 Page 1 of 2

Length	Texture					Facies	Grains	Sed. Struct.	Visible Porosity		Fracture		Stylolite		Photo	Sample	Comments
	M	W	P	G	B				Rel. Abun.	Type(s)	Freq.	Cement	Freq.	Type			
1705						(CF)	SK		F		6						
1706						PSB	SK									7-26-10-13SA	
1707																7-26-10-12SA	
1708																7-27-10-9SA	BREAKS INTO CM-SCALE PLATY CHIPS
1709						LRM										7-27-10-10SA	
1710																7-27-10-11SA	
1711																	
1712																	
1713						AF	SK				R					7-27-10-8SA	Amphipora plus Amphipora-sized coral
1714							SK									7-27-10-7SA	
1715							SK				3						ELEVATED ϕ ON CORE ANALYSIS. NO MACRO ϕ OBSERVED IN CORE OTHER THAN SOLUTION ENLARGED FRACTURES
1716						CF(R)	SK				5						
1717							SK						3				
1718							SK						8				
1719						PSB	SK						4			7-27-10-6SA	
1720							SK						6				
1721						SW(R)	SK						7				
1722							SK						15			7-27-10-5SA	
1723							SK						15				
1724						SW(O)	SK									7-27-10-4SA	
1725							SK									7-27-10-3SA	
1726							SK									7-27-10-2SA	
1727						SW(R)	SK										
1728							SK										
1729							SK									7-27-10-1SA	
1730											R						

Core diameter = 8.5 CM

CORE BASE

Metric Units (2.5cm = 3m)

Project/Location: JEAN MARIE
00-13-32-L-94-I-04-0
Date: 7-28-2010

Logged By: ATCHLEY
Page 2 of 2

Length	Texture				Facies	Grains	Sed. Struct.	Visible Porosity		Fracture		Stylolite		Photo	Sample	Comments
	M	W	P	G				Rel. Abun.	Type(s)	Freq.	Cement	Freq.	Type			
1688																CORE - 0.5m = LOG DEPTH
1689																7-27-10-26SA
1690																7-27-10-25SA
1691																750' 7-27-10-24SA
1692																750' 7-27-10-23SA
1693																7-27-10-22SA
1694																
1695																
1696																10' 7-27-10-21SA 7-27-10-20SA
1697																THIN, WISPY 7-27-10-19SA STYLOLITES 7-27-10-18SA
1698																THROUGHOUT 7-27-10-16SA
1699																11' 7-27-10-15SA
1700																7-27-10-14SA
1701																
1702																
1703																7-27-10-14SA
1704																

Core diameter = 2.5 cm

Metric Units (2.5cm = 3m)

Logged By: ATCHLEY

Page 1 of 1[illegible]

Core diameter = 10 cm

Metric Units (2.5cm = 3m)

$$\text{CORE DEPTH} + 0.5 \text{ m} = \text{LOG DEPTH}$$

Project/Location: 00/B-060-C/04-1-12/0 JM

Logged By: JM

Date: 5/18/11

Page 1 of 1

Length	Texture					Facies	Grains	Sed. Struct.	Visible Porosity		Fracture		Stylolite		Photo	Sample	Comments
	M	W	P	G	B				Rel. Abun.	Type(s)	Freq.	Cement	Freq.	Type			
Top of Core																	
1490							G ₂ ~				BP	0				ES-18-11-47	
1491							G ₂ ~				BP	0				ES-18-11-46	
1492							G ₂ ~				BP	9	C			ES-18-11-45 ES-18-11-44	
1493							G ₂ ~				BP	3	C			ES-18-11-43 ES-18-11-42	
1494							G ₂ ~				BP	5	C			ES-18-11-41-JM	
1495							G ₂ ~				BP	5	C			ES-18-11-40-JM	©
1496							G ₂ ~				BP	6	C			ES-18-11-39.5-JM	©
1497							G ₂ ~				BP	6	C			ES-18-11-39-JM	©
1498							G ₂ ~				BP	12	C			ES-18-11-38-JM	
1499							G ₂ ~				BP	15	C			ES-18-11-37-JM	
1500							G ₂ ~				BP	7	C			ES-18-11-36.5-JM	BP in peloid green stone deposits. Pilling growth. Fracture.
1501							G ₂ ~				BP	8	C			ES-18-11-36-JM ES-18-11-35-JM	
1502							G ₂ ~				BP	6	C			ES-18-11-34-JM	© moved all pores Pilling w/ crystalline calcite
1503							G ₂ ~				BP	15	C			ES-18-11-33-JM	
1504							G ₂ ~				BP	10	C			ES-18-11-32-JM	©
1505							G ₂ ~				BP	6	C			ES-18-11-31-JM	
1506							G ₂ ~				BP	7	C			ES-18-11-30-JM	Porosity in acid greenstone bedrock
1507							G ₂ ~				BP	4	C			ES-18-11-29-JM	
1508							G ₂ ~				BP	4	C			ES-18-11-28-JM	
Base of core 1508.1																	

Core diameter = 8.5cm slabbled

Metric Units (2.5cm = 3m)

core depth = log depth

USE THIS ONE

Project/Location: JM 00-B-069-A-094-I-10-0

Logged By: JSN

Date: 7/21/10 (revised 7/28/10) Sheet # type Page 1 of 1

Length	Texture				Facies	Grains	Sed. Struct.	Visible Porosity		Fracture		Stylolite		Photo	Sample	Comments
	M	W	P	G				Rel. Abun.	Type	Fract.	Cement	Freq.	Type			
1186					Top											
1187					BLM											7-21-10-12-JM
1188					SR											7-21-10-13-JM
1189					BLM											7-21-10-10-JM
1190					AF			10	C							pyrite replacing grains
1191								5	C							7-21-10-9-JM
1192					CF			20	C							7-21-10-8-JM
1193					METB			20	C							7-21-10-7-JM
1194								5	C							weak local float black organic
1195					CF			5	C							7-21-10-6-JM
1196								5	C							
1197								15	C							
1198								50	C							7-21-10-5-JM
1199								50	C							
1200					METB			40	C							
1201								40	C							
1202								30	C							
1203								20	C							7-21-10-4-JM
1204					SR			5	C							
1205								0								7-21-10-3-JM
1206					CF			1	C							7-21-10-2-JM
1207					METB			0	C							7-21-10-1-JM
1208								0	C							articulated chertoid pyrite coating organic
1209					CF			0	C							
1210					Base											

Core diameter =

Metric Units (2.5cm = 3m)

Page 1 of 1

Metric Units (2.5cm = 3m)

JEAN MARIE

Project/Location: 00-B-0841-D-094-I-03-0

Logged By: JSM

Date: 7/28/10

Page 1 of 1

Length	Texture					Facies	Grains	Sed. Struct.	Visible Porosity		Fracture		Stylolite		Photo	Sample	Comments
	M	W	P	G	B				Rel. Abun.	Type(s)	Freq.	Cement	Freq.	Type			
							Top core 1										
1693							SIW						20 ~			7-28-10-13-JSM	
1694							SIW						15 ~			7-28-10-12-JSM	
1695																	
1696							BLM										
1697																	
1698																	
1699							SW				1 C	10 ~				7-28-10-11-JSM	
1700							AF					4 ~				7-28-10-10-JSM	
1701							AF				2 C	3 ~				7-28-10-9-JSM	Pyrite and iron grains
1702							AF				2 C	8 ~				7-28-10-8-JSM	
1703							Base core 1										
1704							Top core 2										
1705							AF				1 D	1 ~				7-28-10-6-JSM	grains coated
1706							CF					11 ~				7-28-10-5-JSM	
1707							CF					10 ~				7-28-10-4-JSM	
1708							SW				3 C	12 ~					
1709							SW				1 C	14 ~					grains coated in some locations
1710							SW				3 C	18 ~				7-28-10-3-JSM	
1711							PSB				5 C	4 ~				7-28-10-2-JSM	
1712							Base									7-28-10-1-JSM	possibly thin sectioned

Core diameter = 9.5cm

Metric Units (2.5cm = 3m)

Project/Location: JEAN MARIE
00-B-085-D-094-I-12-0
 Date: 7-28-2010

Logged By: ATCHLEY
 Page 1 of 1

Length	Texture					Facies	Grains	Sed. Struct.	Visible Porosity		Fracture		Stylolite		Photo	Sample	Comments
	M	W	P	G	B				Rel. Abun.	Type(s)	Freq.	Cement	Freq.	Type			
1808																	
1509						RBM							11	ac			
1510						PSB					3	C	8	ac			7-27-10-335A
1511													10	ac			
1512													9	ac			7-27-10-325A
1513													6	ac			
1514													7	ac			
1515						RBM							6	ac			
1516													7	ac			
1517											1	C	10	ac			
1518													4	ac			7-27-10-34, 352A
1519											4	C	8	ac			7-27-10-315A
1520													9	ac			7-27-10-305A
1521											5	C	8	ac			
1522													10	ac			
1523											3	C	7	ac			
1524						CF					6	C	5	ac			7-27-10-293A
1525											10	C	8	ac			7-27-10-273A
1526											10	C	5	ac			7-27-10-285A

Core diameter = 9cm
 DEPTH SHIFT = ?

Metric Units (2.5cm = 3m)

Logged By: ATCHLEY
Page 1 of 1

Core diameter = 3.5" Imperial Units (1" = 10')

DEPTH SHIFT = ??

Logged By: Kelly Jones

Date: 05-18-11

Page 1 of 1

[illegible]

Core diameter = 3.5 in

Imperial Units (1" = 10')

unable to depth shift between core and well logs

Logged By: ATCHLEY
Page 1 of 1

Metric Units (2.5cm = 3m)

DEPTH CORRECTION

Logged By: ATCHLEY

Page 1 of 1

Length	Texture				Facies	Grains	Sed. Struct.	Visible Porosity		Fracture		Stylolite		Photo	Sample	Comments
	M	W	P	G B				Rel. Abun.	Type(s)	Freq.	Cement	Freq.	Type			
CORE NOT SLABBED!																
1430	CORE TOP															
1431	B				MESB		?	3	C	1	nh					DARK BP
	B						?	4	C	1	nh					MATRIX
1432	B							7	C	1	nh					
1433	B				FGP			11	C	1	nh					FRACTURES BOTH PRE-DATE AND POST DATE
1434	B							8	C	1	nh					
1435	B				PSB			5	C	1	nh					
1436	B							3	C	6	nh					
1437	B									6	nh					
1438	B									4	nh					
1439	B				CF						nh					
1440	CORE BASE															
CORE DEPTH & LOG DEPTH																

Core diameter = 9 cm

Metric Units (2.5cm = 3m)

APPENDIX D

Core Descriptions from UWI starting with 200-C

Project/Location: ^{JEAN MARIE} C-006-K/094-I-08
 Date: 5-24-2011

Logged By: AISLYN TRENDLE; CURTIS BARCLAY
 Page 1 of 1

Length	Texture					Facies	Grains	Sed. Struct.	Visible Porosity		Fracture		Stylolite		Photo	Sample	Comments
	M	W	P	G	B				Rel. Abun.	Type(s)	Freq.	Cement	Freq.	Type			
1236											0						
1237											0					5-24-2011-24AT	
1238											0					5-24-2011-24AT	COLONIAL RWG/SSZ IN INTRACLAST
1239											9	C				5-24-2011-24AT	
1240											28	C				5-24-2011-24AT	
1241											38	C					
1242											25	C					*VERTICLE THROUGHOUT FRACTURE
1243											23	C				5-24-2011-24AT	
1244											29	C					
1245											18	C				5-24-2011-19AT	
1246											35	C				5-24-2011-18AT	
1247											26	C				5-2011-17AT	
1248											30	C					
1249											15	C/O				5-24-2011-16AT	
1250											12	C/O					
1251											0					5-24-2011-15AT 5-24-2011-14AT	
1252											0					5-24-2011-13AT 5-24-2011-12AT	
1253											0					5-24-2011-11AT	
1254																	MISSING CORE BASE 1254.5

Core diameter = 10cm

Metric Units (2.5cm = 3m)

CORE + 0.5m = WELL LOG @ 1238.5m

Project/Location: Jean Marie
C-10-F/94-I-5
Date: 5-18-2011

Logged By: CJB Curtis Barclay
Page 1 of 1

top
608.2

Length	Texture M W P G B	Facies	Grains	Sed. Struct.	Visible Porosity Rel. Abun. Type(s)	Fracture Freq. Cement	Stylolite Freq. Type	Photo	Sample	Comments
1608		BLM	none		- -	0			5-18-11-18CSB	shale
1609		AF			- -	7 C			5-18-11-17CSB	small g in mud
1610		CEO	⊗ ⊗ ~ SK BP		- -	0				game 2
1611		CEO	⊗ ⊗ ⊗ TH SK		- -	0			5-18-11-16CSB	large corals in muddy wack matrix
1612		PSB	~ A ~ SK		- -	2 C				few grains
1613		PSB	~ ~		- -	3 C			5-18-11-15CSB	few large grains few fractures φ very low
1614		EPG	~ ~		BP F	17 c/o			5-18-11-14CSB	return of grain diversity and quantity
1615		EPG	~ ~		BP F	29 c/o				few grains (large)
1616		EPG	~ ~		BP F	27 c/o				(large) few grains
1617		EPG	~ ~ SK		BP F	35 c/o			5-18-11-13CSB	few grains (large)
1618		EPG	~ ~		BP F	14 c/o				very grainy high φ
1619		PSB	~ ~ SK		F	20 c/o			5-18-11-12CSB	muddy again
1620		PSB	~ ~ SK		F	19 c/o				
1621		PSB	~ ~ SK		BP F	7 c/o			5-18-11-11CSB	goes from muddy to grainy BP φ
1622		PSB	~ ~ SK		F	8 c/o			5-18-11-10CSB	low porosity and muddy
1623		MESB	~ ~ SK		BP F	15 c/o			5-18-11-9CSB 5-18-11-8CSB	makes from grainy to wackstone matrix w/ large grains
1624		MESB	~ ~ SK		BP F	19 c/o				Lots of BP porosity very grainy texture
1625		MESB	~ ~ SK		BP F	8 c/o				facies
1626										

1627
Bottom = 1626.2
Core diameter = 9.5 cm

Metric Units (2.5cm = 3m)

Depth Shift = Core depth - 1 meter = log depth

Logged By: JSM

Page 1 of 1

[illegible]

Subtract
1.0 m

Core diameter = 9.5 cm

Metric Units (2.5cm = 3m)

Logged By: *Jm*

Date: 5/24/11

Page 1 of 1

[illegible]

Core diameter = 9 cm

Metric Units (2.5cm = 3m)

log depth may $\approx$ core depth

W. K. P. h.

Logged By: AISLYN TRENDLE

Date: 5-19-2011

Page of [illegible]

Core diameter = 8.5 cm.

Metric Units (2.5cm = 3m)

* Burma 1459 does not show up on well log.

* Cannot depth shift on ANYTHING! Well logs show no ϕ or GR4

JEAN MARIE

Project/Location: JM00-C-029-J-094-I-11-0

Logged By: JSM

Date: 7/23/10

Page 1 of 1

Length	Texture				Facies	Grains	Sed. Struct.	Visible Porosity		Fracture		Stylolite		Photo	Sample	Comments
	M	W	P	G				Rel. Abun.	Type(s)	Freq.	Cement	Freq.	Type			
Total core length																
* - has the general appearance of AF but lacks oncoides and is a mudstone which leads me to believe this is actually a tempestite																

Depth
C
1311.6 = 1312
+0.4m
Core 1.4m
log depth

Depth
1326.5 = 1326.5
+0.2m
Core 0.2m
log depth

Core diameter = 9cm

Metric Units (2.5cm = 3m)

Subcore 1.0m

Logged By: ATCHLEY
Page 1 of 1

CORE DEPTH = 1 m = LOG DEPTH

JEAN MARIE

Project/Location: 00-C-030-G-094-I-12-0

Logged By: JSM

Date: 7/18/10 / 7/29

Page 1 of 1

Length	Texture				Facies	Grains	Sed. Struct.	Visible Porosity		Fracture		Stylolite		Photo	Sample	Comments
	M	W	P	G				Rel. Abun.	Type(s)	Freq.	Comment	Freq.	Type			
						Top										
1496						~ ~ ~				5	C	9	M	7-29-10-14-JSM		anhypite nodules with stylolite
1497						MESB				10	C	9	M	7-29-10-13-JSM		Interbedded MESB
1498						CF								7-29-10-12-JSM		CF
1499														7-29-10-11-JSM		
1500						~ ~ ~										What appears to be micro interparticle porosity
1501						~ ~ ~				3	C	8	M	7-29-10-10-JSM		
1502						~ ~ ~				4	C	6	M			
1503						~ ~ ~				4	C	8	M	7-29-10-9-JSM		Pebbles sized anhydrite conglomerate
1504						~ ~ ~				6	C	8	M	7-29-10-8-JSM		2-3cm lens of anhydrite nodules associated with a stylolite
1505						~ ~ ~				10	C	12	M	7-29-10-7-JSM		
1506						~ ~ ~				7	C	8	M	7-29-10-6-JSM		
1507						~ ~ ~				3	C	4	M			
1508						MESB				2	C	3	M	7-29-10-5-JSM		some micro interparticle and nodular porosity throughout section
1509						CF								7-29-10-4-JSM		of MESB
1510						~ ~ ~				5	C	10	M	7-29-10-3-JSM		50% to section if it is dry
1511						~ ~ ~				2	C	3	M			
1512						~ ~ ~				4	C	2	M	7-29-10-2-JSM		
1513						MESB								7-29-10-1-JSM		
1514						Base										

Core diameter = 9cm

Metric Units (2.5cm = 3m)

Logged By: Kelly Jones

Date: 05-18-11

Page 1 of 1

[illegible]

Core diameter = 8.5cm
Core depth = well log depth

Metric Units (2.5cm = 3m)

Project/Location: JM 00/C-036-B/094-I-15/0 Logged By: AISLYN TRENDLE
 Date: 5-18-2011 Page 1 of 1

Length	Texture					Facies	Grains	Sed. Struct.	Visible Porosity		Fracture		Stylolite		Photo	Sample	Comments
	M	W	P	G	B				Rel. Abun.	Type(s)	Freq.	Cement	Freq.	Type			
1189																	
1190																	
1191																	
1192																	
1193																	
1194																	
1195																	
1196																	
1197																	
1198																	
1199																	
1200																	
1201																	
1202																	
1203																	
1204																	
1205																	
1206																	
1207																	

Core diameter = 10cm

Metric Units (2.5cm = 3m)

* CORE - 3m = WELL LOG @ 1202 and 1197

Project/Location: JEAN MARIE
C-037-L/094-I-05
Date: 5.20.2011

Logged By: AISCINTRENDELL
Page 1 of 2

Length	Texture					Facies	Grains	Sed. Struct.	Visible Porosity		Fracture		Stylolite		Photo	Sample	Comments
	M	W	P	G	B				Rel. Abun.	Type(s)	Freq.	Cement	Freq.	Type			
1555						SWR	↓				4	c/o			5-20-11-13AT		
1556							↓				4	c/o			5-20-11-12AT		
1557							↓				16	c/o			5-20-11-11AT		
1558						RSSR	↓				9B	c/o			5-20-11-10AT		
1559							↓				6	c/o					
156							↓				5	c/o					
1561							↓				23	c/o			5-20-11-9AT		
1562						PSB	↓				7	c/o					
1563							↓				16	c/o			5-20-11-8AT		
1564							↓				12	c/o					
1565							↓				23	c/o					
1566						MESB	↓				31	c			5-20-11-7AT		
1567							↓				51	c/o					
1568															CORE MISSING = 0.5m		
1569						MESB	↓				36	c			5-20-11-6AT		
1570						MESB/FPA	↓				15	c					
1571						MESB/FPA	↓				7	c			5-20-11-5AT		*Playstroms appear to be on an angle - flow deposit
1572							↓				32	c					
1573							↓				25	c					
1574						MESB	↓				41	c			5-20-11-4AT		
1575							↓				20	c					
1576						MESB/FPA	↓				34	c					
1577						MESB	↓				40	c					
1578						MESB/FPA	↓				0				5-20-11-3AT & 5-20-11-2AT		
1579						MESB	↓				8	c					
1580							↓				8	c			5-20-11-1AT		

Core diameter = 10cm

CORE BASE = 1581m

Metric Units (2.5cm = 3m)

CORE - 1m = WELL LOG @ 1554.5m → TOP OF ONCOID RICH UNIT, BASED ON SLIGHTLY HIGHER GR.

Metric Units (2.5cm = 3m)

Logged By: JM

Date: 5/14/11

Page 1 of 1

Length	Texture				Facies	Grains	Sed. Struct.	Visible Porosity		Fracture		Stylolite		Photo	Sample	Comments
	M	W	P	G				Rel. Abun.	Type(s)	Freq.	Cement	Freq.	Type			
1164					BLM	ΣX Y _g				10	C/P					* 5-18-11-62 This makes no sense! Thru 4-18-11-62 fault. No GR thick. zone
1165					MEB	ΣX Y _g				10	C/P					5-18-11-61-Jm
1166						ΣX N				BP						5-18-11-60-Jm
1167					PSB	N Y G B				17	C					5-18-11-59-Jm
1168					SW	ΣX N				0	C					5-18-11-57-Jm
1169						ΣX N				0						5-18-11-56-Jm
1170					SIW	ΣX N				0						5-18-11-55-Jm
1171						ΣX N				0						5-18-11-54-Jm
1172					IFM	ΣX N				0						5-18-11-53-Jm
1173					BLM	ΣX N				0						5-18-11-51-Jm
1174						ΣX N				0						5-18-11-50-Jm
1175						ΣX N				0						5-18-11-50-Jm
1176						ΣX N				0						5-18-11-50-Jm
1177						ΣX N				0						5-18-11-50-Jm
1178						ΣX N				0						5-18-11-50-Jm

Core diameter = 10.5 cm not ^{Base of cone 117.3 m} _{slabbed}

Metric Units (2.5cm = 3m)

cone depth - 3.2 m = log depth

Project/Location: JM 00/C-045-F/094-I-08/0

Logged By: AISHLYN TRENDLE

Date: 5.19.2011

Page 1 of 1

Length	Texture					Facies	Grains	Sed. Struct.	Visible Porosity		Fracture		Stylolite		Photo	Sample	Comments
	M	W	P	G	B				Rel. Abun.	Type(s)	Freq.	Cement	Freq.	Type			
1259																	
1260																	
1261																	
1262																	
1263																	
1264																	
1265																	
1266																	
1267																	
1268																	
1269																	
1270																	
1271																	
1272																	
1273																	
1274																	
1275																	
1276																	
1277																	
1278																	
1279																	
1280																	

Core diameter = 10 cm

Metric Units (2.5cm = 3m)

CORE - 3m = WELL LOG @ 1276m

Project/Location: Jean Marie
00-C-645-G/94-I-12
Date: 5-18-11

Logged By: Curtis Barclay (CJB)
Page 1 of 2

Length	Texture					Facies	Grains	Sed. Struct.	Visible Porosity		Fracture		Stylolite		Photo	Sample	Comments
	M	W	P	G	B				Rel. Abun.	Type(s)	Freq.	Cement	Freq.	Type			
Core 1 ↑ 1488																	
1489																	Core not recovered
1490																	
↓ 1491						CFR	sk 0+ 02	~	-		0					5-18-11-24CSB	
1492						CFR	sk 0+ 02	~	-		0						
Core 2 ↑ 1493						CFR	sk 0+ 02	~	-		0					5-18-11-23CSB	oncoids (CFR)
1494						SIW	sk 0+ 02	~	-		0						
1495						SIW	sk 0+ 02	~	-		0					5-18-11-22CSB	
↓ Core 1 1496						SIW	sk 0+ 02	~	-		0						Grains get fairly large
1497						SIW	sk 0+ 02	~	-		0						
1498						SIW	sk 0+ 02	~	-		0						
1499						SIW	sk 0+ 02	~	-		0					5-18-11-21CSB	
1500						SIW	sk 0+ 02	~	-		0					5-18-11-20CSB	storm deposit
1501						IFM	sk 0+ 02	~	-		0					5-18-26-11-19CSB	burrow full of shell fragments
1502						IFM	sk 0+ 02	~	-		R						mostly R rubble
1503						IFM	sk 0+ 02	~	-		R						mostly rubble
1504																	
1505																	
1506																	Core not recovered
1507																	
1508																	
1509																	
1510																	
1511																	
1512																	
1513																	
1514																	

Core diameter = 6.5 cm
bottom core = 1513.5

Metric Units (2.5cm = 3m)

Depth Shift = core depth - log depth

Project/Location: Jenn Marie
00/C-067-F/094-I-12/0
Date: 5-20-11

Logged By: Curtis Barclay (CSB)
Page 1 of 2

Length	Texture M W P G B	Facies	Grains	Sed. Struct.	Visible Porosity Rel. Abun. Type(s)	Fracture Freq. Cement	Stylolite Freq. Type	Photo	Sample	Comments
1478		BLM	none		-	R				very
1479		BLM	none		-	R			5-20-11-15CSB	
1480		SWR	SK G		F	7 C				
1481		SWR	SK G		-	7 C			5-20-11-14CSB	very low ϕ
1482		SWR	SK G		F	13 C				few grains less fractures
1483		SWR	SK G		F	38 C			5-20-11-13CSB	few grains highly fractured
1484		AF	SK G		F	20 C			5-20-11-12CSB	very muddy & fractured
1485		METB	SK G		F	37 C				
1486		METB	SK G		M	21 C				same
1487		METB	SK G		M	6 C				same
1488		METD	SK G		BP M	19 C			5-20-11-11CSB	bound SK grains
1489		METB	SK G		BP M	13 C				a few large fracture but filled w/ calcite
1490		METB	SK G		BP M	16 C			5-20-11-10CSB	diverse grains bound by granulation
1491									no recovery	
1492		PLM	none		-	0			5-20-11-9CSB	no visible ϕ
1493		MESB/PSB	SK G		BP M	3 C			5-20-11-8CSB	large calcite fill
1494		MESB/PSB	SK G		BP M	4 C				very grainy matrix
1495		MESB/PSB	SK G		BP M	5 C			5-20-11-7CSB	large wags large calcite fill
1496		MESB/PSB	SK G		BP M	4 C			5-20-11-6CSB	GF filled w/ calcite mud matrix
1497		MESB/PSB	SK G		BP M	5 C			5-20-11-5CSB	fault? fracture
1498		MESB/PSB	SK G		BP M	6 C			5-20-11-4CSB	very muddy with lots of ~ (low ϕ)
1499		MESB/PSB	SK G		BP M	14 C				
1500		MESB/PSB	SK G		BP M	15 C			5-20-11-3CSB	bound by platy and tab shows
1501		MESB/PSB	SK G		BP M	11 C				more fractures but filled w/ calcite
1502		MESB/PSB	SK G		BP M	5 C			5-20-11-2CSB	large calcite fracture/fault fill
1503		MESB/PSB	SK G		BP M	0			5-20-11-1CSB	very grainy low density

Core diameter = 9.5 cm

Bottom of core = 1504.0 (lost 3 meters)

Metric Units (2.5cm = 3m)

Depth Shift = unknown

Logged By: *Curtis Barclay (CTB)*
Page 2 of 2

[illegible]

Core diameter = 9.5 cm

Metric Units (2.5cm = 3m)

Depth Shift = unknown (no log data)

Project/Location: JEAN MARIE
C-71-K 94-I-1
Date: 7-27-2010

Logged By: ATCHLEY
Page 1 of 1

Length	Texture					Facies	Grains	Sed. Struct.	Visible Porosity		Fracture		Stylolite		Photo	Sample	Comments
	M	W	P	G	B				Rel. Abun.	Type(s)	Freq.	Cement	Freq.	Type			
1368							CORE TOP										
1369							SK. 22				4		7	nh			
1370							SK. 22				4		5	nh			
1371						METB	SK. 22				2	C	5	nh			HAIRLINE AND
1372							SK. 22				5		5	nh			SOLUTION-ENLARGED FRACTURES
1373							SK. 22				R		5	nh			
1374													6	nh			
1375						SWCO	SK. 22						6	nh			MICRO BP? (OIL-STAINED)
1376													12	nh			
1377							SK. 22						8	nh			COMMON GF SPARRY CALCITE CEMENT
1378						METB	SK. 22				3		5	nh			SOLUTION-ENLARGED FRACTURE
1379							SK. 22						10	nh			
1380						PSB	SK. 22						5	nh			
1381							SK. 22				16	C	12	nh			HAIRLINE FRACTURES
1382						SWCO	SK. 22				14	C	16	nh			
1383							SK. 22										
1384						SIW	SK. 22						>50	nh			
1385							SK. 22										
1386						IFM	SK. 22						12	nh			
1387						BLM	SK. 22										
							CORE BASE										

Core diameter = 10CM

Metric Units (2.5cm = 3m)

CORE DEPTH - 1.5m = LOG DEPTH

Logged By: JM

Page 1 of 1

[illegible]

Metric Units (2.5cm = 3m)

Core depth = CG depth

Project/Location
Date: 5/19/11

Page 1 of

Top of core

Base of cone = 1483.95

Core diameter = 8.5 cm

Metric Units (2.5cm = 3m)

- * Rip up clasts s. relative to other cone of the laminated clasts. There are oligonietic (some clasts gneiss; some Pine red) poss. ble. transgressive long layers of t. Material is mud that has been recrystallized to fine calcite crystals, etc.

$$\text{core depth} - 0.7 \text{ m} = \text{log depth}$$

Logged By: ATCHLEY
Page 1 of 1

Core diameter = 10 cm

Metric Units (2.5cm = 3m)

CORE DEPTH - 1.3 m = LOG DEPTH

Project/Location: Jean Marie 002 - 093-D-094-1-0510 Logged By: Kelly Jones
 Date: 05-19-2011 Page 1 of 1

Length	Texture					Facies	Grains	Sed. Struct.	Visible Porosity		Fracture		Stylolite		Photo	Sample	Comments	Top Core 1
	M	W	P	G	B				Rel. Abun.	Type(s)	Freq.	Cement	Freq.	Type				
11614						SWA			-		4	C			05-19-11-26KJ		Rugose + Thamnopora typically nucleates of oncoids	
11615									-		4	C			05-19-11-25KJ			
11616						SR			-		12	C			05-19-11-24KJ			
11617									-		14	C			05-19-11-23KJ			
11618						RBM	-		-		16	C			05-19-11-22KJ			
11619							-		-		16	C						
11620							-		-		16	C			05-19-11-21KJ			
11621						MESB				WP	19	C			05-19-11-20KJ		Growth from pores occluded by calcite sp. cement	
11622											23	C			05-19-11-19KJ			
11623						Rubble			-		R	-			05-19-11-17KJ			
11624																		
11623																		
11627																		
11628																		
11629																		
11630																		
11631																		
11632						Top Core 2					2	C			05-19-11-16KJ			
11633						PSB					4	C			05-19-11-15KJ			
11634											5	C			05-19-11-14KJ			
11635											2	C						
11636						SWA					0				05-19-11-13KJ			
11637											2	C						
11638											1	C						
11639											3	C			05-19-11-12KJ			
11640											5	C			05-19-11-11KJ			

Core diameter = 10.0cm

Metric Units (2.5cm = 3m)

depth shift-??

Logged By: Kelly Jones

Date: 05-19-11

Page 1 of 1[illegible]

Core diameter = 9.0 cm

Metric Units (2.5cm = 3m)

Depth shift = ?

Project/Location: JM 00/C-096-3/094-I-05/0
 Date: 5.19.2011

Logged By: AISHA TRENDLE
 Page 1 of 1

Length	Texture					Facies	Grains	Sed. Struct.	Visible Porosity		Fracture		Stylolite		Photo	Sample	Comments
	M	W	P	G	B				Rel. Abun.	Type(s)	Freq.	Cement	Freq.	Type			
1476						SWR					1	C				5-19-11-33AT ← 5-19-11-34AT	
1477											1	C					
1478											10	C/O					
1479											6	C/O				5-19-11-32AT	
1480						SWR					1	C/O					
1481											4	C/O				5-19-11-31AT	
1482											14	C/O					
1483						AF					4	C				5-19-11-30AT	
1484											15	C/O					
1485											132	C					
1486						CFR					42	C					
1487											29	C				5-19-11-29AT	
1488						CF					34	C					
1489											27	C					
1490											3	C					
1491						MESB					9	C				5-19-11-28AT	
1492											4	C					
1493						SWR					3	C				5-19-11-27AT	
1494											7	C					

CORE BASE = 1494.80

Core diameter = 10cm

Metric Units (2.5cm = 3m)

* CORE-1m = WELL LOG @ 1493m and 1478m

APPENDIX E

Core Descriptions from UWI starting with 200-D

Project/Location: JEAN MARIE
D-37-L-94-I-9
Date: 5/19/2011

Logged By: ATCHLEY
Page 1 of 1

Length	Texture					Facies	Grains	Sed. Struct.	Visible Porosity		Fracture		Stylolite		Photo	Sample	Comments
	M	W	P	G	B				Rel. Abun.	Type(s)	Freq.	Cement	Freq.	Type			
955																	NO CORALS OR CRINOIDS! NORMAL PROGRADATION OR ABNORMAL FACIES SUCCESSION ABOVE SEQUENCE BOUNDARY
																	CORE TOP
960						ACLM	SK	GF		AREAL, SK	1				5-19-11-355A 5-19-11-365A		
											1				5-19-11-345A		ARCNICOLITES SEQUENCE BOUNDARY?
											1				5-19-11-375A 5-19-11-335A 5-19-11-325A		BLACKENED HARDGROUND TRYPANITES, PYRITIZED, BLACKENED SURFACE AND BLACKENED CLASTS
						DSW	SK	GF		UT	3				5-19-11-315A		
											4				5-19-11-305A 5-19-11-295A		CRINOIDES, BRACHS, AND CORALS
965						MESB (BACK REEF)					7 %						CYLINDRICAL CORALS
											20 %						
									F		22 %				5-19-11-285A		
									F		59 %				5-19-11-275A		
									F		19 %						
						MESB (REEF REST)			F		75 %						
970									F		26 %				5-19-11-265A		
									F		20 %						
									F		32 %				5-19-11-255A		CYLINDRICAL CORALS
						(SLOPE)			GF		10 %				5-19-11-245A		ABUNDANT LATE STAGE, COARSE SPARRY CALCITE W/IN POROSITY
						PSB	SK		GF		9 %						
975						DSW (LOWER SLOPE)									5-19-11-235A		
976															5-19-11-225A		
																	CORE BASE

Core diameter = 10 cm

Metric Units (2.5cm = 3m)

CORE DEPTH + 0.5m = LOG DEPTH?

Project/Location: JM D38-A-094-1-02-0

Logged By: JSM

Date: 7/26/10

Page 1 of 1

Length	Texture					Facies	Grains	Sed. Struct.	Visible Porosity		Fracture		Stylolite		Photo	Sample	Comments
	M	W	P	G	B				Rel. Abun.	Type(s)	Freq.	Cement	Freq.	Type			
1593						BLM											
1594						BLM											
1595						AF							5	~		7-26-10-10-JSM	
1596						CFW							10	~		7-26-10-9-JSM	Coastal community coated w/ algae some @ 1m layer/1cm or col. has
1597						CFW							3	~		7-27-10-8-JSM	Grains commonly algal coated
1598						MESB							15	~		7-27-10-7-JSM	
1599						CFW											
1600						CFW							5	~		7-27-10-7-JSM	@ 1m very small
1601						CFW							5	~			
1602						CFW							5	~		7-26-10-6-JSM	large @ 1m
1603						MESB											
1604						MESB											
1605						SUP							15	~		7-26-10-4-JSM	How some in interbedded MESB, but one likely attached to very shallow reef P. grains larger than the vertical bed
1606						CFW							3	~		7-26-10-5-JSM	Grains 10-15mm diameter
1607						STW							0	~		7-26-10-3-JSM	Less grainy no real dominant grain large brachiopods
1608						STW											
1609						STW											
1610						STW											
1611						ITM											

Core diameter = 9.5cm

Metric Units (2.5cm = 3m)

Grains are in interbedded coarse brachiopod community otherwise fine and fine coarse brachiopod

Logged By: AISLYN TRENDLE
Page 1 of 1

[illegible]

Metric Units (2.5cm = 3m)

CORE + 1m = WELL LOG @ 1533m ON BLM TOP

Project/Location: Secor Marine 001D-043-1/0914-1-06/10 Logged By: Kelly Jones

Date: 05-24-11

Page 1 of 1

Length	Texture					Facies	Grains	Sed. Struct.	Visible Porosity		Fracture		Stylolite		Photo	Sample	Comments
	M	W	P	G	B				Rel. Abun.	Type(s)	Freq.	Cement	Freq.	Type			
1410																	
1411						AF/SW(0)	40% Th				4	C			05		Probably AF or possibly SW(0)
1412							20% Th				1	C					
1413							20% Th				2	C			05-24-11-7KS		
1414						SW(0)	20% Th				0				05-24-11-6KS		Possibly possibly recrystallization of interparticle space? Can not be seen in core
1415							20% Th				2	C					
1416							20% Th				1	C					
1417							20% Th				2	C					
1418						SW(0)	20% Th				7	C			05-24-11-5KS		Possibly weakly developed PSB
1419							20% Th				1	C			05-24-11-4KS		
1420						SW(0)	20% Th				8	C					
1421							20% Th				0				05-24-11-3KS		
1422						SW	20% Th				0						Brachiopods have been recrystallized
1423							20% Th		P		0	RR			05-24-11-1KS		

Core diameter = 10.0 cm

unable to depth chisel

Metric Units (2.5cm = 3m)

Logged By: TH

Date: 5/20/11, 5/24/11

Page 1 of 1

[illegible]

Core diameter = 6.5 cm stubbed

Metric Units (2.5cm = 3m)

core I = core depth - 2.45 m = log depth
core II = core depth - 3.5 m = log depth

$$\text{Core II} = \text{core depth} - 3.5 \text{ m} \approx \text{log depth}$$

Project/Location: JEAN MARIE
 00-D-048-H-094-I-11-0
 Date: 7/27/10

Logged By: ATCHLEY
 Page 1 of 1

Length	Texture M W P G B	Facies	Grains	Sed. Struct.	Visible Porosity Rel. Abun. Type(s)	Fracture Freq. Cement	Stylolite Freq. Type	Photo	Sample	Comments
CORE NOT SLABBED										
4200'										
	F		SK	OST	UTH		12		7-27-10-10SA	ARGILLACEOUS
	F	CF(O)	SK	OST	UTH		12			ARGILLACEOUS
	F		SK	OST					7-27-10-9SA	
4210'		BLM								
									7-27-10-8SA	
4220'	F		SK	OST					7-27-10-7SA	← TRY PANITES
	F		SK	OST						HARD GROUND
	F		SK	OST					7-27-10-6SA	
4230'	F	CF(O)	SK	OST			1			
	F		SK	OST			1		7-27-10-5SA	
	F		SK	OST						
4240'		SW	SK				3			
			SK						7-27-10-4SA	
			SK				1			
4250'			SK				1			
		CF(R)	SK				10		7-27-10-3SA	
			SK				10		7-27-10-2SA	
		PSB	SK				5			
			SK				7			
4260'		CF(R)	SK				30		7-27-10-1SA	DARK, ARGILLACEOUS, VIRTUALLY ALL GRAINS ALGALLY COATED

Core diameter = 10 CM

CORE BASE

Imperial Units (1" = 10')

CORE + 3.5' = LOG DEPTH

Project/Location: Jean Marie 0010-068-K/094-1-12

Logged By: Kelly Jones

Date: 05-20-11

Page 1 of 2

Length	Texture					Facies	Grains	Sed. Struct.	Visible Porosity		Fracture		Stylolite		Photo	Sample	Comments
	M	W	P	G	B				Rel. Abun.	Type(s)	Freq.	Cement	Freq.	Type			
1454												0			05-20-11-30KJ		Grades up core into RSSR
1455												2C					
1456						MESB	~					9C			05-20-11-29KJ		Growth framework pore space occluded by sparry calcite cement, sometimes
1457							GR					11C			05-20-11-28KJ		with open pore space at center of calcite cement
1458							GR					9C					
1459										wp/GF		30C			05-20-11-27KJ		
1460						MESB/PSB	~			wp/GF		30C					
1461							~			GF		3C			05-20-11-26KJ		Bottom Core 1
1462							Y					2C			05-20-11-25KJ		Top Core 2
1463							GR			wp		2C					
1464							GR					3C					Dominated by platy stromatolites but core banded together
1465							GR					0			05-20-11-24KJ		
1466						MESB/PSB	~					1C					
1467							GR					4C			05-20-11-23KJ		
1468							Y					0					Growth framework pores occluded by sparry calcite cement, often with open pores at center of cement throughout MESB/PSB
1469							GR					1C					
1470							Y					10			05-20-11-22KJ		
1471							GR					1C					
1472							GR					3C			05-20-11-21KJ		
1473							GR					8C			05-20-11-20KJ		
1474							Y					6C					
1475						PSB	~					8C			05-20-11-19KJ		
1476							~					10C			05-20-11-18KJ		Darker, fewer stromatolites at base
1477							~					12C					
1478						Strom.	~					0			05-20-11-17KJ		
1479						CFLO	~					GR			05-20-11-16KJ		

Core diameter = 10.0cm

Metric Units (2.5cm = 3m)

core depth = log depth

Project/Location: 00D-66-K/094-1-12/0
 Date: 05-20-11

Logged By: Kelly Jones
 Page 2 of 2

Length	Texture					Facies	Grains	Sed. Struct.	Visible Porosity		Fracture		Stylolite		Photo	Sample	Comments
	M	W	P	G	B				Rel. Abun.	Type(s)	Freq.	Cement	Freq.	Type			
1443							Top Core 1										
1444							AF				2	C				05-20-11-43KS	
1445											3/4	C				05-20-11-42KS	
1446											11	C				05-20-11-41KS	
1447											Mo	0				05-20-11-40KS	Moldic porosity appears in megacrysts
1448							RSSR				Mo	0				05-20-11-39KS	
1449											Mo	1	C				
1450											4	C				05-20-11-38KS	
1451							FPB				Mo	4	C				
1452							RSSR				Mo	3	C			05-20-11-37KS	
1453											1	C				05-20-11-36KS	

Core diameter = 10.0cm

Metric Units (2.5cm = 3m)

Project/Location: JEAN MARIE
D-69-F-94-I-1
Date: 7-23-2010

Logged By: ATCHLEY
Page 1 of 1

Length	Texture					Facies	Grains	Sed. Struct.	Visible Porosity		Fracture		Stylolite		Photo	Sample	Comments
	M	W	P	G	B				Rel. Abun.	Type(s)	Freq.	Comment	Freq.	Type			
1477																	
1478																	
1479																	
1480																	
1481																	
1482																	
1483																	
1484																	
1485																	
1486																	
1487																	
1488																	
1489																	
1490																	
1491																	
1492																	
1493																	
1494																	

Core diameter = 10 cm

Metric Units (2.5cm = 3m)

CORE + 3.5m = LOG DEPTH

Logged By: ATCHLEY
Page 1 of 1

Core diameter = 11 cm

CORE DEPTH = LOG DEPTH

Date: 5/19/2011

Page 1 of 2[illegible]

Core diameter = 9.8 cm

Metric Units (2.5cm = 3m)

CORE DEPTH $\approx$ LOG DEPTH

Project/Location: JEAN MARIE 0-89-E-94-I-4
Date: 5/19/2011

Logged By: ATCHLEY
Page 2 of 2

[illegible]

Core diameter = 9.8 cm

Metric Units (2.5cm = 3m)

Logged By: ATCHLEY
Page 1 of 1

Core diameter = 10 cm

CORE DEPTH - 1.25m = LOG DEPTH?

Logged By: Curtis Barclay (CJB)
Page 1 of 1

[illegible]

Core diameter = 9.5 cm bottom of core = 1152.0

Metric Units (2.5cm = 3m)

Depth Shift : core depth = log depth

Project/Location: JM 00/D-094-J/94-I-12/0 Logged By: AISLYN TRENBELL
 Date: 5-24-2011 Page 1 of 1

Length	Texture				Facies	Grains	Sed. Struct.	Visible Porosity		Fracture		Stylolite		Photo	Sample	Comments
	M	W	P	G				Rel. Abun.	Type(s)	Freq.	Cement	Freq.	Type			
1439						Fig				0					5-24-2011-10AT	*Muddy Boloid pocket
1440										0						
1441										0					5-24-2011-9AT	
1442										2	C					
1443										3	C				5-24-2011-8AT	
1444										5	C				5-24-2011-7AT	
1445										0						
1446										1	C					
1447										0						
1448										1	C				5-24-2011-6AT	
1449										2	C/O					
1450										3	C/O				5-24-2011-5AT	
1451										0						
1452										7	C					* POROSITY (NPHI) ↑
1453										4	C				5-24-2011-4AT	
1454										6	O				5-24-2011-3AT	
1455										5	O				5-24-2011-2AT	* INTRACLAST OF ONCOLIC ROCKS IMMEDIATELY BENEATH THE MCSB UNIT.
1456										4	O				5-24-2011-1AT	

Core diameter = 10 cm

Metric Units (2.5cm = 3m)

CORE-1m = WELL LOG @ 1452.5m

Project/Location: Sean Marie 0010-096-D/0944-096

Logged By: Kelly Jones

Date: 05-19-11

Page 1 of 1

Length	Texture				Facies	Grains	Sed. Struct.	Visible Porosity		Fracture		Stylolite		Photo	Sample	Comments
	M	W	P	G				Rel. Abun.	Type(s)	Freq.	Cement	Freq.	Type			
1146								-		6	C				05-20-11-15KJ	
1147								-		11	C					
1148					SW(R)			-		9	C				05-20-11-14KJ	
1149								-		8	C				05-20-11-13KJ	
1150								-		7	C				05-20-11-12KJ	
1151					PSB			-		6	C				05-20-11-11KJ	Very Weak PSB
1152								-		3	C				05-20-11-10KJ	Dark and Muddy
1153								-		8	C				05-20-11-9KJ	
1154					SW(R)			-		9	C				05-20-11-7KJ	
1155								-		3	C				05-20-11-6KJ	
1156								-		0					05-20-11-5KJ	Grades upward into an SW(R)
1157					SR			-		0						
1158								-		0					05-20-11-4KJ	
1159					IFM			-		R					05-20-11-3KJ	Small. ofm interbedded SR at 1158.84-1158.93m depth
1160					BLM			-		R					05-20-11-2KJ	
								-							05-20-11-1KJ	

Core diameter = 8.5cm
Core depth = log depth

Metric Units (2.5cm = 3m)

Project/Location: D-98-J-94-I-11
Date: 5/24/2011

Logged By: ATCHLEY
Page 1 of 1

Core diameter = 10 cm

Metric Units (2.5cm = 3m)

$$\text{CORE DEPTH} + 0.5\text{m} = \text{LOG DEPTH}$$

APPENDIX F

Core Descriptions from UWI starting with 202

JEAN MARIE

Project/Location: 02-A-05B-C-094-I-02-0 Logged By: ATCHLEY

Date: 7-27-2010

Page 1 of 1

Length	Texture					Facies	Grains	Sed. Struct.	Visible Porosity		Fracture		Stylolite		Photo	Sample	Comments
	M	W	P	G	B				Rel. Abun.	Type(s)	Freq.	Cement	Freq.	Type			
1597																	CORE TOP
1598																	
1599						BLM											FISSILE "POKER-CHIP" RECOVERY
1600																7-27-10-325A	
1601																7-27-10-315A	
1602																	THIN-SHELLED (ARTICULATED)
1603																	← 1cm PYRITE NODULE
1604						SWCR										7-27-10-303A	MINIATURE FAUNA THROUGHOUT FACIES
1605																7-27-10-295A	
1606																	
1607																	
1608																7-27-10-285A	
1609						(PSD) MES. B										7-27-10-275A	
1610																7-27-10-265A	
1611						CF(R)										7-27-10-255A	MICRO-FRACTURES
1612																	
1613						SIW										7-27-10-245A	COLONIAL TABULATE

Core diameter = 10 cm

CORE BASE

Metric Units (2.5cm = 3m)

CORE DEPTH = 1.25 m = LOG DEPTH

Project/Location: Jean Marie
02/B-008-3/094-I-12/0
Date: 5-24-11

Logged By: Curtis Barclay (CJB)
Page 1 of 2

Length	Texture				Facies	Grains	Sed. Struct.	Visible Porosity		Fracture		Stylolite		Photo	Sample	Comments
	M	W	P	G				Rel. Abun.	Type(s)	Freq.	Cement	Freq.	Type			
1450					BLM	none				0						
1451					BLM	none				0			✓	5-24-11-21CJB		
1452					BLM					4	C		✓	5-24-11-20CJB		
1453					CFO	~ O				2	C		✓	5-24-11-19CJB		
1454					PSB/CFO	~ O R				4	C					limited
1455					PSB/CFO	~ O R				6	C		✓	5-24-11-18CJB		muddy low
1456					PSB	~ O R				14	C/O		✓	5-24-11-17CJB		muddy low
1457					MESB	~ O R				9	C/O		✓	5-24-11-16CJB		at pores open
1458					MESB	~ SK				12	C/O		✓	5-24-11-15CJB		GF sometimes calcite filled but sometimes open
1459					MESB	~ O R				4	C		✓	5-24-11-13CJB		calcite in GF but open too
1460					MESB	~ A G				14	C		✓	5-24-11-11CJB		very high & light calcite (grainy)
1461					MESB	~ O R				15	C		✓	5-24-11-10CJB		calcite in GF
1462					MESB	~ O R				17	C		✓	5-24-11-9CJB		
1463					MESB	~ O R				10	C/O					matrix starting getting darker (still grainy)
1464					MESB	~ O R				11	C/O					
1465					MESB	~ O R				17	C/O		✓	5-24-11-8CJB		
1466					MESB	~ O R				24	C/O		✓	5-24-11-7CJB		band by stains fairly grainy
1467					PSB	~ O R				59	C/O		✓	5-24-11-6CJB		
1468					SR	~ O R				55	C/O					
1469					SR	~ O R				21	C		✓	5-24-11-5CJB		lots of mud corals
1470					PSB	~ O R				13	C		✓	5-24-11-4CJB		
1471					PSB	~ O R				12	C		✓	5-24-11-3CJB		very diverse
1472					CFO	~ O R				14	C					very muddy
1473					CFO	~ O R				6	C		✓	5-24-11-2CJB		low visible porosity
1474					CFO	~ O R				3	C					
1475					CFO	~ O R				3	C					

core 1
↑
core 2
↓

Core diameter = 8.5 cm bottom of core = 1476.2 m

Metric Units (2.5cm = 3m)

Depth shift = core depth + 2.5 meters = log depth

Logged By: Curtis Barclay CSB
Page 2 of 2

[illegible]

Core diameter = 8.5 cm

Metric Units (2.5cm = 3m)

$$\text{Depth Shift} = \text{Core depth} + 2.5 \text{ meters} = \log \text{ depth}$$

REFERENCES

- Adams, C., Schwabe, M. and Riddell, J., 2006, British Columbia Oil & Gas Exploration, Activity Report A, BC Ministry of Energy, Mines and Petroleum Resources: <http://www.em.gov.bc.ca/mining/geoscience/publicationscatalogue/oilgas/ogreports/Pages/default.aspx> (accessed October 2011).
- Ahr, W. M., 1973, The carbonate ramp; an alternative to the shelf model. *Transactions - Gulf Coast Association Of Geological Societies*, v. 23, p. 221-225.
- Blakey R.C., 2008, Paleogeography and Geologic Evolution of North America: <http://www2.nau.edu/rcb7/nam.html> (accessed November 2011).
- Bond, G. C., and Kominz, M. A., 1991, Disentangling middle Paleozoic sea level and tectonic events in cratonic margins and cratonic basins of North America, *Journal of Geophysical Research*, v. 96(B4), p. 6619-6639.
- Corlett, H., and Jones, B., 2011, The influence of paleogeography in epicontinental seas; a case study based on Middle Devonian strata from the MacKenzie Basin, Northwest Territories, Canada. *Sedimentary Geology*, v. 239 (3-4), p. 199-216.
- Goldhammer, R. K., Dunn, P. A., and Hardie, L. A., 1990, Depositional cycles, composite sea-level changes, cycle stacking patterns, and the hierarchy of stratigraphic forcing; examples from Alpine Triassic platform carbonates, *Geological Society Of America Bulletin*, v. 102(5), p. 535-562.
- Hallam, A. A., and Wignall, P. B., 1999, Mass extinctions and sea-level changes, *Earth-Science Reviews*, v. 48(4), p. 217-250.
- Johnson, J. G., Klapper, G., and Sandberg, C. A., 1985, Devonian eustatic fluctuations in Euramerica, *Geological Society Of America Bulletin* v. 96(5), 567-587.
- Klapper, G. G., 1988, The Montagne Noire Frasnian (Upper Devonian) conodont succession, *Canadian Society Of Petroleum Geologists, Memoir* v. 14, p. 449-468.
- Mei, S., 2009, New insights on faults in the Peace River Arch region, northwest Alberta, based on existing well-log data and refined trend surface analysis, *Canadian Journal of Earth Sciences*, v. 46(1), p. 41-65.
- MacNeil, A. J., and Jones, B. G., 2006, Sequence stratigraphy of a Late Devonian ramp-situated reef system in the Western Canada Sedimentary Basin; dynamic responses to sea-level change and regressive reef development, *Sedimentology*, v. 53(2), p. 321-359.

- Pittman, W., 1978, Relationship between eustasy and stratigraphic sequences of passive margins, *Geological Society Of America Bulletin*, v. 89(9), p. 1389-1403.
- Plint, A., Eyles, N., Eyles, C. H., and Walker, R. G., 1992, Control of sea level change, *in* R.G. Walker and N.P. James (eds.), *Facies Models: Response to Sea Level Change*, Geological Association of Canada, p. 15-25.
- Potma, K., Weissenberger, J. W., Wong, P. K., and Gilhooly, M. G, 2001, Toward a sequence stratigraphic framework for the Frasnian of the Western Canadian Basin, *Bulletin Of Canadian Petroleum Geology*, v. 49(1), p. 37-85.
- Price, R. A., and Mountjoy, E. W., 1970, Geology along the Bow River from west of Calgary to Lake Louise, *in*: R.A. Price (ed.), *A geological guide along the highways between Drumheller, Calgary, and Lake Louise*, Alberta Society of Petroleum Geologists.
- Price, R. A., 1994, Cordilleran tectonics and the evolution of the Western Canada sedimentary basin, *in*: G. D. Mossop (ed.), *Geological Atlas of the Western Canada Sedimentary Basin*, Canadian Society of Petroleum Geologists, p. 12-24.
- Reineck, H., and Wunderlich, F., 1968, Classification and origin of flaser and lenticular bedding, *Sedimentology*, v. 11(1-2), p. 99-104.
- Scotese, C. R., 2004, A continental drift flipbook, *Journal Of Geology*, v. 112(6), p. 729-741.
- Sloss, L. L., 1963, Sequences in the cratonic interior of North America, *Geological Society Of America Bulletin*, v. 74(2), p. 93-113.
- Srivastava, P., 2006, Meso-Neoproterozoic coated grains and palaeoecology of associated microfossils; the Deoban Limestone, Lesser Himalaya, India, *Palaeogeography, Palaeoclimatology, Palaeoecology*, v. 239(3-4), p. 241-252.
- Van Wagoner, J. C. 1995, Overview of sequence stratigraphy of foreland basin deposits; terminology, summary of papers, and glossary of sequence stratigraphy, *in*: J. C Van Wagoner (ed.), *Sequence stratigraphy of foreland basin deposits; outcrop and subsurface examples from the Cretaceous of North America*, American Association of Petroleum Geologists, Memoir v. 64, p. ix-xxi.
- Wendte J, Byrnes A, Sargent D, and Al-Aasm I, 2009a, Depositional facies framework, evolution, and reservoir architecture of the Upper Devonian Jean Marie Member (Redknife Formation) in the July Lake area of northeastern British Columbia, *Bulletin of Canadian Petroleum Geology*, v. 57(3), p. 209-250.

- Wendte, J., Byrnes, A., and Sargent, D., 2009b, The control of hydrothermal dolomitization and associated fracturing on porosity and permeability of reservoir facies of the Upper Devonian Jean Marie Member (Redknife Formation) in the July Lake area of northeastern British Columbia, *Bulletin Of Canadian Petroleum Geology*, v. 57(4), p. 387-408.
- Whalen, M. T., and Day, J. E., 2010, Cross-basin variations in magnetic susceptibility influenced by changing sea level, paleogeography, and paleoclimate; Upper Devonian, Western Canada Sedimentary Basin, *Journal of Sedimentary Research*, v. 80(12), p. 1109-1127.
- Wilson, J. L., 1975, *Carbonate facies in geologic history*, Springer-Verlag, New York , p. 471.