Mixed Carbonates and Siliciclastics along the Coast of Southern Belize (Central America): Sediment Cores as Archives of Late Quaternary Coastal Development and Major Storms*

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Abstract

The modern southern shelf of Belize is characterized by a carbonate-to-siliciclastic transition. Along the coast, quartz sand, that is brought into the system from the hinterland by rivers and small streams, may form small deltas and is transported along the coast by currents to form beaches, berms, and sand spits. Behind berms and sand spits, shallow coastal lagoons, mangrove swamps, marshes, and flood plains occur. Tidal deltas are found occasionally. Mangrove coastline without beaches or sand barriers is rare. Twenty-six cores with an average length of 2.8 m taken along five traverses across the coast were taken in order to detail late Pleistocene and Holocene coastal evolution and to identify event (storm) layers. Late Pleistocene facies as recovered in core are largely greenish to reddish loams with quartz grains. Holocene facies include brown to black (organic-rich) muds, peats, and quartz sand, as well as mollusk shell and coral coquinas. Lithologic repetitions in the cores suggest laterally shifting facies. Retrogradation and aggradation may have occurred during rapid to moderate sea-level rise such as during the early and mid Holocene. Slow sea-level rise or stalling sea level produced progradation as observed in the late Holocene. Coquinas are interpreted as either expressions of colonization events and/or storm deposits. Radiocarbon dating of peat, wood, mollusk shells, and coral skeletons is currently under way and will allow detailed facies correlations.

Selected References

Emanuel, K., 2005, Increasing destructiveness of tropical cyclones over the past 30 years: Nature, v. 436, p. 686-688.

Gischler, E., and J.H. Hudson, 2004, Holocene development of the Belize barrier reef: Sedimentary Geology, v. 164/3-4, p. 223-236.

McCloskey, T.A., and G. Keller, 2009, 5000 year sedimentary record of hurricane strikes on the central coast of Belize, in S.A.G. Leroy, and T.M. Niemi, (eds.), Hurricanes and typhoons; from the field records to the forecoast: Quaternary International, v. 195/1-2, p. 53-68.

Webster, R.J., G.J. Holland, J.A. Curry, and H.R. Chang, 2005, Changes in tropical cyclone number, duration, and intensity in a warming environment: Science, v. 309/5742, p. 1844-1846.

Mixed carbonates and siliciclastics along the coast of southern Belize: sediment cores as archives of late Quaternary coastal development and major storms

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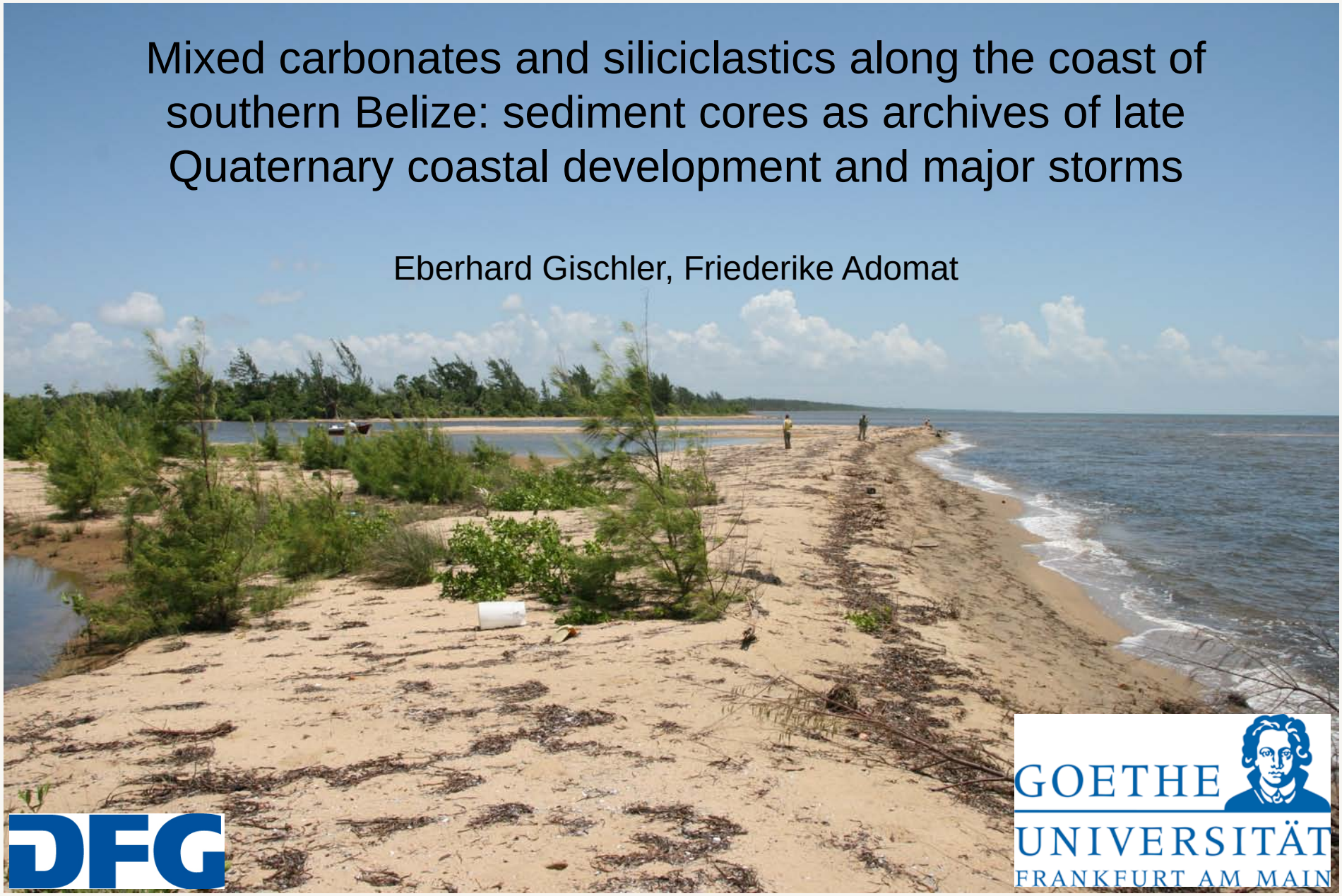


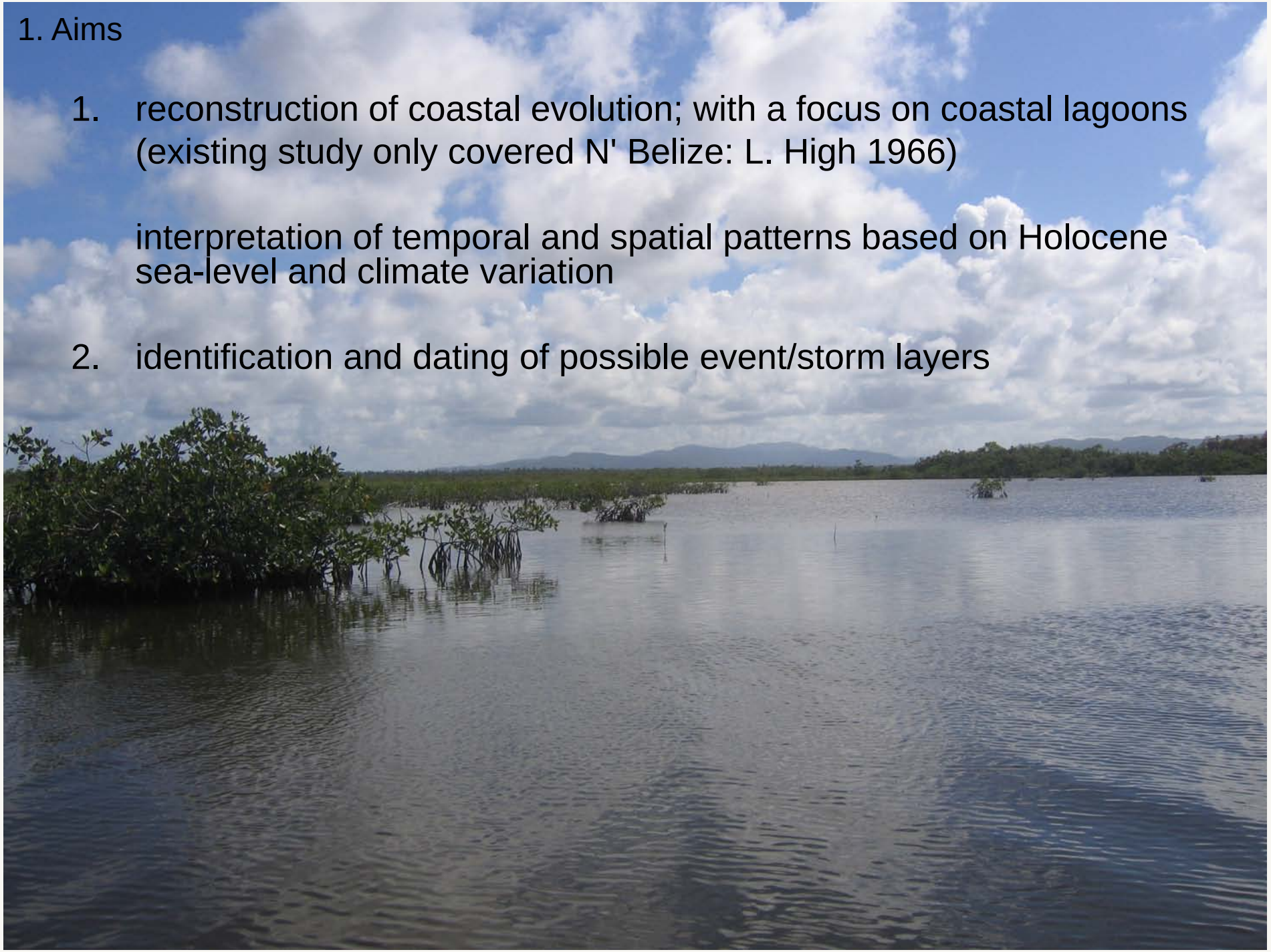
AAPG-SEPM annual meeting, April 2012, Long Beach, USA

1. Aims

1. reconstruction of coastal evolution; with a focus on coastal lagoons (existing study only covered N' Belize: L. High 1966)

   interpretation of temporal and spatial patterns based on Holocene sea-level and climate variation

2. identification and dating of possible event/storm layers

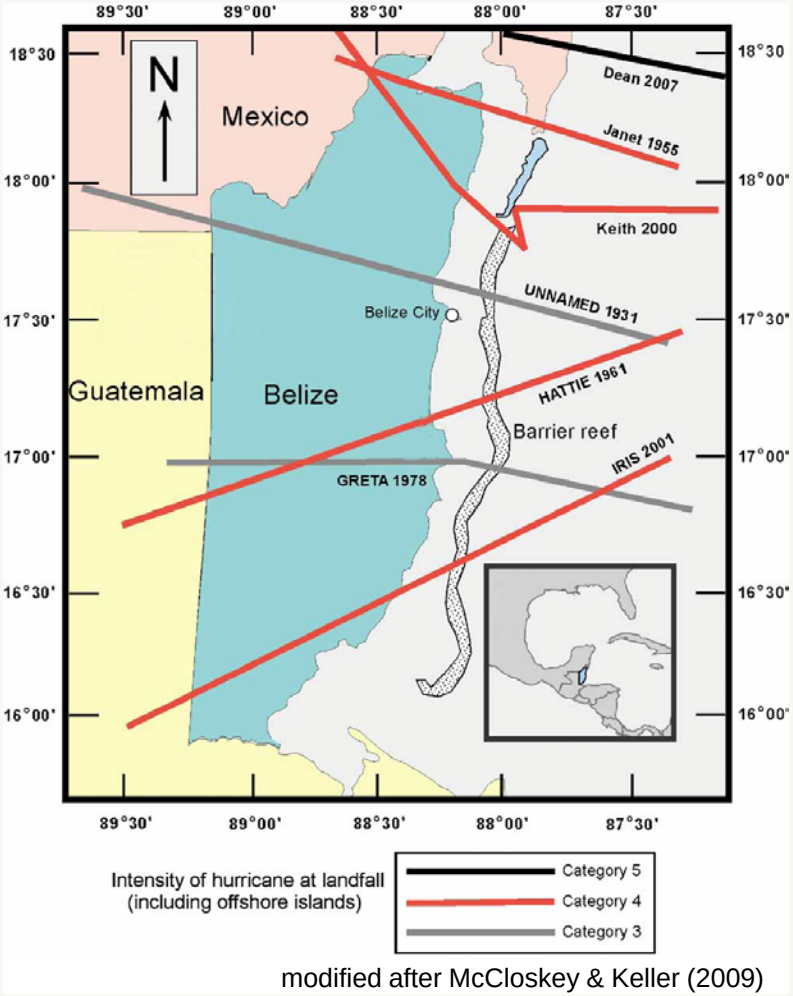


1. Aims

events/storms

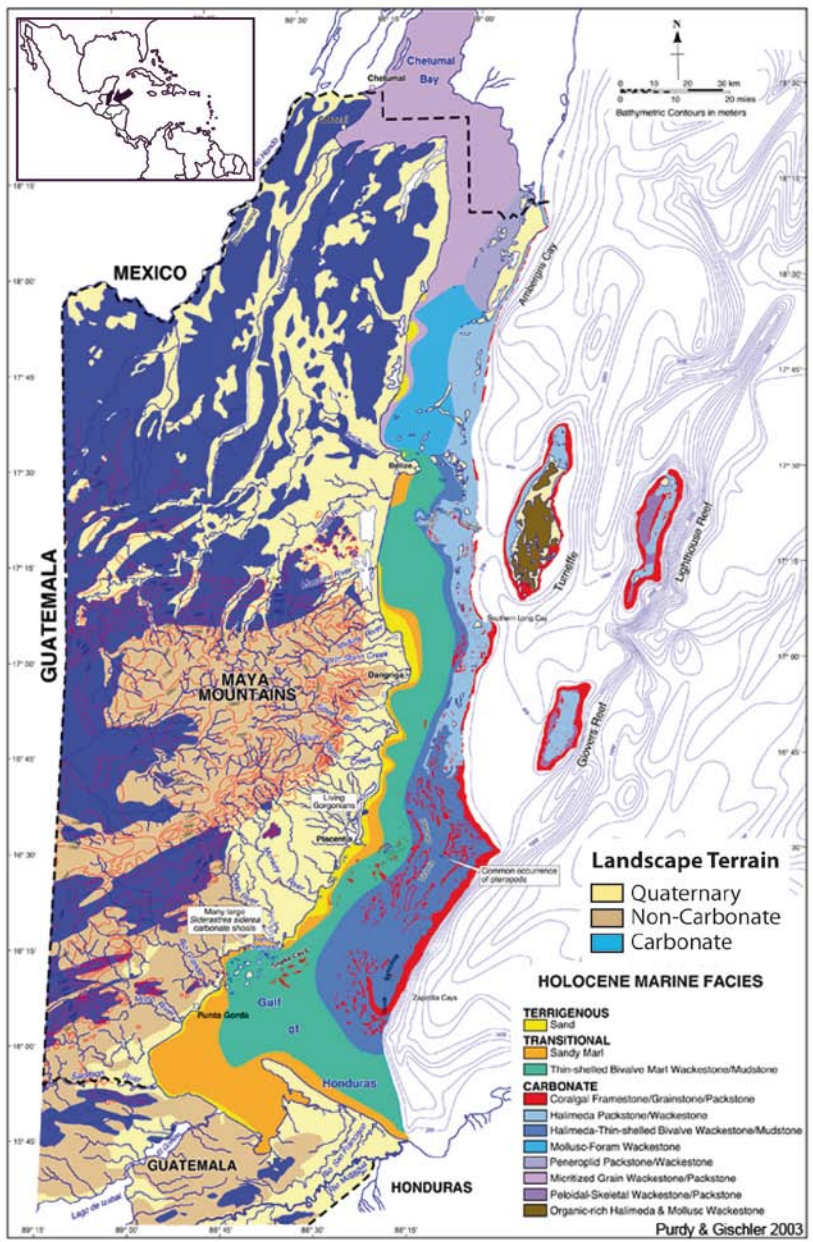
- increase in intensity of cyclones over the past decades (Elsner et al. 2005, Emanuel 2005, Webster et al. 2005)

- hurricane sediments: coarse grained deposits in muds and silts, overwash sand layers, storm rubble, boulder ridges, onshore marine organisms



modified after McCloskey & Keller (2009)

2. Study area



modified after Purdy & Gischler (2003)

Belize

- **climate:** subtropical
- **tidal range:** microtidal (< 30 cm)
- **geology:** Paleozoic Maya Mountains

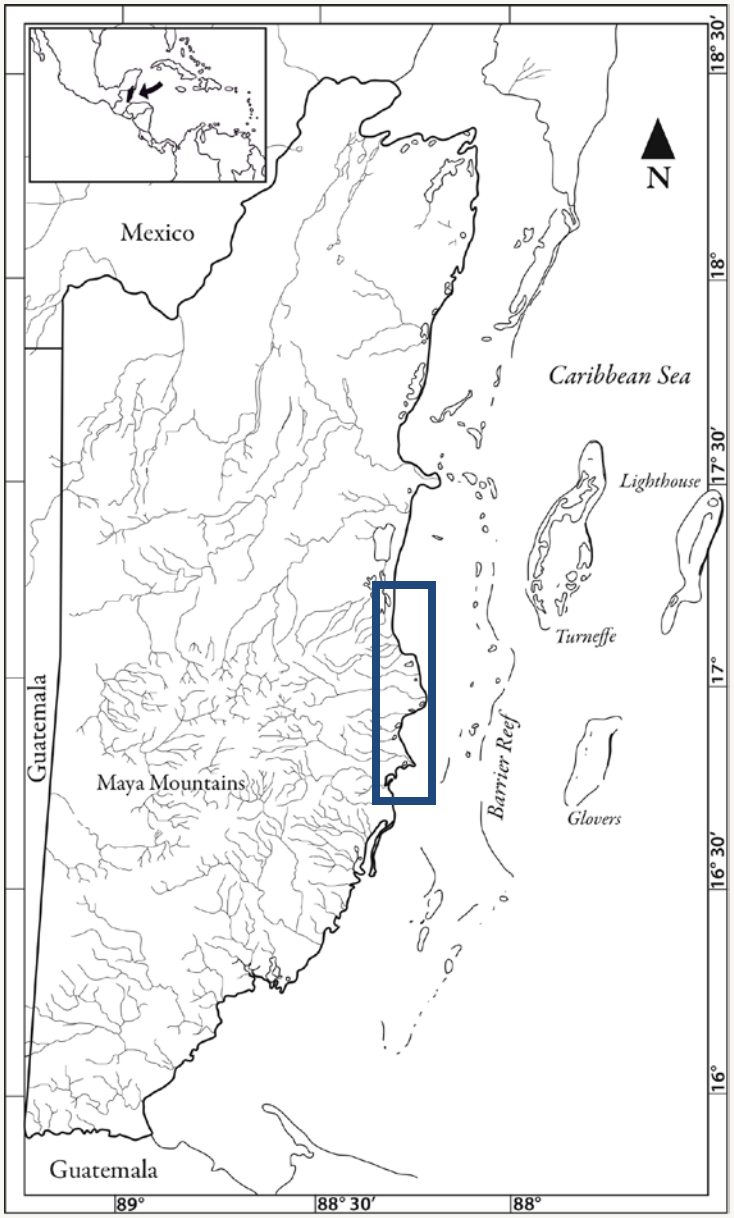
  Cretaceous and Tertiary limestone/dolostone

  Quarternary sediments

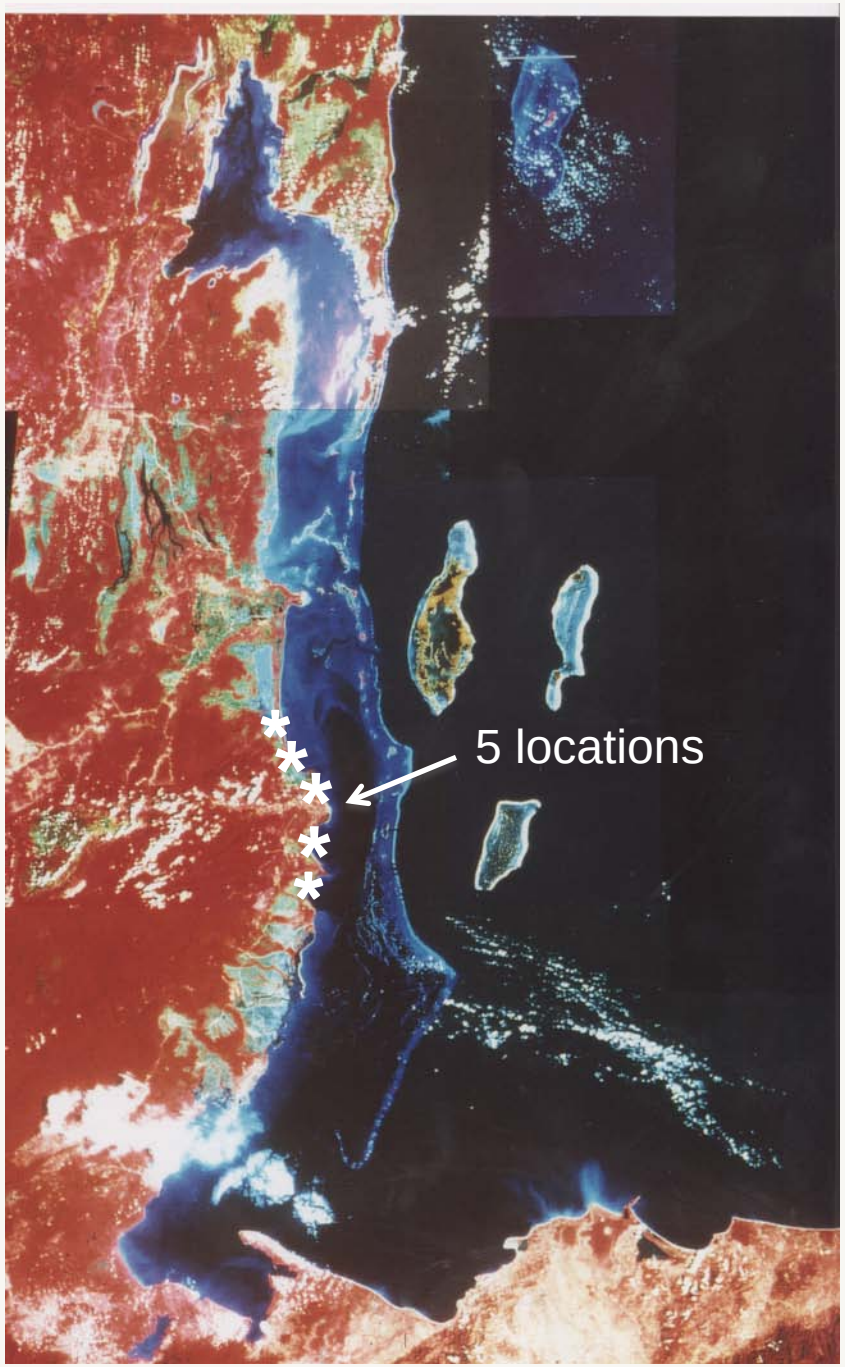
  northern shelf: carbonates

  southern shelf: carbonates and siliciclastics

2. Study area



modified after High (1966)



satellite image (false color)

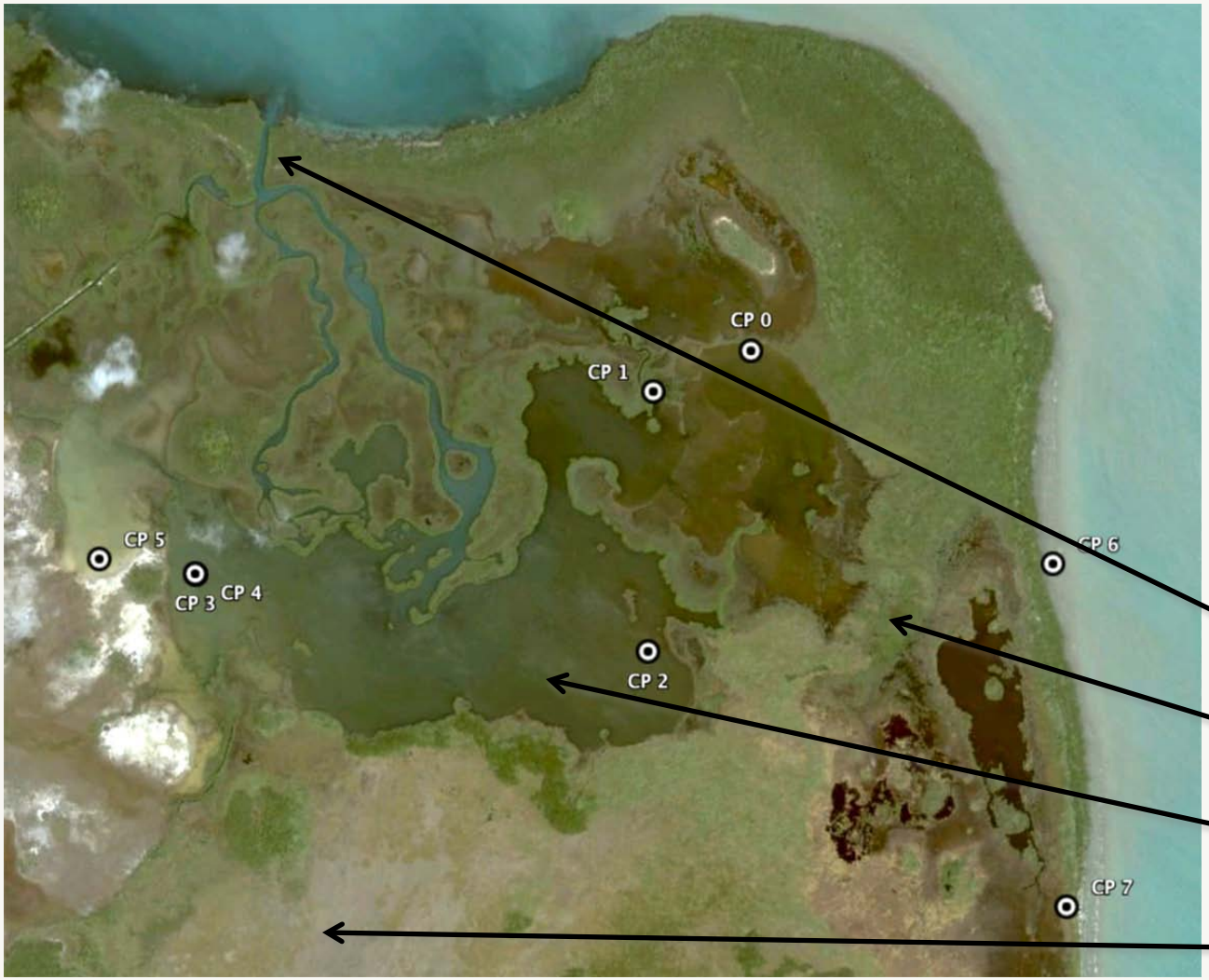
3. Field work

- vibracorer ("Lanesky")
- aluminium-pipe (600 cm length, 7.5 cm diameter)
- 26 cores
- core length: 99 – 457.5 cm

  mean length 277 cm;

  total length ≈ 73 m

3. Field work



source: GoogleEarth

Colson Point Lagoon

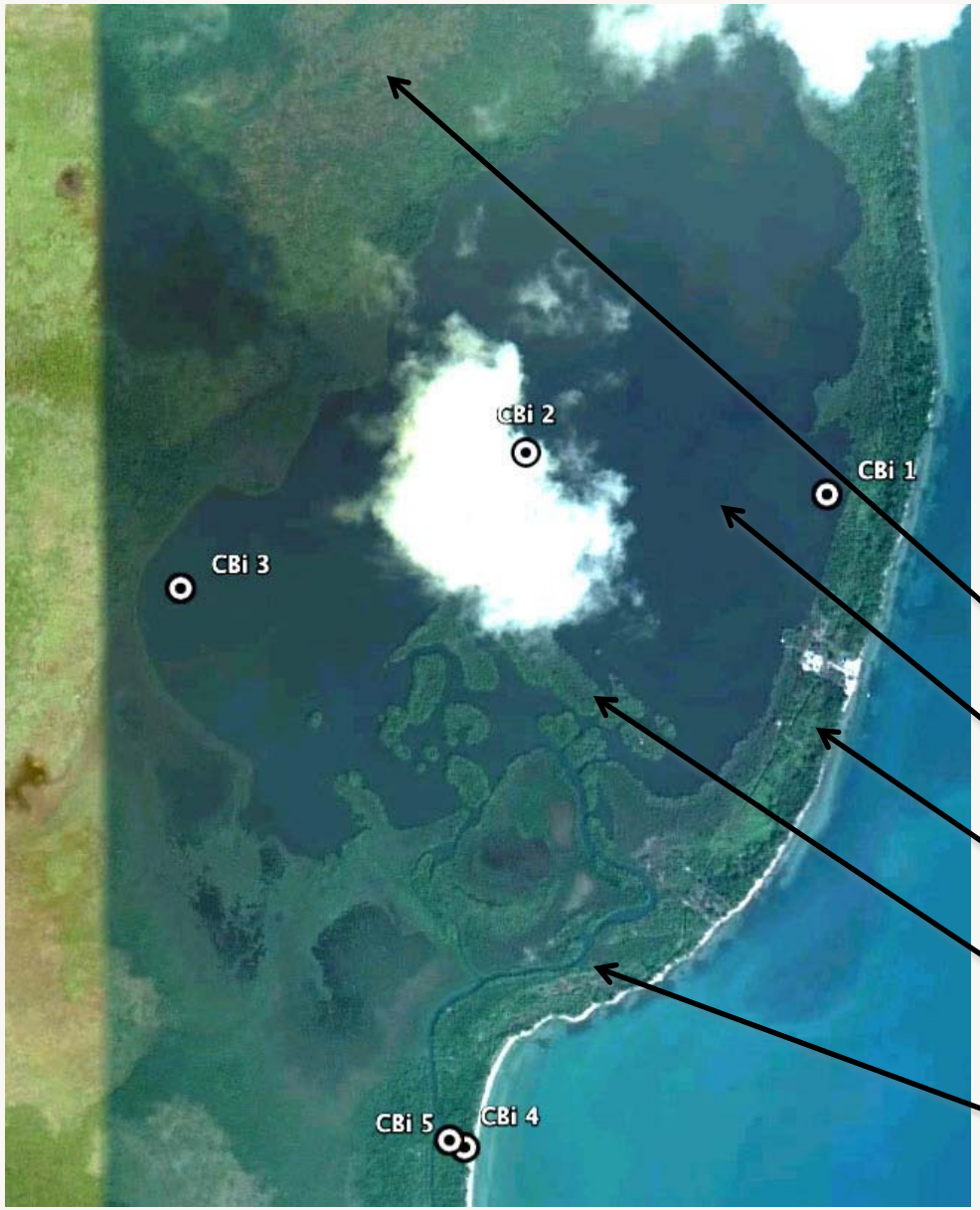
lagoon-shoreline
860 m, 1250 m

area 2.5 × 1.2 km

water depth ≤88 cm

salinity 3.1 - 7‰

3. Field work



source: GoogleEarth

Commerce Bight Lagoon

lagoon-shoreline: 130 m

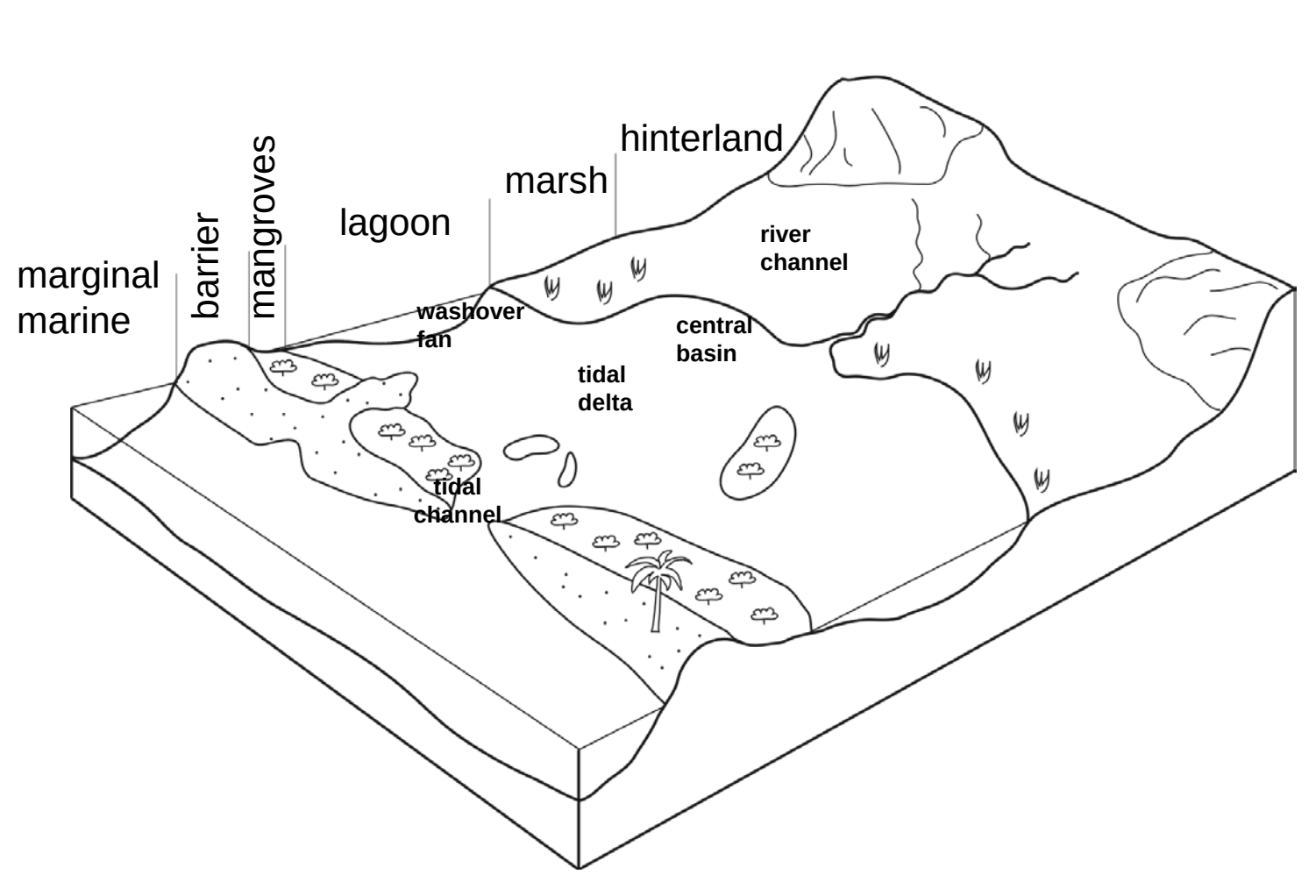
area 1.4 × 1.6 km

water depth ≤1.02 m

salinity 8 - 14.1‰

3. Field work

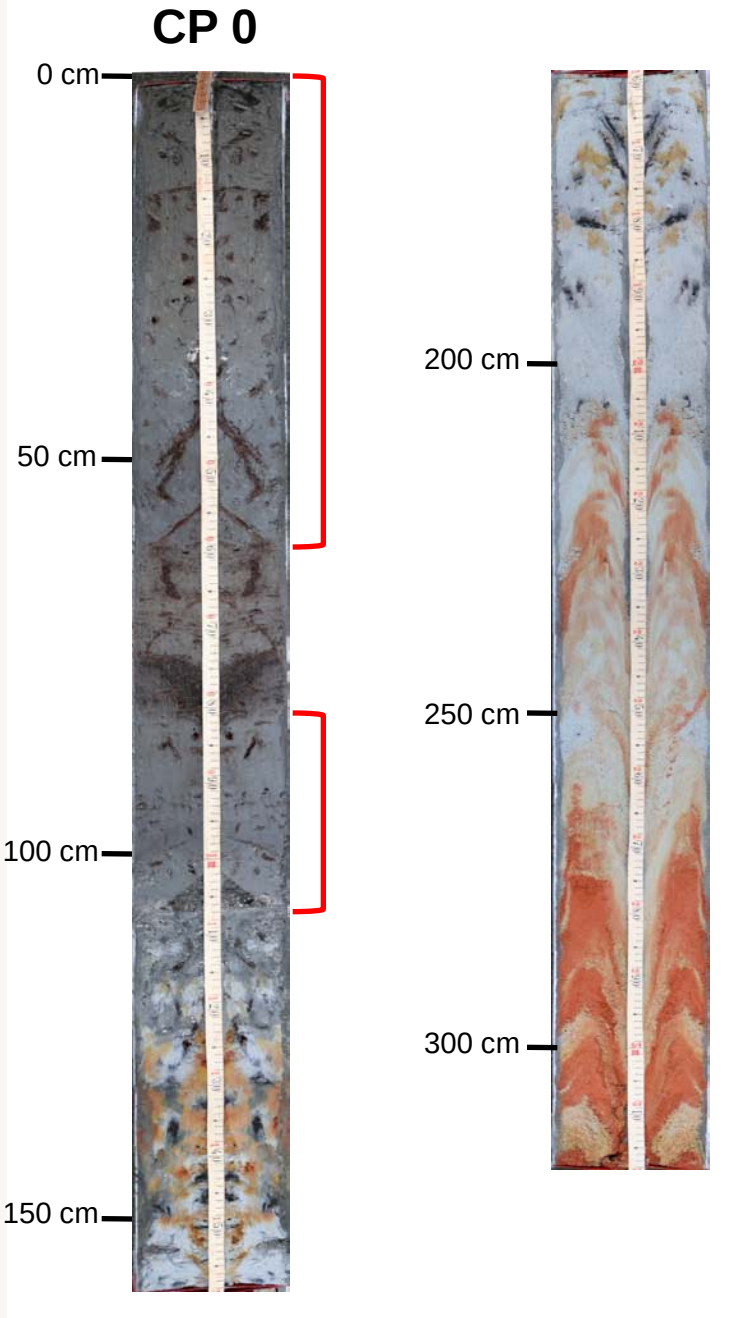
coastal lagoon geomorphology (summary)



4. Laboratory work

- core description, documentation, logging
- identification of shells, skeletons, etc.
- grain-size analysis
- measurement of carbonate content
- measurement of organic matter content
- X-ray diffraction (XRD)
- radiocarbon dating

5. Results



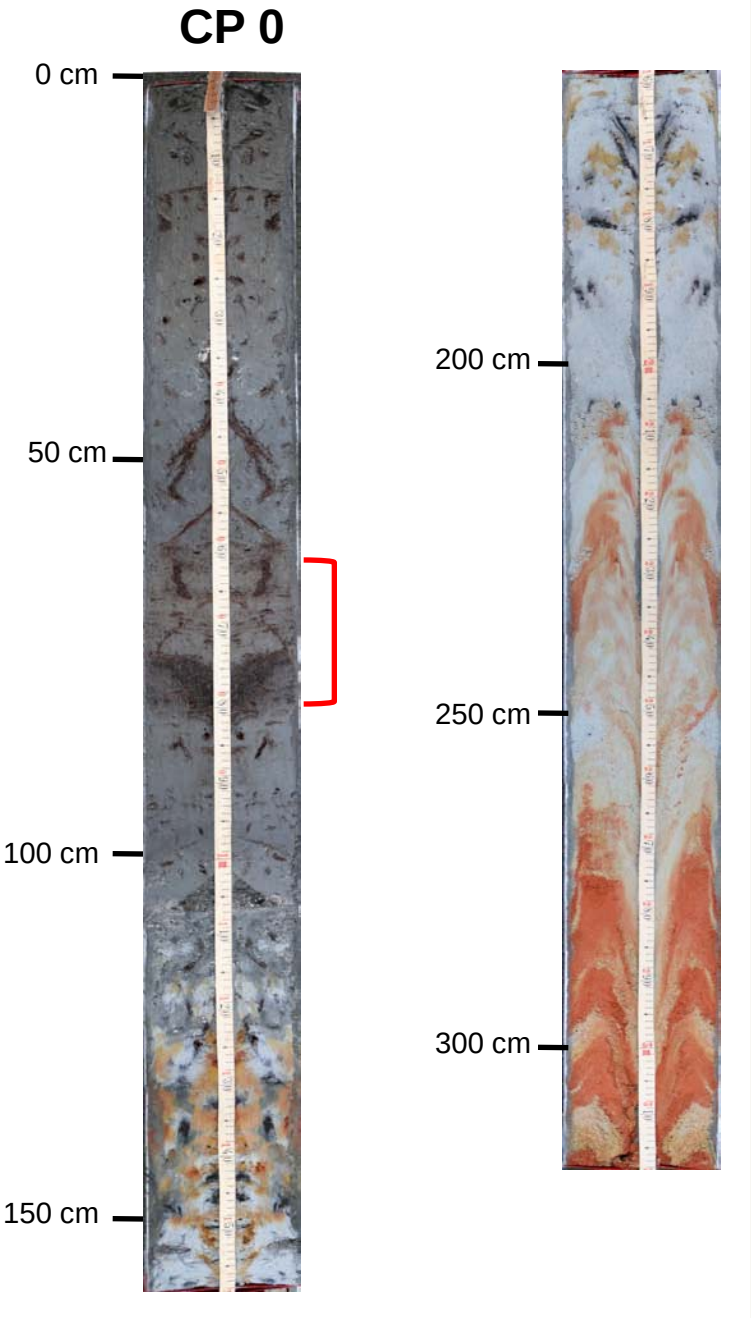
facies

mud

- marl (-10% $CaCO_3$)
- mollusk shells
- mangrove roots

→ lagoonal sedimentation

5. Results

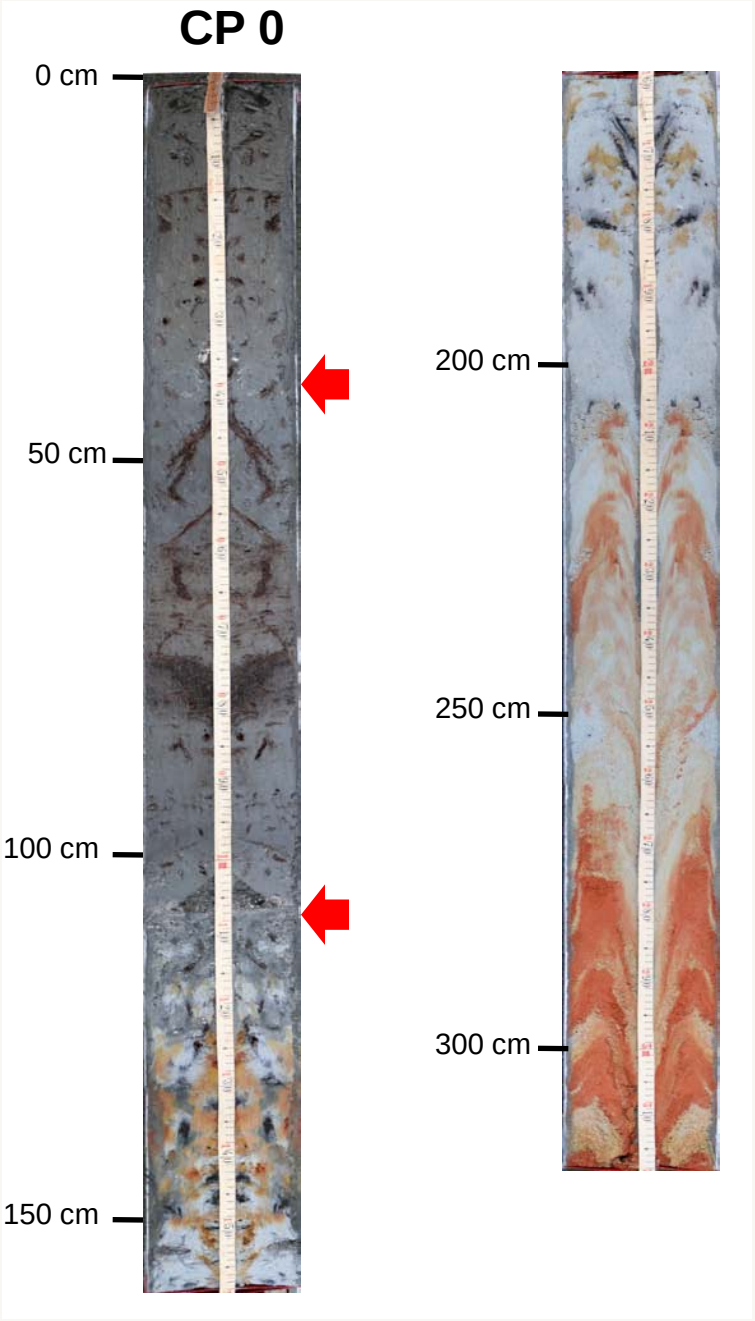


facies

peat, peaty sediment

→ red mangrove growth

5. Results



facies

shell layers

→ autochthonous or allochthonous?

5. Results

shell layers

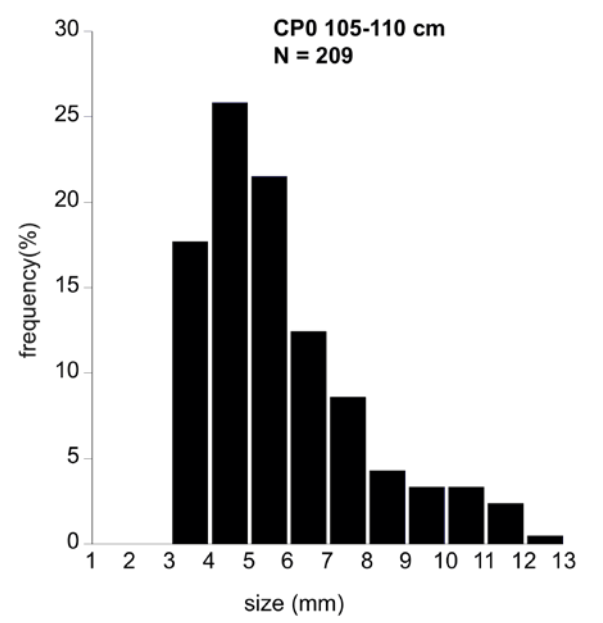
Anomalocardia cuneimeris
(photo: Poppe Conchology Inc.)

lagoon: - mollusk shells (bivalves and gastropods)
- dominant species: *A. cuneimeris*
Cerithiidae
- brackish species

marginal marine: - higher diversity
- marine mollusc species,
corals (*Porites, Cladocora*)

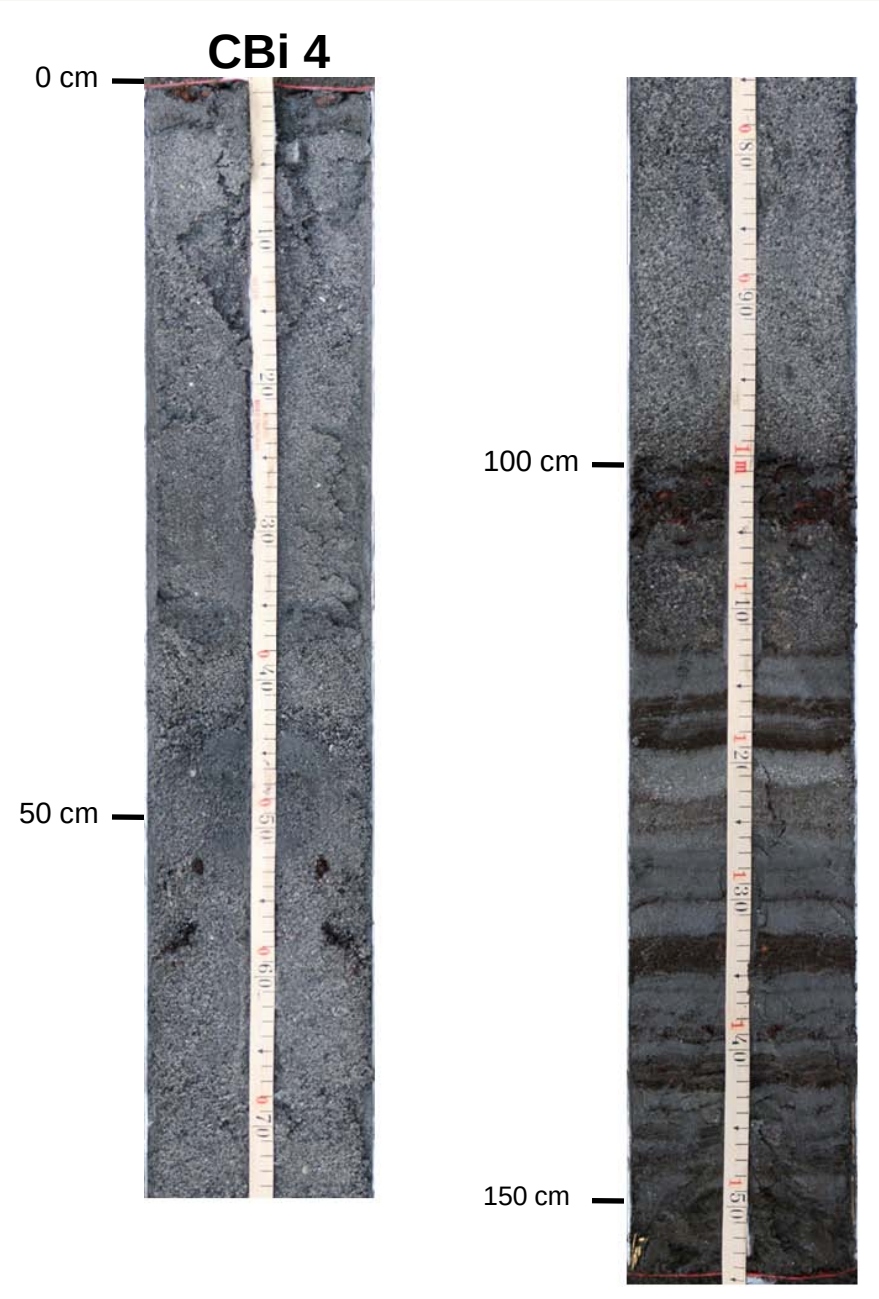
➔ autochthonous

➔ not storm - related



Size-frequency diagram of
Anomalocardia cuniemeris

5. Results



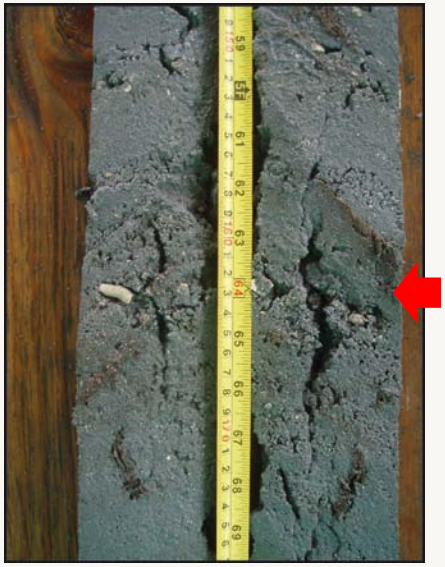
facies

quartz sands (with coral layers)

→ fluvial (and/or storm-induced?)
→ coastal transport?

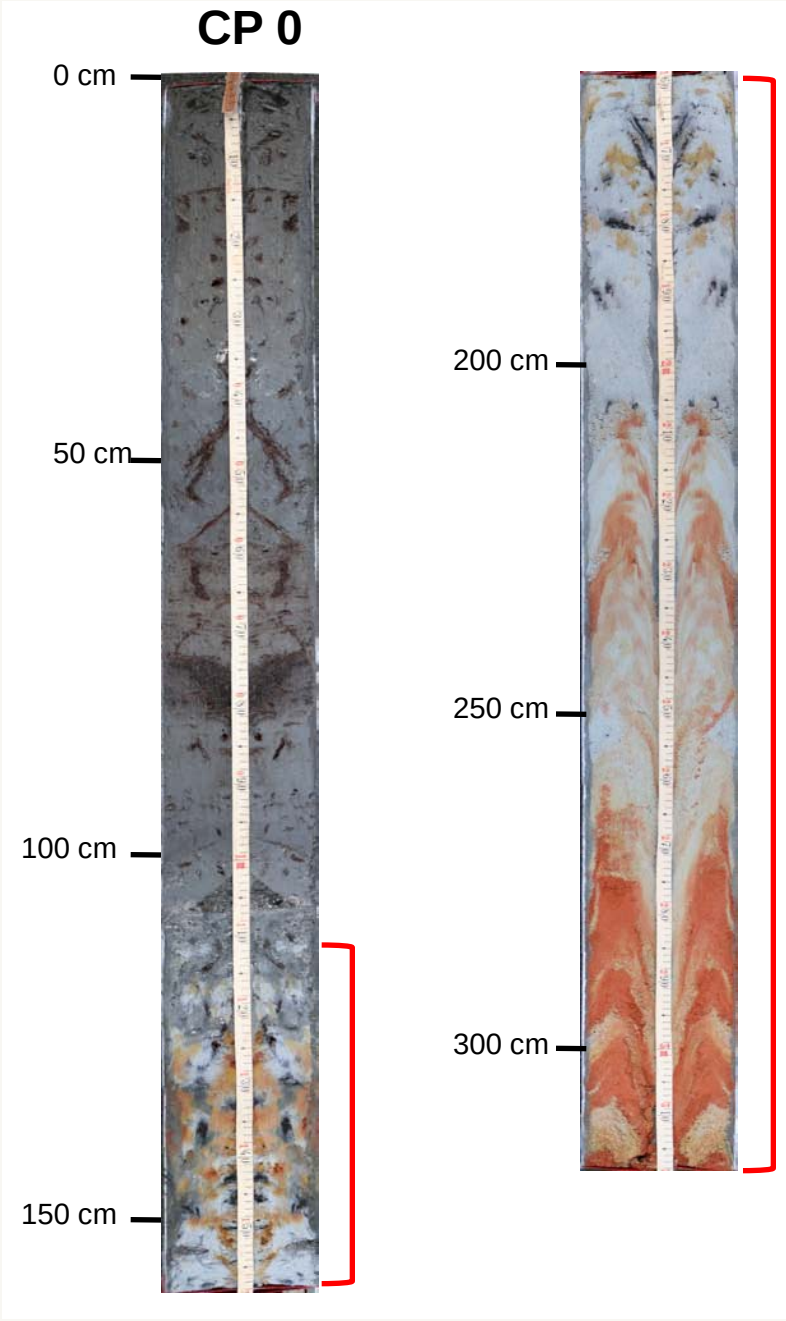
peat and mud/silt succession

→ rapidly shifting facies



coral layer

5. Results

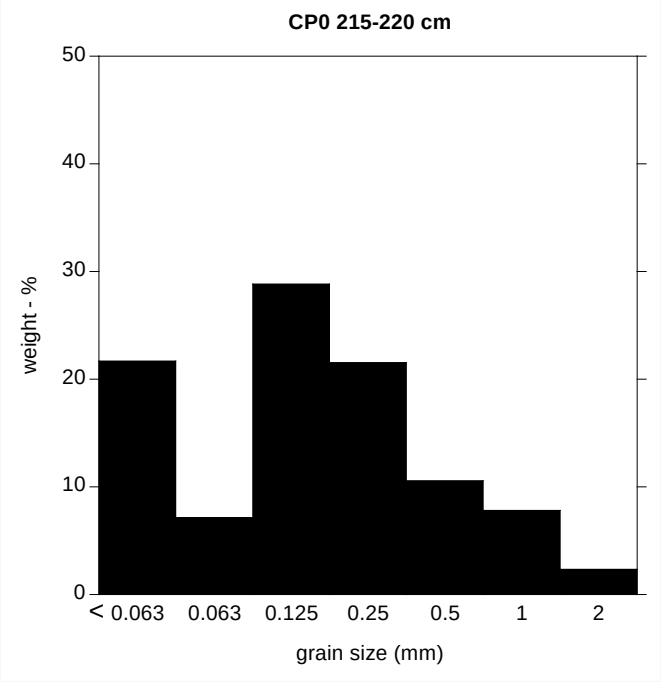


facies

blueish-grey loam; Pleistocene

- with quartz-sand
- orange-yellow to red stain

→ terrestrial



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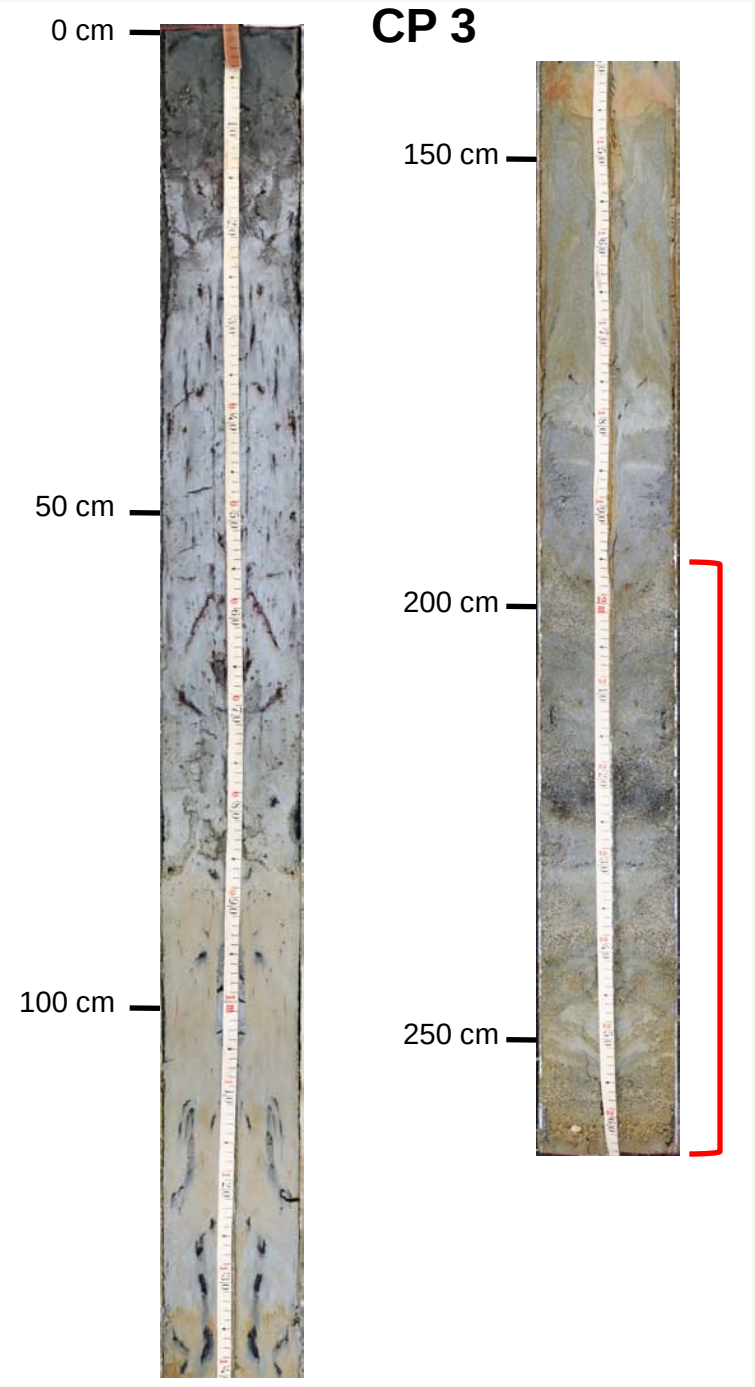
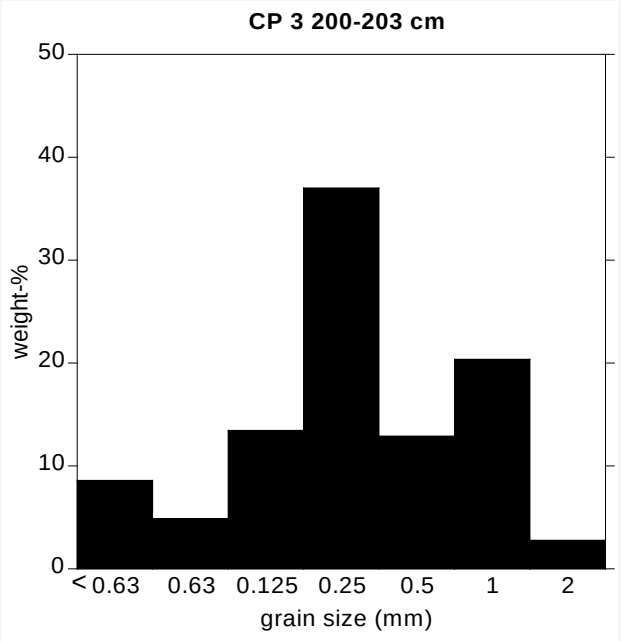


facies

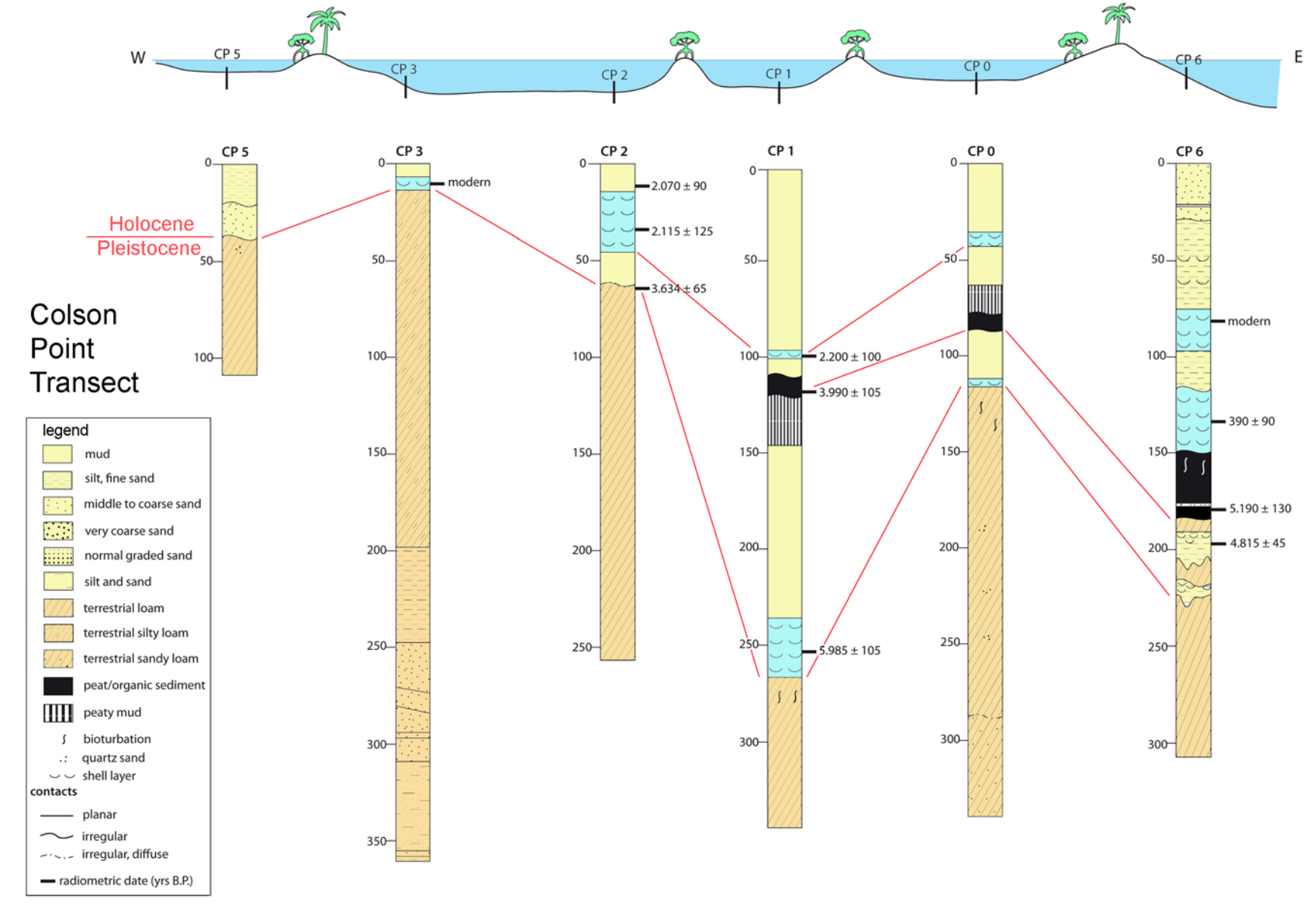
Pleistocene sand, silt

- with cross bedding

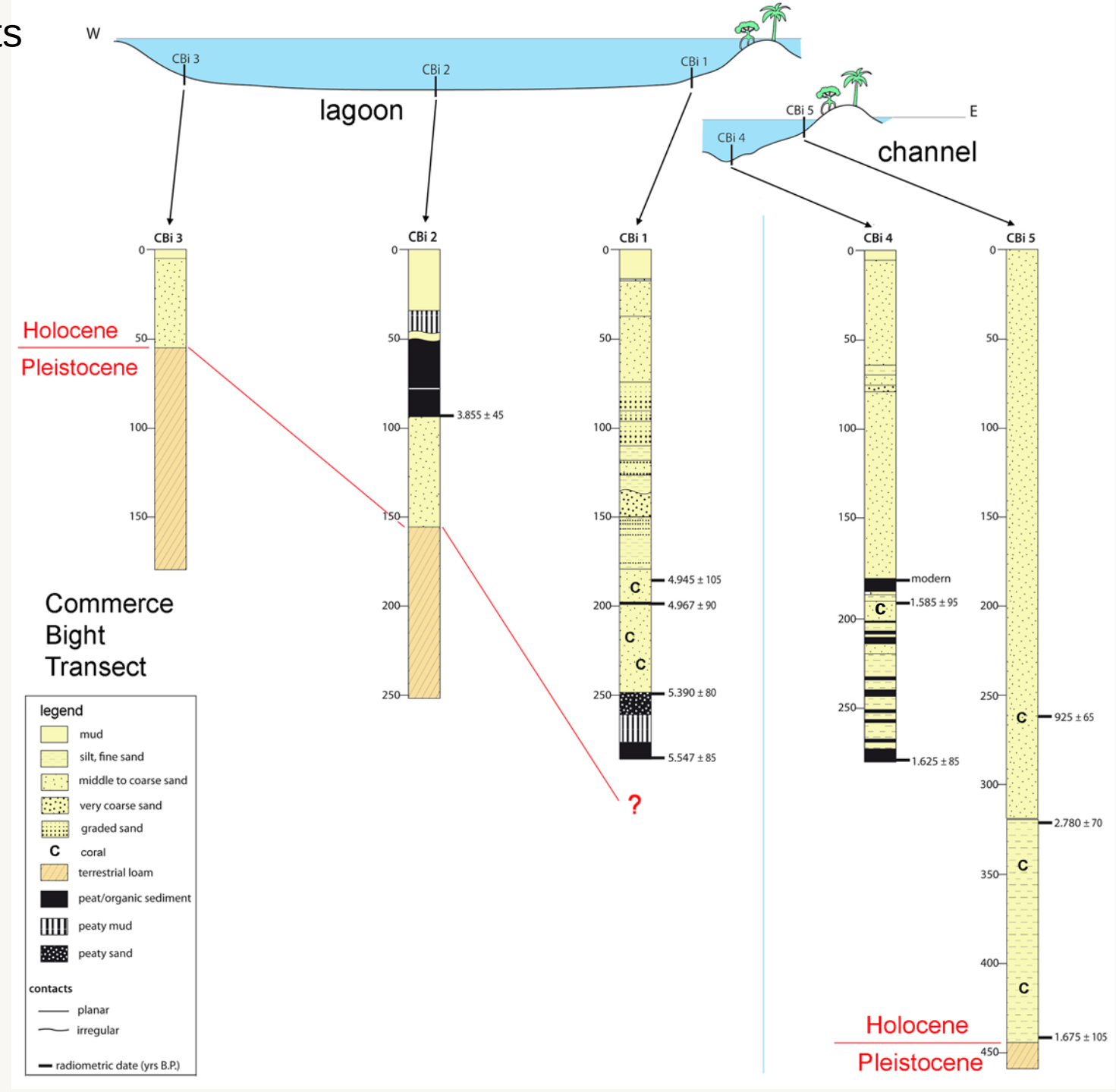
→ fluvial



5. Results

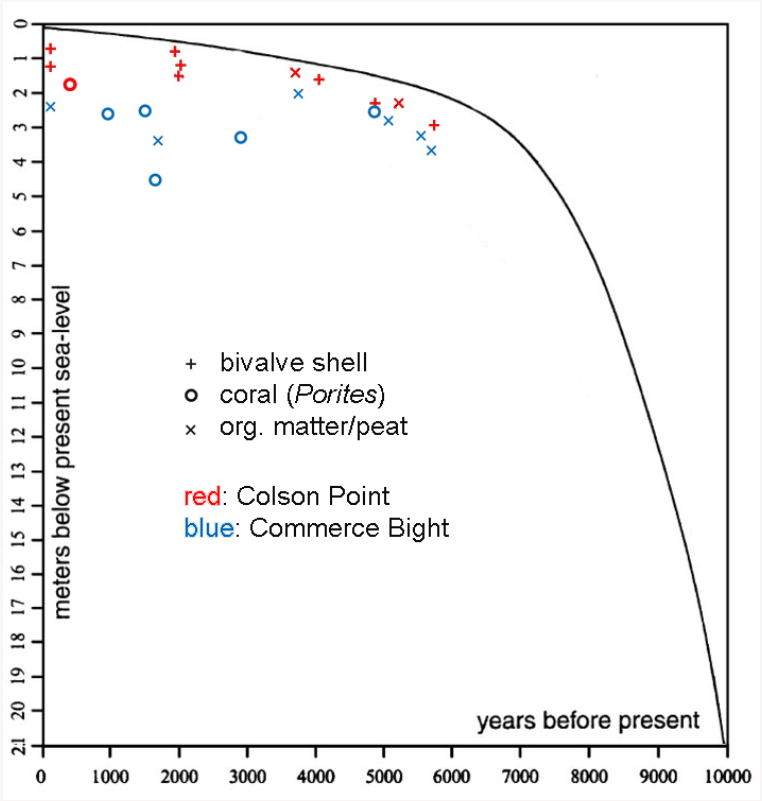

W
E
CP 5
CP 3
CP 2
CP 1
CP 0
CP 6
Holocene
Pleistocene
Colson
Point
Transect
modern
2.070 ± 90
2.115 ± 125
3.634 ± 65
2.200 ± 100
3.990 ± 105
5.985 ± 105
modern
390 ± 90
5.190 ± 130
4.815 ± 45
legend
mud
silt, fine sand
middle to coarse sand
very coarse sand
normal graded sand
silt and sand
terrestrial loam
terrestrial silty loam
terrestrial sandy loam
peat/organic sediment
peaty mud
bioturbation
quartz sand
shell layer
contacts
planar
irregular
irregular, diffuse
radiometric date (yrs B.P.)

5. Results


W
CBi 3
CBi 2
CBi 1
lagoon
CBi 5
E
CBi 4
channel
CBi 3
CBi 2
CBi 1
CBi 4
CBi 5
Holocene
Pleistocene
3.855 ± 45
4.945 ± 105
4.967 ± 90
5.390 ± 80
5.547 ± 85
modern
1.585 ± 95
1.625 ± 85
925 ± 65
2.780 ± 70
1.675 ± 105
?
Commerce
Bight
Transect
legend
mud
silt, fine sand
middle to coarse sand
very coarse sand
graded sand
C coral
terrestrial loam
peat/organic sediment
peaty mud
peaty sand
contacts
planar
irregular
radiometric date (yrs B.P.)

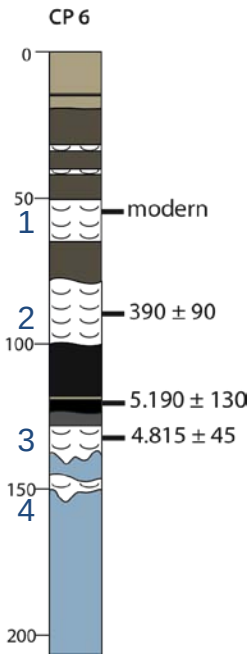
5. Results

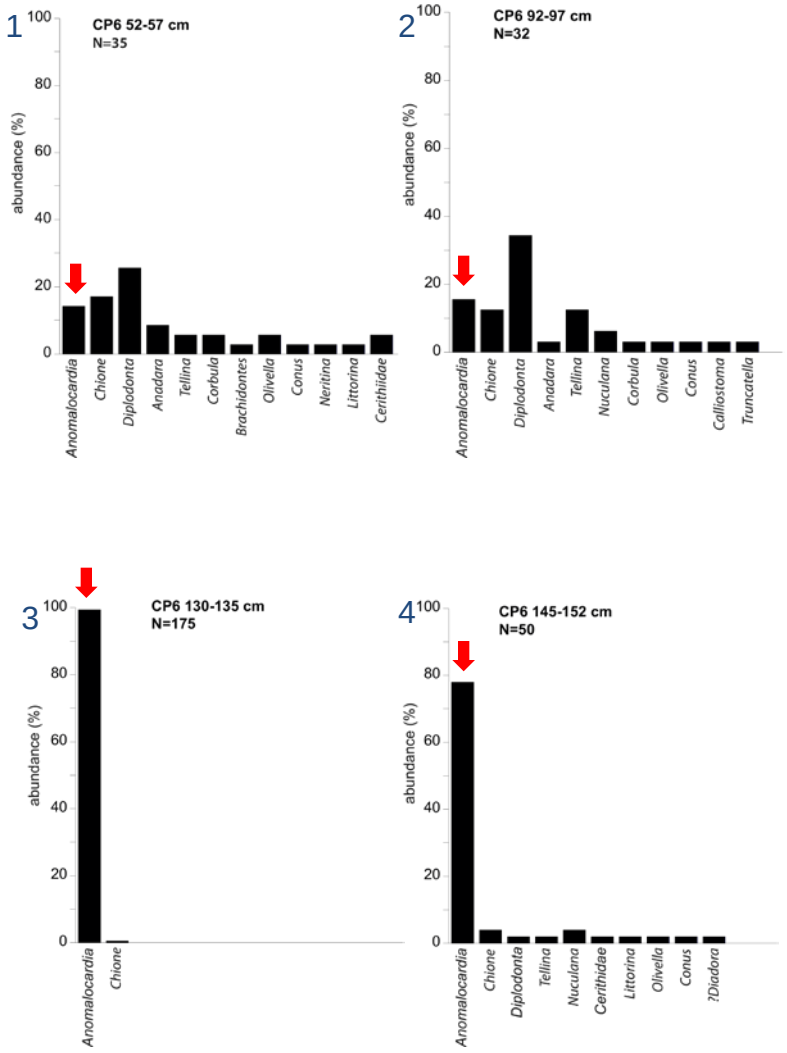
retrograding coast
(due to sea-level rise)



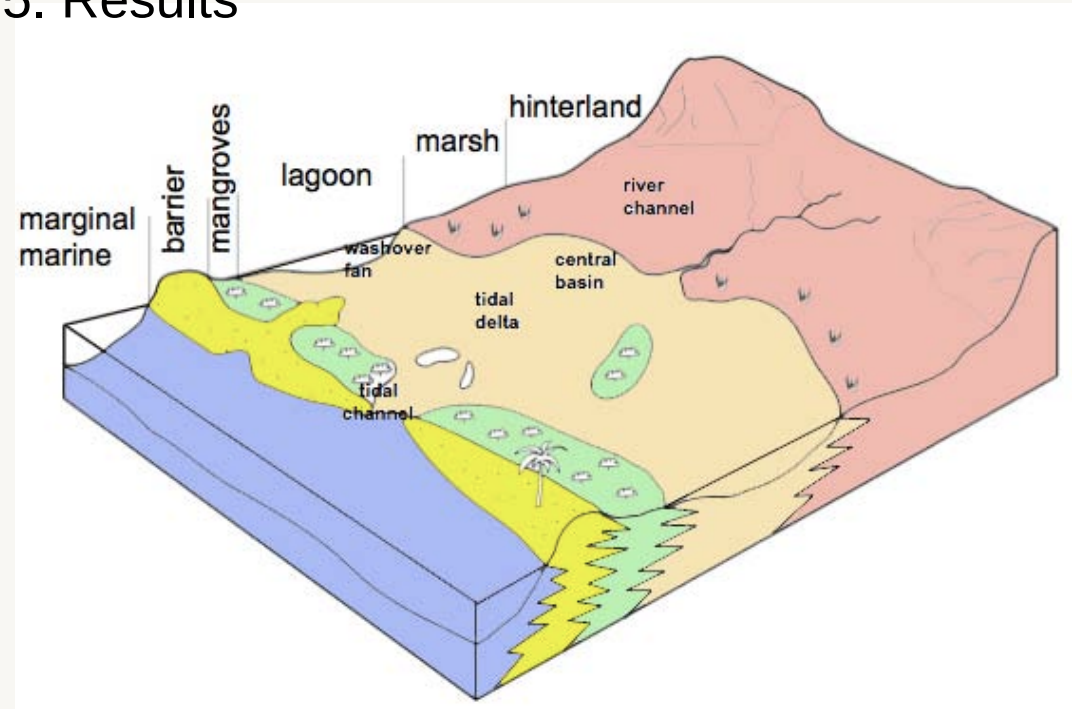
Belize sea level
(after Gischler and Hudson 2004)

marginal marine core:
open marine fauna superposes restricted lagoonal fauna

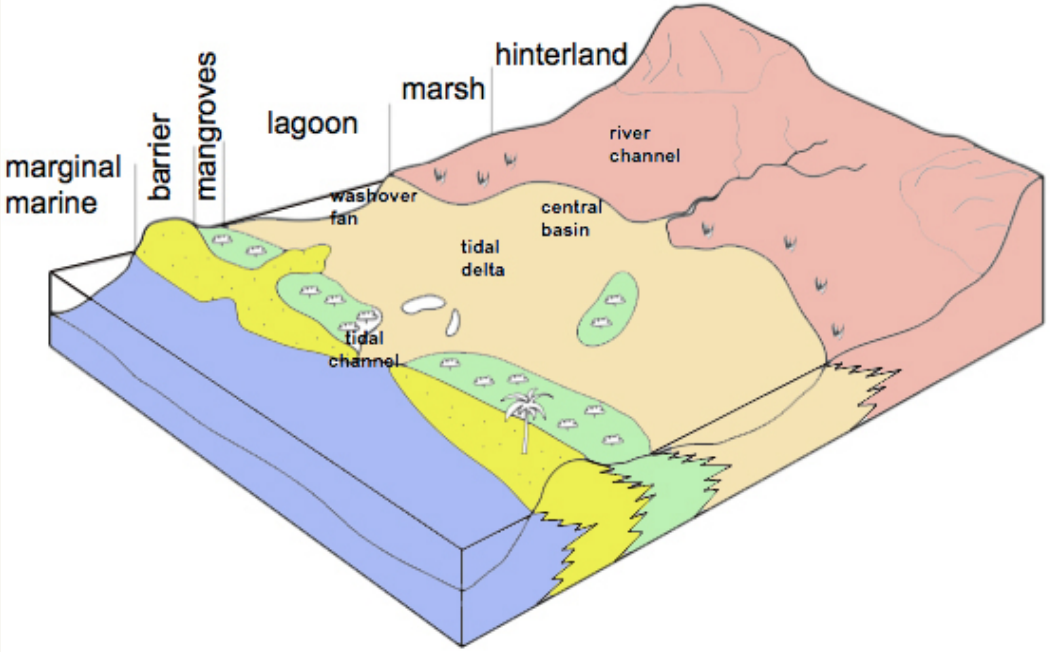




5. Results



1 simple retrogradation (TST)



2 retrogradation and progradation (TST, HST)

6. Results

event deposition

- coral layers:
  1,600 yrs BP
  4,950 yrs BP

- quartz sands: ? →
  .....

author	area	Intense cyclones, YBP
Liu & Fearn, 1993	Florida, Alabama	3200-3000, 2600, 2200, 1400, 800
Liu & Fearn, 2000	Florida	3400-1000
Scott et al., 2003	S`Carolina	1000-0
Donnelly & Woodruff, 2007	Puerto Rico	2500-1000
Gischler et al., 2008	Belize	1350-1150, 1000, 800-700, 550-450
McCloskey & Keller, 2009	Belize	4500-2500, 1500-1000

cyclone records from the western side of the northern Atlantic

- so far hardly any similarities between results and published record

- not surprising as each storm has track of limited diameter

Porites →

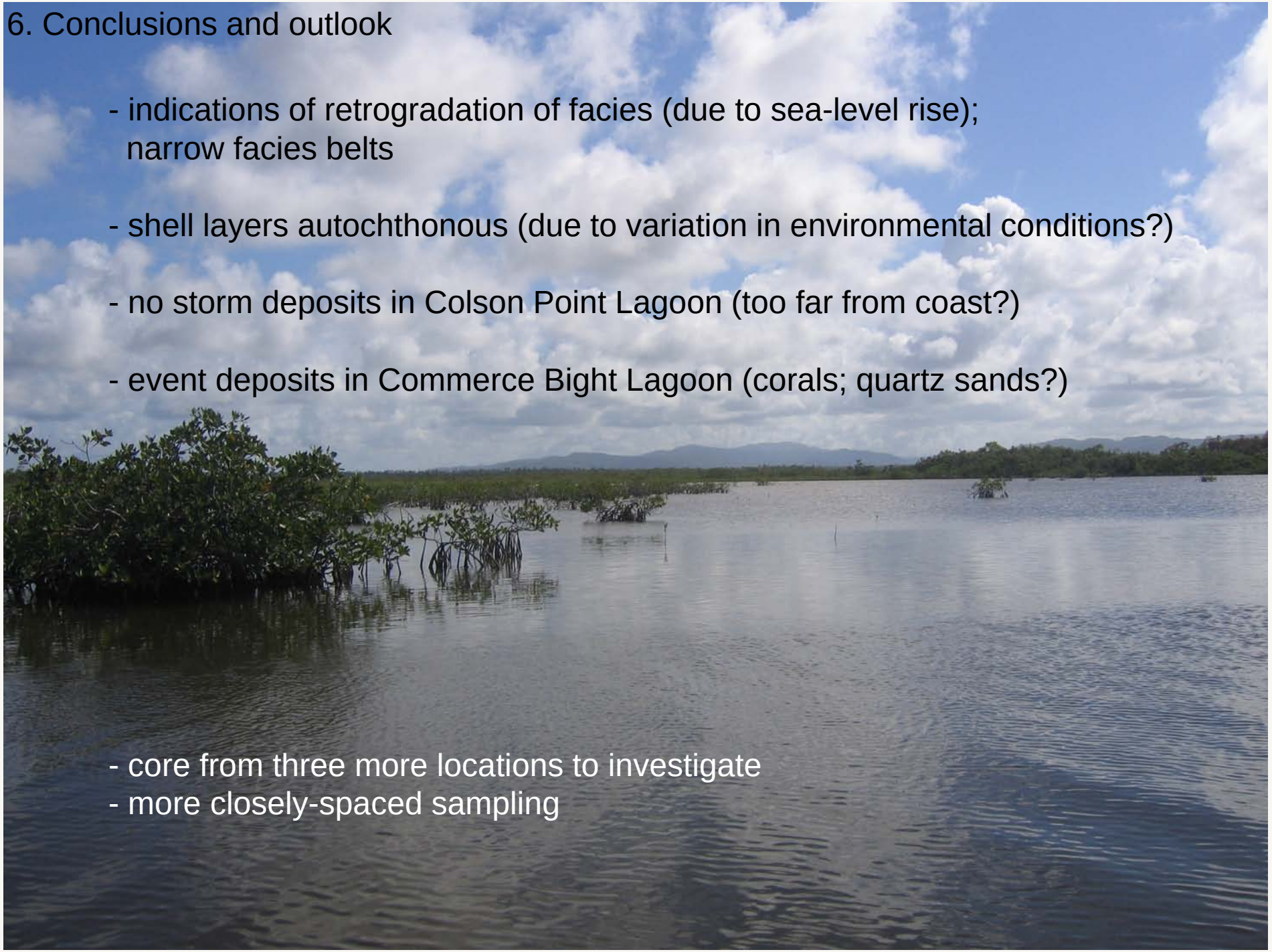
6. Conclusions and outlook

- indications of retrogradation of facies (due to sea-level rise); narrow facies belts

- shell layers autochthonous (due to variation in environmental conditions?)

- no storm deposits in Colson Point Lagoon (too far from coast?)

- event deposits in Commerce Bight Lagoon (corals; quartz sands?)



- core from three more locations to investigate
- more closely-spaced sampling