DEPOSITIONAL HISTORY OF UPPER BAFFIN BAY,

TEXAS

By

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CHAPTER I

INTRODUCTION

Problem and its significance:

Incised valleys are an important component of the transgressive system tract because they contain the most complete stratigraphic record of transgression and coastal response to sea-level rise (Belknap and Kraft, 1981; Belknap et al., 1994). As they provide the highest preservation potential of shallow-marine environments within the transgressive system tract, incised valleys are also important targets for exploration geologists and serve as excellent stratigraphic traps (Van Wagoner, 1990; Zaitlin et al., 1994). Although many studies have been conducted on incised-valley systems, they are focused on systems containing either well developed sandy tidal bars or large amounts of fluvial sand and/or tidal-delta complexes (Allen and Posamentier, 1993; Thomas and Anderson, 1994; Bowen et al., 2003). Few examples of incised valleys filled with mixed siliciclastic/carbonate-fill have been documented.

Mixed siliciclastic/carbonate-filled incised valleys may be difficult to recognize. Most incised valleys are picked by their basinward shift in facies such as fluvial sands in an otherwise shelf setting dominated by marine muds. Generally when exploration geologists find ooids, reefs, or other carbonate deposits within a cored interval, they will look toward a carbonate depositional setting but not an incised-valley system.
Hence, the proper identification of mixed siliciclastic/carbonate-filled incised valleys is necessary for the identification of sequence boundaries that might otherwise be left unnoticed. These unnoticed sequence boundaries can be traced through the basin to find other incised valleys and even shelf-margin deltas and lowstand fans, which are excellent stratigraphic traps. Moreover, mixed siliciclastic/ carbonate-filled incised valleys themselves contain environments such as reefs, ooid sands, and tidal deltas which may serve as petroleum reservoirs. In addition, a detailed study of the facies architecture of incised valleys may provide a better understanding of the evolutionary changes that occur within incised-valley systems, which may help in predicting the environmental effects to future increases in the rate of sea-level rise.

**Objective:**

The objective of this study is to document the internal architecture of Baffin Bay, a mixed siliciclastic/carbonate incised valley. As part of this objective, three specific questions will be addressed in this study. 1) When did the loss of stream power by the Baffin Bay incised-valley system occur? 2) What was the cause of the loss of stream power? 3) Is there any relationship between flooding of fluvial terraces and the development of parasequences within the incised valley? In addition, we will create one of the first facies models for the Holocene deposits of upper Baffin Bay.

**Hypothesis:**

*Timing of the loss of Stream Power:*

The creeks flowing into Baffin Bay created an incised valley up to 24 m deep during a sea-level fall between 120-20 ka (Behrens, 1963). However, at present they do
not produce a bay-head delta or deliver enough sediment to inhibit carbonate deposition within their estuary. According to Behrens and Land (1972), dolomite deposition within Baffin Bay, usually excluded by the delivery of large amounts of siliciclastic materials, was initiated prior to 4,000 years ago. This suggests that the creeks flowing into Baffin Bay lost their power to deliver sediments prior to 4ka.

Cause of Loss of Stream Power:

We considered two possibilities that may account for the loss of stream power: a stream-capture event or climate change. A stream-capture event is questioned by Daub (1979) who finds that that the Nueces River, the closest river system to the creeks flowing into Baffin Bay, captured a portion of the Baffin Bay drainage well before the Miocene. Although the possibility of a stream capture event is ruled out, climate changes affecting the region are supported by some studies. Investigations of the late Quaternary climate history of central Texas have shown significant changes in the climate of Texas over the last 20 ka. (Bryant, 1977; Bryant and Holloway, 1985; Toomey et al., 1993; Humphery and Ferring, 1994, Nortd et al., 1994; Goodfriend and Ellis 2000; Russ et al., 2000; Musgrove et al., 2001; Nortd et al., 2002). A study by Simms (2005) has shown a significant impact of climate on the architecture of the Nueces incised valley located 55 km to the north of Baffin Bay (Fig. 1). The presence of oyster mittens reported by Breuer (1957) along the shorelines of Baffin Bay suggests a wetter climate in Baffin Bay sometime during the past.

Flooding of Fluvial Terraces:

Rodriguez et al. (2005) suggested that the flooding of fluvial terraces formed during the fall in sea level between 120-20 ka is one possible mechanism for
Figure 1. Location map of the study area. Inset is the sequence boundary that formed during the last lowstand in sea level across the Texas shelf with the location of Baffin Bay and the Trinity and Nueces incised valleys (Modified from Coluburn and Baskin, 1998 and Simms et al., 2007a).
parasequence development within the Trinity and Nueces incised valleys (Fig. 2). One
unrestrained factor relating to this mechanism is the role that winds play in enlarging the
area of fluvial terraces. A study by Reynaud et al. (1999) described a similar feature
within the incised valleys of the southern Celtic Sea and relates the large terraces and
associated changes within the adjacent valley fill to wave-ravinement surfaces.

The fluvial shape of Baffin Bay is better preserved than Galveston and Corpus
Christi bays because of its orientation with respect to the prevailing winds along the
Texas coast (Behrens, 1963; McGowen et al., 1977; Morton and Paine, 1984). Moreover,
the shores of Baffin Bay are relatively difficult to erode due to the cementation of
shoreline sediments and the forming of beach rock at several places along the bay shores
(Behrens, 1963). No work has been done to specifically document the presence of fluvial
terraces in the Baffin Bay incised valley. However, seismic profiles shot by Behrens
(1963) suggest the presence of fluvial terraces beneath Baffin Bay (Fig. 3). Assuming the
terraces exist and their preservation was similar to the bayshore preservation today,
flooding events corresponding to terraces would provide support for the theory proposed
by Rodriguez et al. (2005). If flooding surfaces are not found at the same elevation as
terraces, it favors Reynaud et al. (1999)’s explanation for terrace development.
Figure 2. Graphs showing sedimentation rates, facies changes, and valley morphology for the Nueces and Trinity incised valleys. Decreases in sedimentation rate in valley-fill successions correlate with decreases in valley-wall gradients. (Modified after Rodriguez et al., 2005).
Figure 3. Seismic profile from Behrens (1963) study of Baffin Bay. Note the possible terrace along the flank of the incised valley. See Figure 4 for line A-A’ location.
CHAPTER II
BACKGROUND STUDY

Study Area:

Geographical /Geological Setting:

Baffin Bay is located along the Texas coast about 55 km south of Corpus Christi, Texas (Fig. 1). It is situated at approximately a right angle to the present shoreline of the Gulf of Mexico. The average width of Baffin Bay is 5 km and the length is 25 km. Laguna Madre and Padre Island separate Baffin Bay from the Gulf of Mexico (Fig. 1). The Baffin Bay estuary complex was cut off from the Gulf of Mexico by the evolution of the Padre Island barrier complex approximately 4000 years ago (Fisk, 1959). As a result of this isolation and the semi arid-setting of the bay, the salinity of the bay increased dramatically.

Baffin Bay, which projects inland from Laguna Madre, is the flooded late Pleistocene/Holocene incised valley created by Petronila, San Fernando, and Los Olmos Creeks. During a sea-level fall between 120-20 ka the creeks cut an incised valley between 18-24 m deep at the present coastline (Behrens, 1963) and up to 30 m deep on the shelf (Eckles et al., 2004). The incised valley has partially filled with Holocene sediments following a sea-level rise over the last 20ky. In addition to black mud facies and terrigenous clastic facies, Baffin Bay also contains coated grains, ooids, surpulinid worm tube reefs, stromatolites, and evaporates (Fig. 4), all of which are not usually
Figure 4. Surface deposits of Baffin Bay (Dalrymple, 1964) and location of incised valley axis as mapped by Behrens (1963). Terr = Terrigenous clastics. Note that terrigenous clastics contain 29.7 - 51.7% carbonate material (Dalrymple, 1964). Black mud is composed of 4.9 - 17.1% carbonate (Dalrymple, 1964). Profile A-A’ is shown in Figure 3.
associated with incised valleys (Dalrymple, 1964). Hence, it is clear that Baffin Bay represents an “under-filled” incised valley (Simms et al., 2006) and is the site of a mixed siliciclastic/carbonate depositional system. In addition, studies show that in spite of the creeks’ power to incise a deep valley during the Last Glacial Maximum (LGM), today the creeks are unable to create even the most modest bay-head delta (Dalrymple, 1964; White et al. 1983; Morton et al. 2000).

**Climate:**

Baffin Bay lies within a semi-arid climate (Thornthwaite, 1948). Average normal annual rainfall is 68 cm/year (Fig. 5). Evaporation surpasses rainfall by 53 cm/year. The average annual temperature is 22° C with an absolute maximum temperature around 40°C and an absolute minimum temperature around -11°C (Rusnak, 1960). Continuous strong winds of 14 km/hr to 23 km/hr from the southeast quadrant prevail for about seven months per year (February to August) creating strong waves throughout most of the day. During the night, the wind speeds abate slightly (Rusnak, 1960; Dalrymple, 1964). Such strong wind activity brings noticeable changes in the water levels of Baffin Bay (Dalrymple, 1964).

**Salinity:**

The combination of a semi-arid climate, limited stream inflow, and restricted circulation with normal marine waters has resulted in the hypersaline condition of the bay at the present time (Rusnak, 1960; Dalrymple, 1964, Stewart 1994). In drought conditions, salinities of Baffin Bay reach 85 ppt and in normal conditions range between 40-50 ppt (Beherns, 1966). The surface salinity study of Baffin Bay in 1962 by Dalrymple shows a salinity of 55-62 ppt (Fig. 6).
**Figure 5.** Climatic gradient along the Texas Coast expressed in terms of climate zones (A) and the difference between annual precipitation and mean annual evapotranspiration with contour intervals of 4 inches/year (from Stewart, 1994).
Figure 6. Distribution of surface salinities within Baffin Bay in November 1962 (Dalrymple, 1964).
Though hypersalinity has been prominent in Baffin Bay, it has not been constant. Short term seasonal as well as long term salinity variations have been described for the Baffin Bay area (Breuer 1957, Dalrymple 1964, Behern, 1966, Stewart, 1994). Short term salinity changes are greatest at the heads of the tributary bays, where salinities may drop considerably due to heavy rainfall in the drainage areas of the intermittent streams entering the bay (Dalrymple 1964). Seasonal variations in the salinity are profound throughout the entire bay with the dry summer having the highest values. Concerning long term variation, Breuer (1957) showed that the salinity of Cayo del Grullo was low enough to permit oyster growth during the 1800’s. The study of the foraminiferal biofacies of the upper Holocene (4000-years to the present) suggests that Baffin Bay has experienced high frequency (hundreds of years) cycles in paleosalinity ranging from moderately hyposaline environments (15-30 ppt) to hypersaline (Stewart, 1994).

**Bathymetry:**

The bathymetry of Baffin Bay is complicated due to the presence of numerous rock shoals which are mostly confined to shallow waters near shore. During our field work, the maximum depth recorded was around 2.5 m. However, our study area is limited to the upper portions of the bay. A detailed bathymetry study of the bay by Dalrymple (1964) located maximum water depths of 3 m (Fig. 7).
Figure 7. Generalized bathymetry of Baffin Bay (Dalrymple, 1964).
Holocene Sea-Level History of U.S. Gulf Coast:

Several studies have been conducted on the Late Quaternary coastal geology of the U.S. Gulf coast. However, the Holocene sea-level history of this region is still controversial in many aspects.

During the Last Glacial Maximum (LGM), which occurred around 20,000 years ago, global sea level was approximately 120 m lower than present. Some authors have suggested that sea levels within the U.S. Gulf Coast were also approximately 120 m lower than present during the Last Glacial Maximum (LGM), matching the global lowstand values of sea level (Curry 1960, Berryhill et al., 1986). However, most data suggest that sea level within the U. S. Gulf coast was 35 m shallower at 20 ka (LGM), and 15 m shallower at 10 ka than global sea levels (Fig. 8), (Nelson and Bray 1970, Fairbanks 1989, Bard et al. 1996, Bart and Ghosal, 2003).

Several hypotheses have been proposed to describe this disparity. Redfield (1967), Emery and Garrison (1967), and Bart and Ghosal (2003) propose that uplift due to the large load of Mississippi river sediments is responsible for the disparity. However, a recent study by Simms et al. (2007b) suggests that the large sedimentary load from the Mississippi Fan, a larger than assumed radiocarbon reservoir correction and tectonic activity alone cannot clarify the disparity. With the reconstruction of an appropriate Laurentide Ice Sheet, they suggest that glacio-hydro-isostasy explain the disparity (Simms et al., 2007b).

Records of eustatic sea-level obtained from coral-based studies, show two rapid increases in the rate of sea-level rise at 14.5 ka and 11.3 ka known as Meltwater Pulse 1A and Meltwater Pulse 1B respectively, and are believed to be the result of meltwater
Figure 8. Global sea level and sea level within the Gulf of Mexico (GOM) since the Last Glacial Maximum (LGM) which shows that sea levels within the U. S. Gulf coast were about 35 m shallower at 18 ka (LGM), and 15 m shallower at 10 ka than global sea levels (From Simms et al., 2007b).
discharge from the Laurentide Ice Sheet (Fairbanks, 1989; Brad et al., 1996). It should be noted that the resolution of these coral-based studies is around 5 m (Lightly, 1982), thus events with amplitudes less than 5 m may have also occurred as has been suggested at 8.2 ka (Tornqvist et al., 2004b). Regional sea-level curves of slightly higher resolution have been constructed for the U.S. Gulf coast during this time frame. However, there is still debate as to whether sea-level rise was episodic with abrupt sub-meter scale rises or steady in nature. The idea of rapid sea-level rise alternating with stillstands on the order of millennia has been advocated by Curay (1960), Rehkemper (1969), Nelson and Bray (1970), Frazier (1974), Penland (1991), and Thomas and Anderson (1994). In contrast, the idea of a smooth seal-level rise through out the Holocene has been proposed by Shepherd (1960), McFarland (1961), Coleman and Smith (1964), Toscano and Macintyre (2003), and Tornqvist et al. (2004a).

Another controversy remains on the existence of mid-Holocene highstands in the U.S. Gulf coast. Many scientists suggest that sea level generally rose 3-5 m during the last 5 ka and is presently at its highest position since the Last Glacial Maximum (LGM) along the U.S Gulf coast (Curray, 1960; Nelson and Bray, 1970; Frazier, 1974; Tornqvist et al., 2004a, Simms et al., 2007b). However, recent studies in Texas and Alabama have proposed one or more middle Holocene highstands 1.5 m-2 m above present sea level (Fig. 9), (Morton et al., 2000; Blum and Crater, 2000; Blum et al., 2000, Blum et al., 2001).

Hence, it is clear that the Holocene sea-level history of this region is still debated in many aspects. However, for the purpose of this study, we will use the most recent sea-level-curves proposed by Tornqvist et al. (2004a) and Simms (2005) (Fig.10).
Figure 9. Sea-level curve showing the presence of a proposed mid-Holocene highstand (after Blum and Carter, 2000).
Figure 10. Sea-level indices for the Gulf of Mexico (GOM) over the last 12 ka (Simms, 2005). Nueces Bay is located 55 km north of Baffin Bay.
Late Pliocene/Holocene Climate History of Texas:

Several studies have been conducted on the Late Pliocene/Holocene climate history of Texas (Bryant, 1977; Bryant and Holloway, 1985; Toomey et al., 1993; Humphery and Ferring, 1994, Nortd et al., 1994; Blum et al., 1994; Goodfriend and Ellis 2000; Russ et al., 2000; Musgrove et al., 2001; Nortd et al., 2002). From these studies five major climate intervals have been identified.

Full-Glacial Environments (ca. 20,000-14,000 yr BP):

Fossils pollen records from peat bogs in central Texas suggest a cool-moist period (boreal conifer pollen as indicators) within central Texas between 22-14 $^{14}$C yr BP (Bryant, 1977). Bryant and Holloway (1985) also came to the conclusion that full-glacial temperatures of the south-central United States were cooler and moister. Vertebrate fossils, pollen, and plant macrofossils from the Edwards Plateau of Texas show that full-glacial temperatures were less than 22° C during the summer months with reduced seasonality, i.e. mild winters. Effective moisture was also higher during this period (Toomey et al., 1993). A study of the growth rate of stalagmites from three caves within the Edwards Plateau by Musgrove et al. (2001) found that during the Last Glacial Maximum (LGM), climate in central Texas was cooler and wetter than present. This wetter period corresponds with an increased growth rate in stalagmites (Fig. 11) documented by Musgrove et al. (2001).

Late-Glacial Environments (ca. 14,000-10,500 yr BP):

Stalagmites within the caves of central Texas exhibit a large drop in their growth
Figure 11. Compilation of independent regional climate records for central Texas compared with the speleothem record. Trends for soil thickness, effective moisture, temperature, and seasonality from Toomey et al. (1993). (From Musgrove et al., 2001). Note: CWN1 = Cave without a name-Stalagmite 1; CWN2 = Cave without a Name-Stalagmite 2; DDS2 = Double Decker Cave-Stalagmite 2, ISS2 = Inner Space Cavern-Stalagmite 2.
rate between 15-12 ka, suggesting a drier climate (Fig. 11) (Mugrove et al., 2001). The loss of the masked shrew (Sorex cinerus/haydeni), which is adapted to cooler summer temperatures, and the emergence of the cotton rat (Sigmodon hispidus), which lives in places where the average summer temperature is more than 24° C, from the Edwards Plateau suggest that average summer temperature increased rapidly during the summer months from 15-13 ka and reached within 2-3° C of present temperatures. Effective moisture also decreased during this period (Toomey et al., 1993). Similarly, stable carbon isotope analysis of organic carbon in alluvial deposits and soils from three stream floodplains in central Texas show that the abundance of C4 grasses reached their maximum, implying warmer and drier climates during this period (Nortd et al., 1994). A continuous record of organic carbon and d13 C from buried soil sequences in south-central Texas shows the reduction in C4 plant productivity between 15,500- 14,000 14C yr BP and 13,000-11,000 14C yr BP correlating with Meltwater Pulses 1A and 1B (Fig. 12), indicating that the climate was cooler during this period (Nortd et al., 2002). Pollen records from east-central Texas (Bryant and Holloway, 1985) indicate that temperatures were almost 5 ° C lower than present between 15,500- 14,000 14C yr BP. Stable carbon isotope analysis of organic carbon in alluvial deposits also implies a cooler climate during this time (Nortd et al., 1994). Regional continental records based on pollen frequencies (Bryant and Holloway, 1985), fossils vertebrate remains (Toomey et al.; 1993), and d18O concentrations in lacustrine marls of north Texas (Humphery and Ferring, 1994) indicate that temperatures were cooler and drier between 13,000-11,000 14C yr BP. Between Meltwater Pulses 1A and 1B, increased C4 plant productivity shows that effective moisture decreased and the climate was drier. C4 plant productivity
increased again between 11,000-10,000 $^{14}$C yr BP, which correlates with the Younger Dryas (Fig. 12) (Nordt et al., 2002).

*Early-Middle Holocene Environments (ca. 10,500-5,000 yr BP)*:

Between 10,000-9,000 $^{14}$C yrs BP, $d^{13}$C values of soil organic carbon decreased slightly, implying similar C$_4$ production and climate during Younger Dryas time. However, the significant decrease in $d^{13}$C values of soil organic carbon at 7,000 $^{14}$C yrs BP suggests a cooling trend (Nordt et al., 2002). At 5,000 $^{14}$C yrs BP, $d^{13}$C values of soil organic carbon again increased implying a drier and warmer climate correlating with the Altithermal of the North American Great Plains (Nordt et al., 2002) (Fig. 12). Similar climatic interpretations have been advocated by Humphrey and Ferring (1994) and Nordt et al. (1994) for this period. Pollen data from Hinds cave of the Edwards plateau shows a significant amount of xerophytes taxa indicating dry conditions between 8700-6000 yr B.P. (Toomey et al., 1993). After ca 8000 yr BP, the upland soil mantle, as recorded in cave deposit of the Edwards plateau, were progressively dissected becoming darker, thinner and stonier, which suggests drier conditions during this time (Toomey et al., 1993). From cal. 6380-6030 yr BP, the accumulation of clusters of oxalate residue on the southwestern part of the Edwards plateau (which is the result of high epilithic lichen activity) also indicates a drier climate (Russ et al., 2000) (Fig.13).

*Late Holocene Environments (ca. 5,000-1,000 yr BP)*:

Fossils pollen records from peat bogs in central Texas indicate a warm and dry period (*Carya* and *Quercus* as indicators) for the Late Holocene, suggesting no further
Figure 12. $^{d_{13}}$C values of soil organic carbon (SOC) in the Medina River buried soil sequence. Values are shown with respect to buried soil, calendar years (left axis), radiocarbon years (right axis), and $^{d_{18}}$O values of foraminifera in the Gulf of Mexico (Nordt et al., 2002).
Figure 13. (a) Temporal distribution of calibrated $^{14}$C ages (cal. yr BP) of calcium oxalate residues from the southern Edwards Plateau. Clusters of radiocarbon ages indicate dry climate periods, while gaps in the data correspond to periods of more wet conditions. Also shown are paleoclimate reconstructions by (b) Bryant and Holloway (1985) based on palynological data and (c) Toomey et al. (1993) based on palynological, plant macrofossil, and vertebrate fossil data. Solid lines show arid periods, while dotted lines indicate moist intervals (from Russ et al., 2000).
climate change in the region (Bryant, 1977). However, several other studies suggest that cooler and moister conditions existed in the Late Holocene (Toomey et al., 1993; Humphrey and Ferring, 1994; Goodfriend and Ellis 2000; Russ et al., 2000; Nordt et al. 2002). A sharp decrease in C4 plant biomass by 4,000 $^{14}$C yrs BP suggests a return to cooler and moister climate conditions which lasted until around 2,500 $^{14}$C yrs BP (Nordt et al., 1994). The carbonate and isotope records of land snail shells from Hinds Cave of the Edwards Plateau also suggests relatively moist conditions around ca. 4,600 yr BP with a progressive change to drier conditions, peaking at ca. 3,500 yr BP (Goodfriend and Ellis 2000). A significant reduction in d$^{13}$C values of soil organic carbon in central Texas for a brief period after 5,000 $^{14}$C yrs BP suggests a cooler and moister period occurred a bit earlier than the other studies and lasted almost 2,000 years and was followed by a return to warmer and drier climates (Nordt et al., 2002).

In regard to Late Holocene environments, Toomey et al. (1993) suggest that conditions were drier and warmer from ca. 5,000-ca. 2,500 yr BP and between ca. 2,500-1,000 yr B.P there was more effective moisture than present. Russ et al., (2000) also found for wet-cool conditions returning around ca. 2,500 yr BP. However, their study also shows a brief dry period ca. 2,080-1,760 yr BP, followed by more moist conditions ca. 1,760-1,360 yr BP (Russ et al., 2000) (Fig. 13).

**Modern Environment (ca. 1,000 yr BP to present):**

Bryant and Holloway (1985), Toomey et al. (1993), and Blum et al., (1994) infer a warm and dry climate in this region for the last 1000 years. However, a study by Russ et al. (2000) based on the accumulation of clusters of oxalate residue on the Edwards
plateau indicates more moist conditions from about 730 $^{14}$C yrs BP to the present (Fig. 13).

**Incised-Valley Systems:**

An incised-valley system is defined by Zaitlin et al. (1994) as a "fluvial-eroded, elongate, topographic low that is typically larger than a single channel form, and is characterized by an abrupt seaward shift of depositional facies across a regionally capable sequence boundary at its base. The fill typically begins to accumulate during the next base-level rise, and may contain deposits of the following highstand and subsequent sea-level cycles." Negative paleotopography, truncation of underlying strata, an erosional base representing the sequence boundary, juxtaposition of proximal facies atop distal deposits, and onlapping of valley walls are the fundamental features of incised-valley systems (Van Wagoner et al, 1988, 1990).

Incised-valley systems have been of major interest to geologists since the publication of Posamentier and Vail (1988), Van Wagoner et al. (1990), and SEPM Special Publication 51 (Dalrymple et al. 1994). Incised valleys are an important component of the transgressive system tract as they provide the most complete stratigraphic record of transgression and environmental response to sea-level rise (Belknap and Kraft, 1981; Belknap et al., 1994). As a result, incised-valley systems have been of interest to coastal geologists (Dalrymple et al., 1994; Thomos and Anderson, 1994). Similarly, in many cases they contain a thick section of clean sand encased in mud, serving as a good stratigraphic trap (Van Wagoner et al, 1990; Posamentier, 1999). Moreover, the sequence boundary can often be traced down dip to shelf-margin deltas.
and basin-floor fans. As a result, incised-valleys systems have been important targets for exploration geologists (Van Wagoner, 1990; Zaitlin et al., 1994).

Incised-valley systems that have their head waters in an area of relatively high relief and cross a ‘fall line’, a region where there is a significant reduction in gradient, are called piedmont incised-valley systems while those incised-valley systems which are confined to low-gradient coastal plains and do not cross a ‘fall line’ are termed coastal-plain incised-valley systems. In general, piedmont incised-valley systems are characterized by coarse grained, immature, fluviually derived sediment, and coastal-plain incised-valley systems are usually characterized by finer-grained and more mature deposits (Zaitlin et al., 1994). The fill of any incised-valley system can be classified as simple or compound. A simple incised-valley system has only one sequence boundary at the base of the fill while a compound incised-valley has more than one sequence boundary within the incised-valley fill (Zaitlin et al., 1994).

Combining the earlier facies models of incised valleys and estuaries (Wright, 1980; Rahmani, 1988; Dalrymple et al., 1992; Allen and Posamentier, 1993), Zaitlin et al. (1994) present a model with a tripartite division of a simple incised-valley fill (Fig. 14 “A”). The outer (seaward) segment (segment 1) of the incised valley extends from the lowstand mouth of the incised valley to the point where the shoreline stabilizes at the beginning of highstand progradation. This segment contains a transgressive succession of fluvial and estuarine facies, overlain by marine sands and shelf muds. The middle segment (segment 2) corresponds to the area occupied by the drowned-valley estuary at the end of transgression. Here, lowstand to transgressive fluvial and estuarine deposits are overlain by highstand fluvial deposits. The inner (landward) segment (segment 3) lies
between the transgressive marine/estuarine limit and the landward limit of incision. This segment is characterized by fluvial deposits throughout its depositional history but the fluvial style may change due to changes in sea level and the rate of accommodation creation (Zaitlin et al., 1994). On the basis of this classification, our study area lies in segment 2 (middle segment).

With the examples of incised valleys along the Texas Coast (Brazos, Colorado, Matagorda, Nueces, Rio Grande, Trinity, and Baffin Bay incised-valleys systems), Simms et al. (2006) suggest a revised classification of incised valleys based on the proportion of fluvial versus estuarine and marine fill. They suggest an extension of the classic model of Zaitlin et al. (1994) to include two end members with respect to fluvial sediments, over-filled incised valleys and under-filled incised valleys (Fig.14). Under-filled incised valleys such as the Matagorda, Nueces, Trinity, and Baffin Bay incised-valley systems contain estuarine and marine deposits as well as fluvial deposits, which fits the classic incised-valley model. Over-filled incised valleys such as the Brazos, Colorado, and Rio Grande incised valleys are completely filled with fluvial sediments and do not contain central-basin deposits (open, middle or lower bay), hence they do not fit the classic incised-valley model. They have a fluvial inner segment and a fluvial-deltaic outer segment (Simms et al., 2006).
Figure 14. Idealized models for the two end-member types of incised-valley fills. (A) shows an underfilled incised valley following the classic model of Zaitlin et al. (1994). (B) Shows the overfilled incised valley (Simms et al., 2006).
CHAPTER III
METHODOLOGY

Data:

To study the internal architecture of Baffin Bay and to investigate the cause, timing and nature of changes that occurred in the bay over the last 10 ka, we conducted two field seasons in Baffin Bay for twelve days in August 2006 and five days in January 2007. During this time we collected 65 km of high-resolution 2-D seismic profiles and seven cores, which include four vibracores up to 3.25 m in length and three long cores up to 14.40 m in length aboard the R/V Trinity, a research vessel equipped with a hydraulic rotary drill (Fig. 15). The location of the cores and seismic track lines is shown in Figure 16.

Sub-bottom seismic reflection profiles were collected along a 65km track within the bay using a boomer system. The track lines were plotted using GPS navigation system which is accurate to within 10 m. The boomer power was set at 200 joules. A 10 ms linear sweep from 1.5-7 kHz was used providing a vertical resolution of a few decimeters. As the seismic survey was single channel, the only processing necessary was the application of simple band-pass filters (100Hz and 400Hz) and automatic gain control (AGC).
Figure 15. Photograph of the *R/V Trinity*, which was used to collect seismic data and cores within Baffin Bay, Texas.
Figure 16. Location of cores (green circles) and seismic survey (green lines).
**Seismic Data Interpretation:**

The seismic data was interpreted following the procedure defined by Mitchum et al. (1977). Based on previous seismic studies of the Pleistocene/Holocene sediments of the Gulf of Mexico (Shideler 1986, Anderson et al., 2004, Maddox 2005, Simms, 2005), we assumed an average velocity of 1500 m/s to convert time to depth.

**Core Descriptions**

Sediment cores were spilt in two halves at the Oklahoma State University Sedimentary lab. The archive halves were stored in a refrigerator and the sample halves were photographed and described for sediment texture, composition, color, structures, fauna and organic material.

Colors of the wet sediment samples were compared with the Munsell Soil Color chart. Canvas 9.1 was used to create lithostratigraphic columns of the cores. Laser diffractometry (Cilas 1180) was used to run grain-size analysis at every 20 cm within the cores. A refractive index of 1.544 was used following the ‘pipette’ method of Sperazza et al. (2004). Each measurement was repeated to test for bias during pipette transfer of the sediment. The cores were described using coarse-fraction analysis modified from the procedure of Shepard and Moore (1954). We also considered the procedure of Ginsberg (1956) for differentiating carbonate environments. His method differentiates the carbonate environments such as back reef, outer reef-arc, and fore reef based on the progressive change in constituent composition (algae, coral, foraminifera, mollusks, non-skeletal grain). However, the sediments we studied were devoid of corals and algal material was very limited. Thus, this method did not suit our data. Sedimentary
structures, macrofauna, as well as the relative abundances of major microfauna were also documented and aided in the interpretation of depositional environment. A LECO carbon analyzer was used to calculate carbon content at approximately 50 cm intervals within selected cores. The total carbon content was measured in the “Soil, Water and Forage Analytical Laboratory (SWFAL)” of Oklahoma State University and the total inorganic carbon was measured in the Geochemistry Lab at the OSU School of Geology. Organic carbon content was determined by subtracting inorganic carbon from total carbon. Selected intervals within the cores were also subjected to x-ray diffraction to analyze the mineralogical composition.

**Chronostratigraphy**

Radiocarbon (AMS) dates of mollusks, wood fragments and algal mats were obtained in order to determine the age of major stratigraphic surfaces and to establish a chronostatigraphic framework for the deposits within Baffin Bay. A total of 13 radiocarbon dates were obtained from mollusk shells, wood fragments and algal mats. Samples were sent to Beta Analytic in Miami, Florida and the University of Tokyo, Japan for AMS analysis. Whenever possible, articulated samples were analyzed for radiocarbon dating. In the absence of articulated shells, we selected shells that did not have signs of abrasion lessening the probability of post-mortem transportation.

Radiocarbon ages have been reported in years before present (cal yr BP) with two-sigma probabilities of the calibration using the Northern Hemisphere marine curve of the Calib 5.0.2, program which was written at the Quaternary Isotope Lab, University of Washington, and is maintained by Paula Reimer and Ron Reimer (Stuiver and Reimer,
1993; Stuvier et al., 2005).

**Paleogeographic Map:**

Paleogeographic maps of the bay through time were constructed using Arc map 9.1 based on seismic data and sedimentary facies from cores. The maps are used to examine the timing and rate of environmental change within Baffin Bay.
CHAPTER IV

RESULTS

A. Sedimentary Facies:

Combining the detailed description of cores (Fig. 17A-G), results of grain-size analysis (Appendix A-B), coarse-fraction analysis and percent carbon (organic and inorganic) (Appendix C), we recognized a total of 14 different sedimentary facies (Fig. 18-21) which fall in three broad types of facies: mud facies (MF), sand facies (SaF) and shell-hash beds (ShF) in our study. All mud facies are dominated by silt and clay with sand content less than 20%. All sand facies consists of greater than 20% sand. While describing the coarse-fraction (Shepard and Moore 1954), we characterized the content based on visual estimates as: dominant (more than 50%), abundant (greater than 25% but less than 50%), prevalent (greater than 15% but less than 25%), moderate (greater than 10% but less than 15%), few (greater than 5% but less than 10%), sparse (1-5%) and absent (0%).

Mud Facies (MF)

MF1: Mud facies 1 (Fig. 18A) is a black (2.5/N) clayey silt with more than 40% clay and less than 3% sand. Quartz-rich sand is dominant in the coarse fraction with abundant mollusk shells, a moderate amount of forams and very sparse plant fragments. *Mulinia lateralis* is the dominant fauna of this facies. The total carbon content of this
Figure 17A. Stratigraphic column of core BB06-01.
Figure 17B. Stratigraphic column of core BB06-02 (continued on next page).
Figure 17B. Stratigraphic column of core BB06-02.
Figure 17C. Stratigraphic column of core BB06-03
**Figure 17D.** Stratigraphic column of core BB07-01 (continued on next page).
Figure 17D. Stratigraphic column of core BB07-01 (continued on next page).
Figure 17D. Stratigraphic column of core BB07-01.
Figure 17E. Stratigraphic column of core BB07-02
Figure 17F. Stratigraphic column of core BB07-03
Figure 17G. Stratigraphic column of core BB07-04
Figure 18 A-F. Mud facies (MF) from the cores of Baffin Bay.
facies is 1.4% with an inorganic carbon content of 0.3% and an organic carbon content of 1.1%. This facies was observed only in the upper 20 cm core BB07-01 (Fig. 17D). Very little sand content and sparse plant fragments suggest a setting distant from terrestrial influence. This facies is interpreted to be deposits that accumulated in an open-bay setting analogous to the environmental conditions within the present central part of Baffin Bay.

MF2: Mud facies 2 (Fig. 18B) is a dark grey to dark greenish grey (4/N, 4/10Y, 5/N) silt with an average silt content of 65%. This is the most abundant facies in the bay. Sand content varies from 1-15%. Cores from the upper part of the bay contain more sand within this facies than cores from the middle bay. Quartz-rich sand is the dominant coarse-fraction component with abundant mollusk shells and prevalent forams. It also contains moderate to sparse plant fragments. *Mulinia lateralis* and *Anomalocardia cuneimeris* are the dominant mollusks in the shallow section while in deeper section *Anomalocardia cuneimeris* is absent. The deeper section contains brackish water fauna like *Chione cancellata*, *Nuculana acuta*. The total carbon content of this facies ranges from 4.5%-2.0% with an inorganic carbon content of 2.5%-1.5% and an organic carbon content of 2.0%-0.7%. Due to the large amount of silt and scarcity of plant fragments, this facies is interpreted to represent open-bay deposits.

MF3: Mud facies 3 (Fig. 18C) is a laminated dark greenish grey mud (4/10Y) with interbedded fine sand laminations. In some places, this facies also contains a few light grey mud laminations. This facies is most common in the upper 3m of the cores. Excluding the sand lamination, this facies contains 20-25% clay, 60-70% silt and 5-10%
sand. The total carbon content of this facies is 2.7% with an inorganic carbon content of 1.0% and an organic carbon content of 1.7%. Well sorted fine to very-fine quartz-rich sand is the dominant coarse-fraction component. This facies contains more forams than mollusk shells. *Anomalocardia cuneimeris* is the dominant mollusk in this facies. Ostracods and plant fragments are sparse. The sand laminations range in thickness from a few millimeters to a maximum thickness of 3 cm. Grain-size analysis shows the sand laminations contain almost 90% fine sand. The coarse fraction of the interbedded sand itself is dominated by quartz-rich clean sand with a moderate amount of forams and mollusk shells. It also contains sparse ostracods and plant fragments.

Due to the large amount of silt and clay and sparse plant fragments, this facies is interpreted as open-bay deposits. The interbedded sand laminations might be the result of hurricanes or may have been transported by the wind from the nearby dunes to the south.

**MF4:** Mud facies 4 (Fig. 18D) is also a laminated greenish grey (5/10Y) mud that contains laminated bands of light greenish grey (8/10Y) mud (MF4a) and/or light grey (7/N) mud. The laminations range in thickness from a few millimeters to a maximum thickness of 2 cm. A few algal mat laminations were present within this facies in core BB06-02 and BB07-02. This facies contains less than 10% sand, 60% silt, and 30% clay. Quartz-rich sand is the dominant coarse fraction with forams and mollusk shells constituting only a minor component. Of the few mollusks present, the populations are dominantly *Anomalocardia cuneimeris*. Due to the presence of laminated structures and scarcity of mollusk shells this facies is interpreted to represent upper-bay deposits. However, during the deposition of algal mats, the environment was most likely extremely
shallow.

MF4a: Mud facies 4a (Fig. 18E) is a light greenish grey (8/10Y) mud. This facies contains up to 7% inorganic carbon. X-ray diffraction (Fig. 21) and LECO carbon analysis indicates it contains up to 55% dolomite. Coarse-fraction analysis shows a few to moderate amount of mollusk shells with sparse forams. In a few cases this white mud is associated with algal mats. The presence of dolomite suggests very little delivery of siliciclastic material and the presence of algal mats suggests an extremely shallow water depth (less than 1 m). Thus, this facies is interpreted to represent tidal flat/shallow-bay deposits within an arid or semi-arid climate.

MF5: Mud facies 5 (Fig. 18F) is a dark bluish grey (3/10B) mud. It is stiff and present only in core BB06-02. Mineralogenic sand is the dominant coarse-fraction component and is more lithic rich than any other facies. Forams are absent. Mollusk shells and plant fragments are very sparse. The high amount of clay, sparse mollusk shells and lithic rich sand suggest that MF5 represents flood-plain deposits.

Sand Facies (SaF):

SaF1: Sand facies 1 (Fig. 20A) is a muddy sand comprised of approximately 50% sand. Its clay content is greater than 10%. It contains less mollusk shells than forams. Among the mollusks, *Mulinia lateralis* and *Anomalocardia cuneimeris* are very common. It contains sparse plant fragments. This facies is present in the upper section of BB06-01 (Fig. 17A), BB06-02 (Fig. 17 B) and BB06-03 (Fig. 17C) and in lower section of BB07-02 (Fig. 17E) and BB07-03 (Fig. 17F). The prevalence of sand, more forams than
Figure 19. X-Ray diffraction results of sample BB07-01-580 at a depth of 5.8 m in core BB07-01 representing MF4a deposits (Fig. 18E).
A) Sand Facies 1 (SaF1)  B) Sand Facies 2 (SaF2)  C) Sand Facies 3 (SaF3)

D) Sand Facies 4 (SaF4)  E) Sand Facies 5 (SaF5)

Figure 20 A-E. Sand Facies (SaF) from the cores of Baffin Bay.
mollusk shells and sparse plant fragments suggest that SaF1 represent distal upper-bay deposits.

SaF2: Sand facies 2 (Fig. 20B) is a dark greenish grey (4/10Y) sandy mud with an average sand content of 30%. This facies is present only in core BB07-01 below 12 m. Some portions of the sand component are found within sand-filled root casts. In coarse fraction, quartz-rich sand is the dominant component with a moderate amount of mollusk shells, forams and plant fragments. *Turbonilla* sp., *Chione cancellata*, and *Retusa canaliculata* are common fauna of SaF2. This sand facies is the most organic-rich of any facies observed in our study after SaF6. Based on the presence of sand-filled root casts and high amount of plant fragments, SaF2 is interpreted to represent delta-plain deposits.

SaF3: Sand facies 3 (Fig. 20C) contains an average of 80% sand with less than 10% clay. Quartz-rich sand is the dominant component in the coarse fraction with a few amount of mollusk shells and a moderate amount of forams. Plant fragments range from a few to a moderate amount. This facies is present only in core BB07-01 (Fig. 17D) below 13.5 m. Based on the presence of very high amounts of sand, fewer mollusk shells and significant plant fragments, SF3 is interpreted to represent fluvially-influenced deposits, possibly the mouth bar of a bayhead delta. In seismic profiles, SaF4 is chaotic in nature supporting our interpretation.

SaF4: Sand facies 4 (Fig. 20D) is only present below 8 m in core BB06-02 (Fig. 17B). It is a light greenish grey sandy mud/muddy sand. Quartz-rich sand is the
dominant component in the coarse fraction with abundant mollusk shells and prevalent 
forams. *Nuculana acuta, Lucina multilineta, and Retusa canaliculata* are common 
mollusk shells of this facies. Most of the mollusk shells are reworked as indicated by 
their broken and fragmented nature. Some mollusk shells are oxidized to a black color 
similar to mollusk shells in local Pleistocene deposits. This facies is different than SaF1 
in that it has more mollusk shells than SaF1 and plant fragments are totally absent within 
this facies. This facies possibly represents spit/tidal-inlet deposits associated with a spit 
system within the bay.

SaF5: Sand facies 5 (Fig. 20E) is a coarse sand facies found only in core BB07- 
02 (Fig. 17E) and BB07-03 (Fig. 17F). The mean phi size is 2.9- 3.2. This facies contains 
abundant shell material, prevalent plant fragments and no forams. Like SaF4, most of the 
mollusk shells are reworked. This facies may represent a spit deposit.

**Shell-Hash Beds (ShF):**

ShF1: Shell-hash bed type 1 (Fig. 21A) is a homogeneous well sorted shell hash. 
These beds consist of more mollusk shells than sand-sized quartz material. Forams are 
sparse and plant fragments are absent. The thickness of these beds range from a few 
millimeters to 2-3 centimeters. These beds are interpreted as storm deposits.

ShF2: Shell-hash bed type 2 (Fig. 21B) is a poorly sorted shell hash. It contains 
very little mineralogic sand. Mollusk shells are much larger than ShF1. This facies was 
observed only in the lowest section of core BB06-03 (Fig. 17C) making it difficult t
Figure 21 A-C. Shell-Hash Beds (ShF) and Pleistocene (Pl) of cores from Baffin Bay.
estimate the thickness of this unit. Based on very little quartz sand material and large shell sizes, ShF2 is interpreted to represent a spit deposit.

**Pleistocene (Pl):**

Pl: Undifferentiated Pleistocene deposits were sampled in core BB06-01 (Fig. 21C). It consists of a stiff yellowish white sandy mud with calcareous nodules up to 7 mm in diameter. Mollusk shells, forams and plant fragments are absent.

A summary of all the above sedimentary facies has been presented in Table 1.

**B. Pleistocene Surface:**

One of the major tasks of our study was the identification and mapping of the Pleistocene/Holocene contact (sequence boundary) beneath the deposits of Baffin Bay. When the seismic data was of sufficient quality, this surface was recognized by the presence of onlapping reflections above and terminating reflections below (Fig. 22). Where seismic data was poor we extrapolated the already identified reflections to our best judgment. The map created using these methods is illustrated in Figure 23.

**C. Seismic facies:**

SF1: Seismic facies 1 consists of horizontal, parallel, closely spaced, medium-high amplitude continuous reflections (Fig. 22). In most cases, SF1 corresponds with sedimentary facies MF1, MF2, and MF3. SF1 is interpreted to represent open-bay deposits.

SF2: Seismic facies 2 contains alternating layers of continuous, high amplitude,
<table>
<thead>
<tr>
<th>Facies</th>
<th>Main characteristics</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>MF1</td>
<td>Black clayey silt with very little sand</td>
<td>Open-bay deposits</td>
</tr>
<tr>
<td>MF2</td>
<td>Dark grey-dark greenish grey silt</td>
<td>Open-bay deposits</td>
</tr>
<tr>
<td>MF3</td>
<td>Greenish grey mud with interbedded fine sand</td>
<td>Open-bay deposits</td>
</tr>
<tr>
<td>MF4</td>
<td>Greenish grey mud with white mud and/or grey mud laminations</td>
<td>Upper-bay deposits</td>
</tr>
<tr>
<td>MF4a</td>
<td>White mud (contains up to 55% of dolomite)</td>
<td>Upper-bay deposits</td>
</tr>
<tr>
<td>MF5</td>
<td>Dark grey stiff mud, no forams, shells and organics are very sparse</td>
<td>Flood plain deposits</td>
</tr>
<tr>
<td>SaF1</td>
<td>Muddy sand/sandy mud, less mollusks shell material than forams</td>
<td>Distal Upper-bay</td>
</tr>
<tr>
<td>SaF2</td>
<td>Dark greenish grey sandy mud, organic rich</td>
<td>Delta plain</td>
</tr>
<tr>
<td>SaF3</td>
<td>Average 80% sand, few shells and forams</td>
<td>Bayhead delta</td>
</tr>
<tr>
<td>SaF4</td>
<td>Light greenish grey sandy mud/muddy sand, abundant shells</td>
<td>Tidal inlet/Spit</td>
</tr>
<tr>
<td>SaF5</td>
<td>Coarse grained sand, no forams, prevalent plant fragments</td>
<td>Spit</td>
</tr>
<tr>
<td>ShF1</td>
<td>Homogeneous well shorted shell hash of few mm to 2-3 cms</td>
<td>Storm deposits</td>
</tr>
<tr>
<td>ShF2</td>
<td>poorly sorted, shells are large, and little sand content</td>
<td>Spit deposits</td>
</tr>
<tr>
<td>Pl</td>
<td>Stiff sandy mud with calcareous nodules</td>
<td>Pleistocene</td>
</tr>
</tbody>
</table>

**Table 1.** A summary of sedimentary facies observed in Baffin Bay within this study.
Figure 22. Seismic Profile along A-A’ showing different seismic facies. B-B’ is shown on Fig. 26.
Figure 23. Elevation (meters below sea level) of the Pleistocene-Holocene contact beneath Baffin Bay. Contour interval is 2 m.
parallel reflections with discontinuous, low amplitude, parallel reflections (Fig. 22). SF2 corresponds with sedimentary facies, MF3 and MF4 and is interpreted to represent upper-bay deposits.

SF3: Seismic facies 3 is composed of very low amplitude continuous, parallel to subparallel reflections (Fig. 22). SF3 corresponds mostly with sedimentary facies MF2 and in some cases with MF4 and SaF4. It is interpreted to represent open-bay deposits.

SF4: Seismic facies 4 is composed of high amplitude, continuous, wavy reflections (Fig. 22). SF4 corresponds with sedimentary facies SaF2 and is interpreted to represent delta-plain deposits.

SF5: Seismic facies 5 consists of sigmoid-oblique reflections (Figs. 24 and 25). Core BB07-04 through this seismic unit recovered very little material in three attempts which consist of a few sand grains and a shell. This seismic facies is interpreted to represent deltaic and/or spit deposits. Where the clinoforms have an erosional base (Fig. 24), we interpreted them to represents spit deposits. Where the clinoforms do not have an erosional base (Fig. 25) and a feeder system was identified, we interpreted the clinoforms to represent delta deposits.

SF6: Seismic facies 6 is chaotic in nature (Fig. 23). Core BB07-01 through SF6 contains sedimentary facies SaF3. This seismic unit is interpreted to represent fluvial-delatic sediments that rest directly above the Pleistocene/Holocene contact.
Figure 24. Seismic Profile along X-X’ showing seismic facies 5 with erosional base, interpreted to represent spit deposits.
Figure 25. Seismic Profile along Y–Y’ showing seismic facies 5 without erosional base, interpreted to represent deltaic deposits.
D. Chronostratigraphy:

A total of 13 radiocarbon dates were obtained from shells (wherever possible articulated) as well as other organic material such as wood fragments and algal mats to establish a chronostatigraphic framework within Baffin Bay (Table 2). All radiocarbon dates here have been reported as years before present (cal yr BP). The ages range from 510 cal yr BP to 8170 cal yr BP. All dates are consistent with depth except a wood date that is from core BB06-02 at a depth of 3.59m. We believe this piece of wood may be reworked.

Marine organisms are relatively depleted in $^{14}$C and thereby can yield apparent ages of hundreds of years (Aten, 1983). This inconsistency is called the reservoir effect and is known to skew radiocarbon dating, but the magnitude of this effect is not the same in all locations. Dating contemporaneous charcoal and shell pairs, Aten (1983) attempted to calculate the reservoir effect along the upper Texas coast. His work suggested a carbon reservoir effect of 225+/-103 yrs in Galveston Bay and 945+/-295 yrs in Lavaca Bay. A study by Simms (2005), using a similar method of paired wood/shell samples suggested a carbon reservoir effect of 760+/-380 yrs in Corpus Christi Bay.

In our study, we were unable to date wood/shell pairs to find the actual reservoir effect in Baffin Bay so we used the Northern Hemisphere Marine curve of calib 5.0.2 (Stuiver and Reimer, 1993; Stuiver et al., 2005) to convert the $^{14}$C dates into calendar years.
<table>
<thead>
<tr>
<th>Code</th>
<th>Depth on core</th>
<th>Depth BSL</th>
<th>Species</th>
<th>Uncorrected age</th>
<th>Error (+/-)</th>
<th>Cal yr BP</th>
</tr>
</thead>
<tbody>
<tr>
<td>BB06-02-22-25</td>
<td>0.25m</td>
<td>1.75m</td>
<td>*Callocardia/Agripoma texasina(J)</td>
<td>530</td>
<td>30</td>
<td>260-0</td>
</tr>
<tr>
<td>BB06-02-70</td>
<td>0.70m</td>
<td>2.20m</td>
<td>*Rangia flexuosa(J)</td>
<td>1760</td>
<td>120</td>
<td>1570-1050</td>
</tr>
<tr>
<td>BB06-02-359</td>
<td>3.59m</td>
<td>5.09m</td>
<td>Wood Fragment</td>
<td>3950</td>
<td>40</td>
<td>4070-3830</td>
</tr>
<tr>
<td>BB06-02-501-503</td>
<td>5.02m</td>
<td>6.07m</td>
<td>*Anamalocardia cuneimeris (J)</td>
<td>3825</td>
<td>35</td>
<td>3885-3665</td>
</tr>
<tr>
<td>BB06-02-674</td>
<td>6.74m</td>
<td>8.24m</td>
<td>Algal Mat</td>
<td>5040</td>
<td>40</td>
<td>5510-5290</td>
</tr>
<tr>
<td>BB07-01-262</td>
<td>2.62m</td>
<td>4.75m</td>
<td>*Unknown</td>
<td>3140</td>
<td>75</td>
<td>3140-2750</td>
</tr>
<tr>
<td>BB07-01-485</td>
<td>4.85m</td>
<td>6.98m</td>
<td>*Rangia flexuosa(J)</td>
<td>4170</td>
<td>80</td>
<td>4470-3995</td>
</tr>
<tr>
<td>BB07-01-667</td>
<td>6.67m</td>
<td>8.80m</td>
<td>Anamalocardia cuneimeris (J)</td>
<td>4350</td>
<td>75</td>
<td>4770-4280</td>
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<tr>
<td>BB07-01-837</td>
<td>8.37m</td>
<td>10.50m</td>
<td>*Rangia flexuosa(J)</td>
<td>5050</td>
<td>80</td>
<td>5585-5240</td>
</tr>
<tr>
<td>BB07-01-946</td>
<td>9.46m</td>
<td>11.59m</td>
<td>*Mulinia lateralis</td>
<td>5515</td>
<td>75</td>
<td>6105-5710</td>
</tr>
<tr>
<td>BB07-01-1113</td>
<td>11.13m</td>
<td>13.26m</td>
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<td>80</td>
<td>7820-7500</td>
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<tr>
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<td>1.05m</td>
<td>Algal Mat</td>
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<tr>
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<td>1.05m</td>
<td>*Unknown</td>
<td>830</td>
<td>40</td>
<td>480-305</td>
</tr>
</tbody>
</table>

**Table 2.** Radiocarbon age date and the description of material sampled. Articulated mollusks are indicated by an asterisk (*). J= Juvenile.
CHAPTER V
DISCUSSIONS

Facies Architecture:

Upper Baffin Bay preserves an excellent record of coastal environment change over the last 8.0 ka. With the combination of seismic data and core data, we observed four major stratigraphic surfaces (S1, S2, S3 and S4) in upper Baffin Bay which have played an important role in shaping the facies architecture of the bay (Fig. 26). The elevation of each of the stratigraphic surfaces is shown in Figures 27-30. S2, S3 and S4 formed in response to rapid rises in water depth, thereby represent flooding surfaces. The contact of these flooding surfaces are better developed and more easily identified within seismic profiles than in cores. However, in core BB07-01, S4 is manifested by a change in sedimentary facies from mud facies 4 (MF4) to Mud facies 2 (MF2) (Fig. 31). Although we were unable to recognize a sharp contact associated with flooding surfaces in most cores, a change in sedimentary facies below and above a missing section of cores inferred the presence of flooding surfaces (e.g. S2 in core BB07-01 and BB06-02, S3 in core BB06-02) (Fig. 31). The depositional changes associated with flooding surfaces within selected cores are shown in Figure 32.

Stratigraphic Surface 1 (S1):
Figure 26. Seismic profiles along B-B’ showing the four major stratigraphic surfaces (S1, S2, S3, and S4). S2, S3 and S4 represent the flooding events. See Figure 22 for location A-A’.
Figure 27. Elevation (meters below sea level) of Stratigraphic Surface 1 (S1). Contour interval is 2 m.
Figure 28. Elevation (meters below sea level) of Stratigraphic Surface 2 (S2). Contour interval is 2 m.
Figure 29. Elevation (meters below sea level) of Stratigraphic Surface 3 (S3). Contour interval is 2 m.
Figure 30. Elevation (meters below sea level) of Stratigraphic Surface 4 (S4). Contour interval is 2 m.
Figure 31. Illustration of the sedimentary facies in between flooding surfaces. Asterisk (*) mark denotes the radiocarbon date in cal yr BP. White color section is missing section in cores.
Figure 32. Depositional environment observed within cores. Asterisk (*) mark denotes the radiocarbon date in cal yr BP. White color section is missing section in cores. See Figure 31 for location WXYZ.
Stratigraphic surface 1 (S1) (Fig. 26) is not a flooding surface but a sharp sedimentological contact between more proximal and distal facies. It was observed only in the lower section of the study area and separates the overlying delta plain from the mouth bar. Overlying the Pleistocene/Holocene contact is seismic facies 5 (SF5) which was sampled by core BB07-01 and corresponds to sedimentary facies SaF3 interpreted as mouth bar deposits within a fluvial delta.

Flooding Surface 2 (S2):

The next stratigraphically significant surface is flooding surface 2 (S2)(Fig. 26) which separates the bay-head delta deposits from overlying upper-bay/open-bay deposits above S1 and below S2, seismic reflections are mainly characterized by seismic facies 4 (SF4) and seismic facies 5 (SF5). Cores BB06-02 and BB07-01 sampled the deposits between S2 and S1. They consist of sedimentary facies MF5 interpreted as flood-plain deposits and SaF2 interpreted as delta-plain deposits. Applying the sedimentation rate between the radiocarbon dates 7,820-7,500 cal yrs BP obtained from core BB07-01 at a depth of 11.13 m which lies 0.40-0.45 m above the S2 event, and 6,110-5,710 cal yrs BP obtained from a depth of 9.46 m, which lies 2 m above the S2 event, S2 formed around 8.0 ka (Fig. 31).

Flooding Surface 3 (S3):

Based on the radiocarbon dates 6,110-5,710 cal yrs BP obtained from core BB07-01 at a depth of 9.46 m lying 0.70 m below the S3 event and 5,580-5,240 cal yrs obtained from a depth of 8.37 m lying 0.40 m above the S3 event, flooding surface 3 formed
around 5.5 ka (Fig. 31). Above S2 and below S3, seismic profiles are mainly characterized by seismic facies 3 (SF3) and seismic facies 2 (SF2). In some places this surface is also marked by the relocation of oblique reflectors (SF5), interpreted as spits or small tributary bay-head delta deposits. Core BB06-02 and BB07-01 sampled sedimentary facies, MF2 (open-bay deposits), MF4 (tidal-flat deposits), and SaF4 (spit tidal-inlet/ deposits) between S3 and S2.

Flooding Surface 4 (S4):

Flooding surface 4 (S4) (Fig. 26) is marked by the disappearance of seismic facies 5(SF5). According to the radiocarbon dates of 4,470-3,995 cal yrs BP obtained from core BB07-01 at a depth of 4.85 m lying about 0.25 m above the S4 event and 4,770-4,280 cal yr BP at a depth of 6.67 m lying about 1.6 m below the S4 event, S4 formed around 4.3 ka (Fig. 31). Cores BB06-02 and BB07-01 sampled the deposits between S4 and S3. They consist of sedimentary facies MF2 (open-bay deposits), MF3 (open-bay deposits) and MF4 (tidal-flat/shallow-bay deposits). The deposition of dolomite, which started after S3, also continues after S4.

Present:

Above flooding surface 4 (S4), seismic reflectors are characterized mostly by SF1 and SF3. Cores BB06-01 and BB07-01 sampled this section and contain sedimentary facies MF1 (open-bay deposits), MF2 (open-bay deposits), MF3 (open-bay deposits), MF4 (open-bay deposits), and SaF1 (distal upper bay).
Evolution of Baffin Bay and Causal Mechanisms:

Several possible mechanisms such as sea-level change, climate change, and the flooding of antecedent topography could explain the multiple flooding events recorded in Baffin Bay. In response to the sea-level fall during the Last Glacial Maximum, the rivers flowing into the bay incised to a depth of 28 m along the US Gulf coast (Fig. 23). During this period, fluvial sediments most likely bypassed the area now occupied by Baffin Bay and were deposited further on the shelf as most sequence stratigraphic models suggest during sea-level fall (Posamentier and Vail, 1988; Van Wagoner et al., 1988, 1990).

A rapid rise in sea level between 15 ka and 9 ka (MWP-1A and MWP-1B) caused by the retreating Laurentide ice sheets (Fairbanks, 1989 and Brad et al., 1996) increased the accommodation along the Texas coast. As a result, lowstand transgressive fluvial sands were deposited within many incised valleys (Nelson and Bray, 1970; Anderson and Thomas 1991). Maddox (2005) shows that the rivers flowing into Matagorda Bay were unable to keep pace with rapidly rising sea-level and its incised valley became inundated with water around 9.6 ka. Studies by Simms (2005) and Rodriguez et al. (2005) also show that initial drowning of Corpus Christi Bay and Galveston Bay took place around 9.6 ka. However, we were unable to recognize this event because our data was limited to the upper part of the bay. It is possible that Baffin Bay was also inundated around 9.6 ka. By the time of flooding surface 2 (S2) (8.0 ka), the landward portion of the incised valley had filled with fluvial/deltaic deposits (Fig. 33). The S2 event is nearly synchronous with the 8.2 ka event associated with the drainage of proglacial Lake Agassiz (Alley et al., 1997, Tornqvist et al., 2004b). Hence, an accelerated rate of sea-level rise could be the possible mechanism for this event. On the other hand, the works of Bryant (1977);
Figure 33. Paleogeographic reconstruction of the upper portion of Baffin Bay before 8.0 ka (S2).
Toomey et al. (1993), Nortd et al. (1994), Nortd et al. (2002) suggests that climate in Texas was changing from a moist and cool to dryer and warmer during this time. So, S2 might also be related to the gradual climate change associated with the warming of the early middle Holocene. However, the paleogeographic reconstruction of the bay shows that the change in depositional setting within the bay was sudden, not gradual as the bay-head delta back stepped at least 15 km landward of the study area and the bay was filled mostly by upper-bay deposits (Fig. 34). If a change in climate was the main mechanism for this event, such sudden change would not be expected unless it crossed a threshold. Thus, we suggest that S2 was related to the sea-level rise event associated with the draining of Lake Agassiz. Moreover, studies from Corpus Christi Bay (Simms, 2005) and Galveston Bay (Rodriguez et al., 2005) also recognized a flooding event at 8.0 ka and 8.2 ka respectively, resulting in the backstepping of the bay-head delta environment. A recent study from three incised valleys in Asia also suggested a flooding event between 9.0-8.5 ka (Hori and Saito, 2007). These contemporaneous events enhance the possibility of S2 being related to a global sea-level rise event.

The upper bay environment expanded until 5.5 ka when flooding once again forced coastal environments to backstep and the open-bay environment started to expand landward (Fig. 35). This event (S3) is synchronous with the mid-Holocene highstand of Blum et al. (2000; 2001). However, we do not believe that this event was associated with a sea-level highstand for two reasons. First, the algal mats found in core BB06-02 at a depth of 8.25 m below present sea level provide a radiocarbon age of 5.5 - 5.3 ka. If a mid-Holocene highstand had existed during that time, we would not expect to find an algal mat at a depth of 8.25 m below sea-level as algal mats within the Baffin Bay area
Figure 34. Paleogeographic reconstruction of the upper portion of Baffin Bay between 8.0 ka (S2) and 5.5 ka (S3).
Figure 35. Paleogeographic reconstruction of the upper portion of Baffin Bay between 5.5 ka (S3) and 4.3 ka (S4).
inhabit water depths of less than 1 m, and in most cases water depths of less than 30 cm (Dalrymple, 1964). Hence we suggest there was no mid-Holocene highstand at least in our study area. Second, core and seismic profiles show the change within the bay was more gradual as compared to flooding event 2 (S2). Prior to S3, the upper bay was gradually retreating and the open bay was expanding landward. If S3 would have been associated with the sea-level change argued by Blum et al. (2000; 2001), we would expect a more sudden event. The flooding of antecedent topography most likely played a minor role in S3 since it is also marked by sudden changes in depositional patterns (Rodriguez et al., 2005).

As stated earlier, climate in Texas was changing to warmer and dryer conditions from around 8.0 ka and this condition prevailed until at least 5 ka. The decreasing effective moisture may have reduced the erosive power of streams flowing into Baffin Bay, decreasing the rate of sediment input. As a result, sedimentation supply could not keep pace with rising sea levels and the abrupt flooding occurred again. Hence we suggest that climate change was a major contributor to S3. However, we also observed a small fluvial terrace in the bay at the same elevation of S3 (Fig. 36). Flooding of the terrace would increase the accommodation in the estuary and may also have made a minor contribution to S3.

The next significant change in the bay took place with flooding surface 4 (S4), which formed around 4.3 ka. The bay-head delta backstepped landward of the study area after this time. The open bay extended further landward and sedimentation in Baffin Bay started to take on its modern characteristics (Fig. 37). The climate was warm and dry during this period (Toomey et al., 1993). We also observed fluvial terraces in the bay at
Figure 36. Seismic profile along C-C’ illustrating a possible fluvial terrace. Location D-D’ and E-E’ is shown on Figure 36.
Figure 37. Paleogeographic reconstruction of the upper portion of Baffin Bay after 4.3 ka (S2).
the same elevation as S4 (Fig. 38). Hence, prolonged dry climate and the flooding of antecedent topography may have had a combined effect to create S4. Moreover, this event is also nearly synchronous with the evolution of the Padre Island barrier complex around 4.0 ka (Fisk, 1959), which isolated the bay from the Gulf of Mexico. As a result, the salinity of the bay increased (Dalrymple 1964, Stewart, 1994). However we did not observe the effect of decreasing wave energy due to the evolution of Padre Island in our deposits.
Figure 38 (A-B). Seismic profile along D-D’ and E-E’ illustrating fluvial terraces. See Figure 36 for location D-D’ and E-E’.
CHAPTER VI

CONCLUSIONS

Baffin Bay is the flooded late Pleistocene/Holocene incised valley created by Petronila, San Fernando, and Los Olmos Creeks. During a sea-level fall between 120-20 ka the creeks cut an incised valley up to 28 m deep at the present coastline. The valley has partially filled with Holocene sediments and preserved an excellent record of coastal environmental changes over the last 8.0 ka.

From the analysis of core data and the interpretation of high-resolution seismic data, we recognized a total of 14 distinct sedimentary facies which can be categorized in three broad facies: mud facies, sand facies and shell hash beds and six different seismic facies. With the combination of sedimentary facies and seismic facies, we were able to recognize four distinct stratigraphic surfaces related to key changes in the depositional environments within the bay. Each of these surfaces was mapped and using 13 radiocarbon dates obtained from mollusk shells, wood fragments and algal mats, a chronostratigraphic framework was developed for these surfaces.

Although we were unable to identify the initial drowning of the valley (because our data was limited to the upper part of the bay), on the basis of previous studies of nearby incised valleys along the Texas coast, we suggest that initial drowning occurred
around 9.6 ka. From initial drowning to 8.0 ka upper portions of the bay were occupied by a fluvial/deltaic environment. At 8.0 ka the bay-head delta backstepped 15 km north and the bay was mostly filled with upper-bay deposits. At 5.5 ka the open bay started to expand landward and the upper bay retreated 10 km to the north. By 4.3 ka, the bay-head delta backstepped completely out of our study area and the bay filled with open-bay deposits.

The 8.0 ka flooding event is interpreted to be the result of a rapid sea-level rise associated with the drainage of Lake Agassiz. The 5.5 ka flooding event is interpreted to have resulted from a shift to a more prolonged dry climate. The decreasing effective moisture may have caused a loss of erosive power of the streams flowing into Baffin Bay, decreasing the rate of sediment input. The flooding of antecedent topography may also have a minor contribution to this event since we observed a small terrace corresponding with the depth of the 5.5 ka event. Although, the 5.5 ka event is synchronous with a proposed mid-Holocene highstand, our data does not support a mid-Holocene highstand above present sea level. The 4.3 ka flooding event is interpreted to have resulted from a combination of a shift to dry climate and the flooding of fluvial terraces.

In summary, our study shows that although sea-level rise was the first order control on the Holocene evolution of Upper Baffin Bay, climate change and antecedent topography also have played important roles in determining the facies architecture of the bay.


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APPENDIX A: RESULTS OF GRAIN SIZE ANALYSIS

Core BB06-01

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<tr>
<th>Depth in (m)</th>
<th>Clay%</th>
<th>Silt%</th>
<th>Sand%</th>
<th>Mean phi</th>
<th>Std Dev.</th>
</tr>
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<tbody>
<tr>
<td>0.02-0.04</td>
<td>19.37</td>
<td>38.89</td>
<td>41.74</td>
<td>5.22</td>
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</tr>
<tr>
<td>0.22-0.24</td>
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<td>-1.34</td>
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<td>7.07</td>
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<td>Depth in (m)</td>
<td>Clay%</td>
<td>Silt%</td>
<td>Sand%</td>
<td>Mean phi</td>
<td>Std Dev.</td>
</tr>
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<td>16.99</td>
<td>6.13</td>
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<td>2.21-2.23</td>
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<td>22.89</td>
<td>5.77</td>
<td>-0.99</td>
</tr>
<tr>
<td>2.41-2.43</td>
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<td>2.00-2.02</td>
<td>12.14</td>
<td>45.86</td>
<td>42</td>
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<td>2.20-2.22</td>
<td>6.15</td>
<td>31.36</td>
<td>62.49</td>
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<td>-0.7</td>
</tr>
<tr>
<td>2.40-2.42</td>
<td>10.75</td>
<td>40.8</td>
<td>48.45</td>
<td>4.74</td>
<td>-0.95</td>
</tr>
<tr>
<td>2.60-2.62</td>
<td>8.84</td>
<td>31.71</td>
<td>59.45</td>
<td>4.45</td>
<td>-0.9</td>
</tr>
<tr>
<td>2.80-2.82</td>
<td>13.76</td>
<td>50.25</td>
<td>35.99</td>
<td>5.23</td>
<td>-0.99</td>
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### Core BB07-03

<table>
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<tr>
<th>Depth in (m)</th>
<th>Clay%</th>
<th>Silt%</th>
<th>Sand%</th>
<th>Mean phi</th>
<th>Std Dev.</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.20-0.22</td>
<td>15.05</td>
<td>55.92</td>
<td>29.03</td>
<td>5.42</td>
<td>-1.31</td>
</tr>
<tr>
<td>0.40-0.42</td>
<td>17.25</td>
<td>48.02</td>
<td>34.73</td>
<td>5.03</td>
<td>-1.92</td>
</tr>
<tr>
<td>0.60-0.62</td>
<td>25.16</td>
<td>72.78</td>
<td>2.06</td>
<td>6.29</td>
<td>-1.06</td>
</tr>
<tr>
<td>0.80-0.82</td>
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<td>43.49</td>
<td>4.56</td>
<td>-1.19</td>
</tr>
<tr>
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<td>12.82</td>
<td>78.68</td>
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<td>-1.51</td>
</tr>
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<td>1.20-1.22</td>
<td>4.7</td>
<td>24.32</td>
<td>70.98</td>
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<td>-0.98</td>
</tr>
<tr>
<td>1.43-1.45</td>
<td>31.93</td>
<td>68</td>
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<td>-0.38</td>
</tr>
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<td>1.60-1.62</td>
<td>33.02</td>
<td>66.98</td>
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<td>1.80-1.82</td>
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<td>55.97</td>
<td>0.07</td>
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<td>-0.38</td>
</tr>
<tr>
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<td>19.83</td>
<td>74.34</td>
<td>2.88</td>
<td>-1.63</td>
</tr>
<tr>
<td>2.20-2.22</td>
<td>11.04</td>
<td>45.45</td>
<td>43.51</td>
<td>4.97</td>
<td>-1.18</td>
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</table>

### Core BB07-04

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<tr>
<th>Depth in (m)</th>
<th>Clay%</th>
<th>Silt%</th>
<th>Sand%</th>
<th>Mean phi</th>
<th>Std Dev.</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.04-0.06</td>
<td>38.77</td>
<td>55.88</td>
<td>5.35</td>
<td>7.17</td>
<td>-0.88</td>
</tr>
<tr>
<td>0.20-0.22</td>
<td>29.44</td>
<td>68.89</td>
<td>1.67</td>
<td>6.92</td>
<td>-0.58</td>
</tr>
<tr>
<td>0.40-0.42</td>
<td>34.42</td>
<td>62.07</td>
<td>3.51</td>
<td>7.03</td>
<td>-0.67</td>
</tr>
<tr>
<td>0.60-0.62</td>
<td>21.74</td>
<td>67.87</td>
<td>10.39</td>
<td>6.37</td>
<td>-0.84</td>
</tr>
<tr>
<td>0.80-0.82</td>
<td>36.01</td>
<td>63.74</td>
<td>0.25</td>
<td>7.21</td>
<td>-0.56</td>
</tr>
<tr>
<td>1.00-1.02</td>
<td>19.2</td>
<td>77.39</td>
<td>3.41</td>
<td>6.48</td>
<td>-0.57</td>
</tr>
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<td>1.20-1.22</td>
<td>28.98</td>
<td>65.02</td>
<td>6</td>
<td>6.78</td>
<td>-0.72</td>
</tr>
<tr>
<td>1.40-1.42</td>
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<td>72.91</td>
<td>1.62</td>
<td>6.79</td>
<td>-0.54</td>
</tr>
<tr>
<td>1.60-1.62</td>
<td>22.58</td>
<td>68.73</td>
<td>8.69</td>
<td>6.48</td>
<td>-0.76</td>
</tr>
<tr>
<td>1.80-1.82</td>
<td>32.5</td>
<td>55.29</td>
<td>12.21</td>
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</tr>
<tr>
<td>2.00-2.02</td>
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<tr>
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<td>54.9</td>
<td>10.5</td>
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<td>-0.91</td>
</tr>
<tr>
<td>2.40-2.42</td>
<td>30.4</td>
<td>66.96</td>
<td>2.64</td>
<td>6.92</td>
<td>-0.62</td>
</tr>
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</table>
APPENDIX B: HISTOGRAM FROM GRAIN SIZE ANALYSIS

Grain-size results from core BB06-01
Grain-size results from core BB06-02

Grain-size results from core BB06-03
Grain-size results from core BB07-01

Grain-size results from core BB07-02
Grain-size results from core BB07-03

Grain-size results from core BB07-04
APPENDIX C: RESULT OF CARBON ANALYSIS

**Core BB07-01**

<table>
<thead>
<tr>
<th>Depth in core (m)</th>
<th>Total Carbon %</th>
<th>Inorganic Carbon %</th>
<th>Organic Carbon %</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.10-0.11</td>
<td>1.42</td>
<td>0.2949</td>
<td>1.13</td>
</tr>
<tr>
<td>0.49-0.50</td>
<td>4.69</td>
<td>2.6939</td>
<td>2</td>
</tr>
<tr>
<td>1.16-1.17</td>
<td>4.5</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>1.36-1.37 (Shell hash)</td>
<td>9.78</td>
<td>9.494</td>
<td>0.29</td>
</tr>
<tr>
<td>1.81-1.82</td>
<td>2.59</td>
<td>1.216</td>
<td>1.37</td>
</tr>
<tr>
<td>2.27-2.28</td>
<td>2.71</td>
<td>0.9689</td>
<td>1.74</td>
</tr>
<tr>
<td>2.48-2.48 (white mud)</td>
<td>4.53</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>4.34-4.35</td>
<td>2.47</td>
<td>0.6801</td>
<td>1.79</td>
</tr>
<tr>
<td>4.84-4.85</td>
<td>2.46</td>
<td>1.0145</td>
<td>1.45</td>
</tr>
<tr>
<td>5.09-5.10 (white mud)</td>
<td>6.64</td>
<td>5.55007</td>
<td>1.09</td>
</tr>
<tr>
<td>5.80-5.81 (white mud)</td>
<td>7.81</td>
<td>7.02405</td>
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<tr>
<td>6.16-6.17 (organic layer)</td>
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<td>6.09-6.10</td>
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<td>2.09</td>
<td>0.5682</td>
<td>1.52</td>
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<tr>
<td>7.49-7.50</td>
<td>2.14</td>
<td>1.41</td>
<td>0.73</td>
</tr>
<tr>
<td>7.96-7.97</td>
<td>2.22</td>
<td>1.02275</td>
<td>1.2</td>
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<tr>
<td>8.40-8.41</td>
<td>1.99</td>
<td>0.7712</td>
<td>1.22</td>
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<td>8.89-8.90</td>
<td>1.86</td>
<td>1.1993</td>
<td>0.66</td>
</tr>
<tr>
<td>9.42-9.43</td>
<td>2.31</td>
<td>1.4816</td>
<td>0.83</td>
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<td>9.66-9.67</td>
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<td>10.51-10.52</td>
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<td>1.4663</td>
<td>0.72</td>
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<td>10.95-10.96</td>
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<td>1.4618</td>
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<td>11.26-11.27</td>
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<td>x</td>
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### Core BB07-02

<table>
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<tr>
<th>Depth in core (m)</th>
<th>Total Carbon %</th>
<th>Inorganic Carbon %</th>
<th>Organic Carbon %</th>
</tr>
</thead>
<tbody>
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<td>0.20-0.21 (Shell hash)</td>
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<td>8.8097</td>
<td>0.01</td>
</tr>
<tr>
<td>0.57-0.58</td>
<td>4.84</td>
<td>2.8086</td>
<td>2.03</td>
</tr>
<tr>
<td>1.08-1.09</td>
<td>3.61</td>
<td>1.08195</td>
<td>2.53</td>
</tr>
<tr>
<td>1.35-1.36</td>
<td>2.26</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>1.61-1.62</td>
<td>3.29</td>
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<td>0.79</td>
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<td>1.88-1.89</td>
<td>1.63</td>
<td>1.1073</td>
<td>0.52</td>
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<td>2.11-2.12</td>
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<td>2.69-2.70</td>
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### Core BB06-02

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<th>Depth in core (m)</th>
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<tr>
<td>0.54-0.55</td>
<td>2.78</td>
</tr>
<tr>
<td>1.21-1.22</td>
<td>2.09</td>
</tr>
<tr>
<td>1.65-1.66 (shell hash)</td>
<td>5.2</td>
</tr>
<tr>
<td>2.24-2.25 (Sand lamination)</td>
<td>0.97</td>
</tr>
<tr>
<td>2.78-2.89</td>
<td>1.57</td>
</tr>
<tr>
<td>3.35-3.36</td>
<td>1.87</td>
</tr>
<tr>
<td>3.58-3.59 (white mud)</td>
<td>4.95</td>
</tr>
<tr>
<td>3.77-3.78</td>
<td>1.35</td>
</tr>
<tr>
<td>4.57-4.58</td>
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</tr>
<tr>
<td>5.07-5.08</td>
<td>1.67</td>
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<tr>
<td>5.41-5.42</td>
<td>1.62</td>
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<tr>
<td>6.12-6.13</td>
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<tr>
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</tr>
<tr>
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<td>8.14-8.15</td>
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X-Ray diffraction result from core BB06-02 at the depth of 3.35m.
X-Ray diffraction result from core BB06-02 at the depth of 5.41m.
X-Ray diffraction result from core BB06-02 at the depth of 8.15m.
X-Ray diffraction result from core BB07-01 at the depth of 1.16m.
X-Ray diffraction result from core BB07-01 at the depth of 2.48m.
X-Ray diffraction results from core BB07-01 at the depth of 5.80m. Interpretation has shown in Fig. 20.
X-Ray diffraction result from core BB07-01 at the depth of 11.26m.
X-Ray diffraction result from core BB07-02 at the depth of 1.08m.
X-Ray diffraction result from core BB07-02 at the depth of 2.70m.
VITA

Niranjan Aryal

Candidate for the Degree of

Master of Science

Thesis: DEPOSITIONAL HISTORY OF UPPER BAFFIN BAY, TEXAS

Major Field: Geology

Biographical:

Personal Data:

Parents: Achyut and Kamala Aryal
Spouse: Jyoti Aryal

Education:
B. S. Tribhuvan University, Kathmandu, Nepal in May 2001
M.S. Oklahoma State University, Stillwater, OK in October 2007

Experience:
1. Research Assistant and Teaching Assistant (2005-2007): School of Geology, Oklahoma State University, Stillwater, OK.

Professional Memberships:

This study is aimed at gaining a better understanding of the internal architecture of upper Baffin Bay, Texas a mixed siliciclastic/carbonate incised valley. Proper identification of mixed siliciclastic/carbonate-filled incised valleys is necessary for the identification of sequence boundaries that might otherwise be left unnoticed. These unnoticed sequence boundaries can be traced through the basin to find other incised valleys and even shelf-margin deltas and lowstand fans, which are excellent stratigraphic traps. In addition, a detailed study of the facies architecture of incised valleys may provide a better understanding of the evolutionary changes that occur within incised-valley systems, which may help in predicting the environmental effects of future increases in the rate of sea-level rise. To accomplish the task, we collected 65 km of high-resolution seismic data and seven cores up to 14.5 m in length. 13 radiocarbon dates were obtained from mollusks, wood fragments and algal mats to establish a chronostratigraphic framework for the changes that occurred within the bay over last 8.0 ka.

Findings and Conclusions:

We recognize three major changes in depositional environments within upper Baffin Bay. These changes occurred at 8.0 ka, 5.5 ka and 4.3 ka. From initial drowning to 8.0 ka upper portions of the bay were occupied by a fluvial/deltaic environment. At 8.0 ka the bay-head delta backstepped landward 15 km and the bay began to fill with upper-bay deposits. A rapid sea-level rise associated with the drainage of Lake Agassiz is believed to be the causal mechanism for this event. At 5.5 ka the open bay began to expand landward and the upper-bay environment retreated 10 km to the north. Prolonged dry climate within Texas is a possible mechanism for this event. The flooding of fluvial terraces may also have contributed to this event. By 4.3 ka, the bay-head delta backstepped completely out of our study area and the bay filled with open-bay deposits. A climate change as well as the flooding of antecedent topography may have played roles in causing this event.