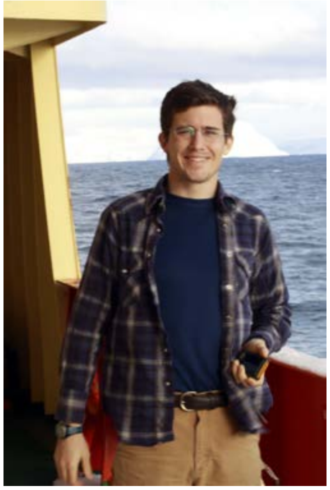

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South Texas Holocene climate reconstructed from δO^{18} measurements of ostracods and gypsum hydration water; elucidating incised-valley stratigraphic response to changes in climate and sea-level

Introduction

Rapid changes in coastal systems often result in significant economical and ecological loss. Modern estuaries, sites of significant population and industry centers, are highly sensitive to changes in relative sea level and sediment supply. Recent studies along the northwestern Gulf of Mexico document rapid back-stepping of estuarine environments up to 20 km 8.0 ka, 4.8, ka, and 2.6 ka (Milliken et al., 2008; Rodriguez et al., 2008). Proposed forcing mechanisms for these back-stepping events include: increased sea-level rise, flooding of relict fluvial terraces, or a decrease in sediment supply. High-resolution paleo sea-level and climate records are needed to understand coastal response to relative sea-level rise and climate change. Paleoclimate studies of southern Texas lack centennial to decadal resolution needed to resolve these back-stepping events. In addition, the few existing paleoclimate records are located well inland of coastal climate regimes. Located along the tectonically stable southern Texas coast, Baffin Bay and a nearby playa, Laguna Salada, provide excellent areas to study eustatic sea-level change and paleoclimate, respectively. The objective of this project is to compare a paleoclimate record derived from the δO^{18} of ostracods, a new high-resolution sea level record (Livsey and Simms; in review), and a seismic survey from Baffin Bay, Tx to understand incised-valley stratigraphic response to changes in climate and sea level respectively.

A grant from the National Science Foundation has funded much of the research thus far. Funding from the Ed Picou Fellowship Grant would provide funding for geochemical analyses for the paleoclimate reconstruction.

Study area

Baffin Bay, Tx formed as the Los Olmos, San Fernando, and Petronilla creeks incised and subsequently flooded during the last glacial cycle (Fig 1; Behrens , 1963). Baffin Bay experienced a subsidence rate of 0.05 mm/yr since the last interglacial ca. 120 ka (Paine, 1993).

Baffin Bay contains laterally extensive, prograding upper-bay mud flats in place of typical bay-head delta deposits. Previous work indicates that the mud flat did not form until after the on-set of xeric conditions in southern Texas at 5.5 ka (Simms et al., 2010). The mud flats, covered in microbial mats, contain only one main distributary channel and are seasonally sub-merged owing to wind-tides from increased prevailing southeast winds in spring through the late summer. A high-resolution sea-level record has been reconstructed from the radiocarbon dates of basal microbial mats (Livsey and Simms, in review).

Laguna Salada, a nearby playa located approximately 35 km southwest of Baffin Bay, formed as dunes to the southeast dammed the drainage of Los Olmos creek. Examination of aerial photographs since 1972 shows that the playa fills and empties on 2-3 year and 10-15 year cycles. A 2 m core, LS08_01 from Laguna Salada sampled laminated clay and gypsum with basal sand dating to 3.3 ka (Fig. 2). Initial examination of the core shows that some intervals are more dominated by gypsum lamination (arid intervals) while other portions of the core are dominated by clay deposition (wet intervals). An XRF scan and 3D x-ray image of the core will provide an initial paleoclimate record of aridity through time and examination of bioturbation that may introduce additional error. The XRF scan and 3D x-ray image of the core will be undertaken at the Scripps Research Institute.

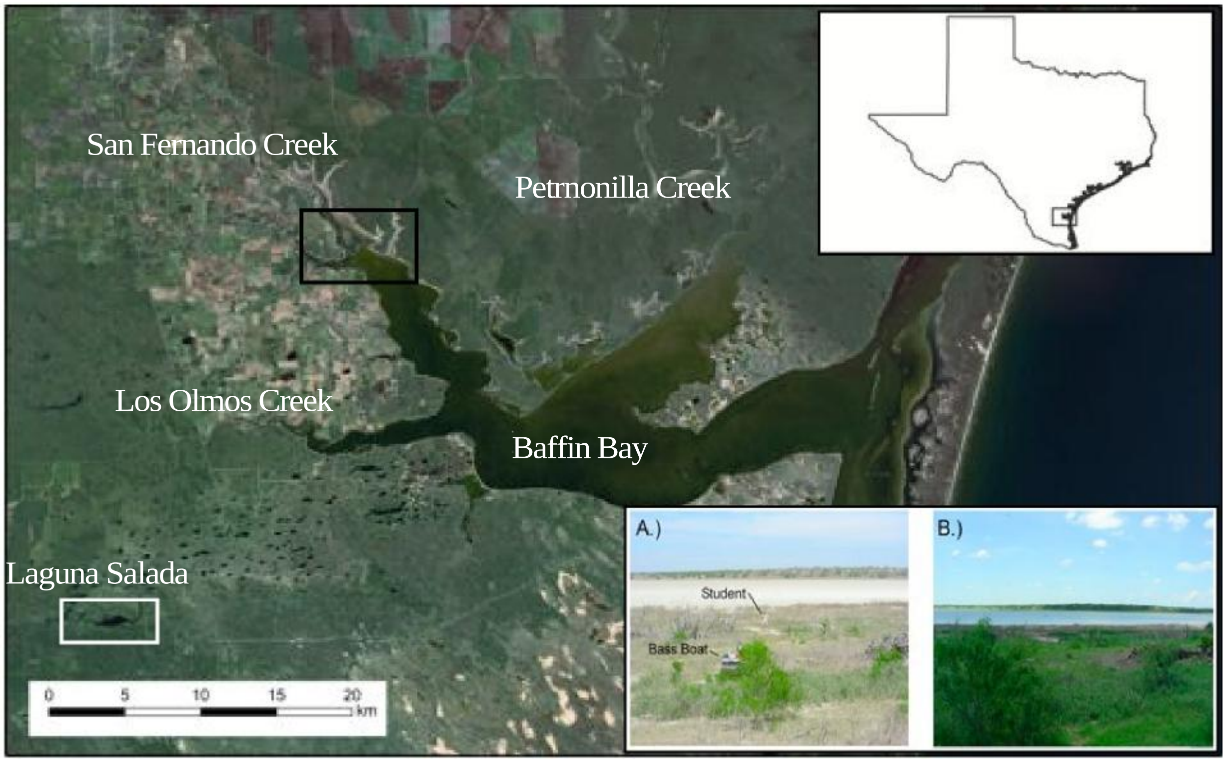

Figure 1 Study map showing location of Baffin Bay and Laguna Salada (white box). **A.** Photograph taken in March 2008 showing Laguna Salada completely dried. **B.** Photograph taken in August 2008 showing Laguna Salada full of water following rain events . Black box indicates the location of the mudflat where the paleo sea-level study was undertaken (Livsey and Simms; in review).

Methods

The above-cited regional coastal backstepping as recorded in estuarine sediments highlights the need for a greater understanding of how coastal systems respond to changes in sea level and climate. To accomplish this goal we will compare a high-resolution sea level record and a paleoclimate record to an estuary in which the facies architecture and stratigraphy is known. Over 101 shallow marine cores and a chirp seismic survey will constrain the stratigraphy and facies architecture of Baffin Bay, Tx. 30 radiocarbon ages from the shallow marine cores and 21 optically stimulated luminescence (OSL) ages from Laguna Salada will provide the age-model for the stratigraphy study and paleoclimate study respectively.

The paleoclimate record is the lacking component. We will use paired measurements of öO18 of planktonic ostracods and the öO18 of gypsum hydration water to derive the Late-Holocene paleo temperature and precipitation provenance from Laguna Salada core LS08-01 (Fig 2). Tandem measurement of biogenic calcite and gypsum hydration water was recently developed by Hoddell et al. (2012). Funding from this grant would allow for the öO18 analyses of the ostracods. The öO18 of the gypsum hydration water is a temperature independent proxy for the öO18 of water in which the ostracod formed. The öO18 of ostracods is dependent upon temperature and the öO18 of water in which the ostracods formed. Therefore with a öO18 proxy for water, paleotemperature may be calculated from the öO18 of the ostracods.

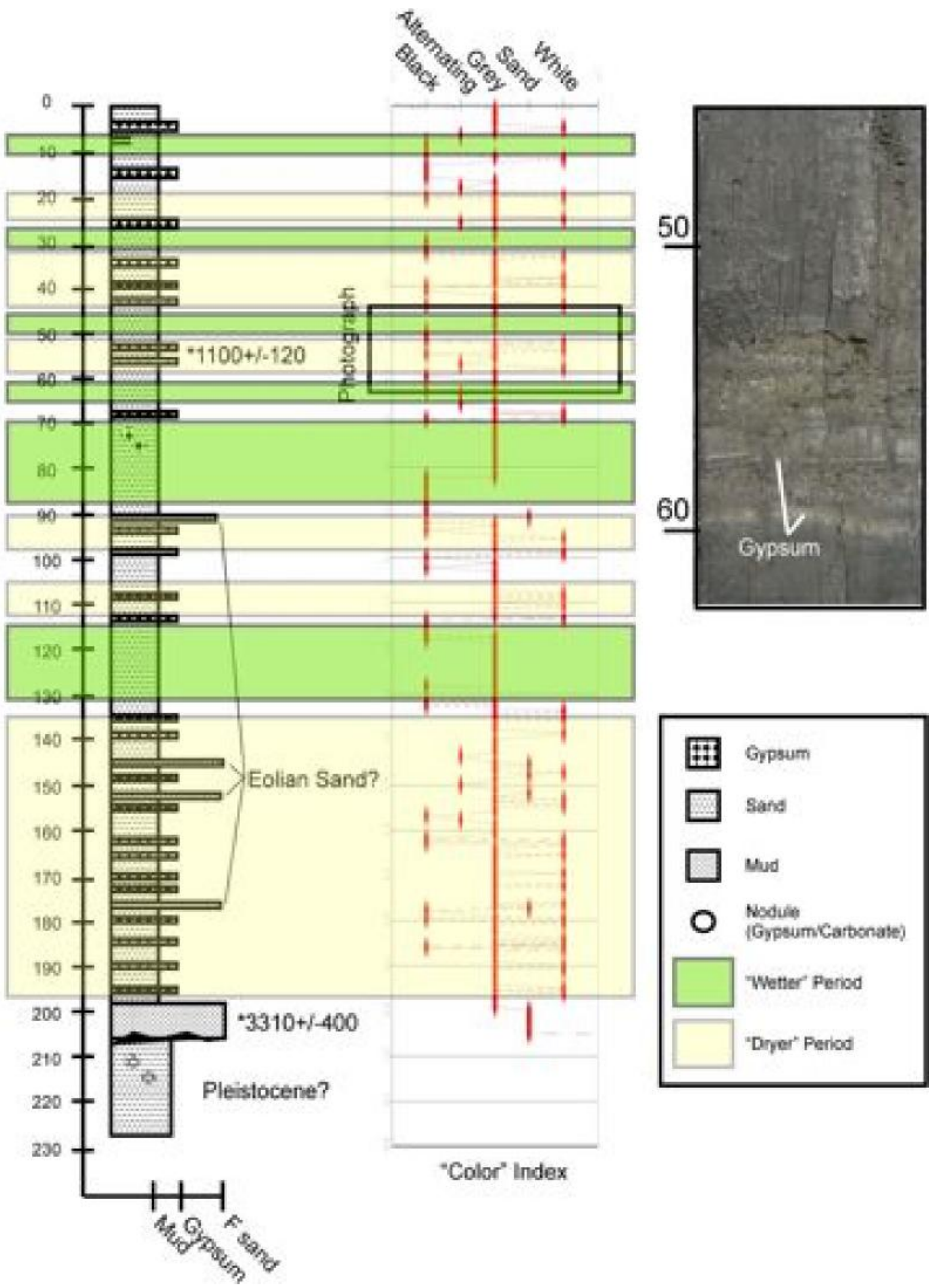

Figure 2 Core description and image of core LS08-01 taken from Laguna Salada. Clay (dark) intervals are interpreted as wet intervals while gypsum (white) intervals are interpreted to represent more arid intervals. XRF scan of core will quantify percent clay versus percent gypsum by measuring relative abundances of Ti (clay) and S (gypsum) (Hoddell et al., 2012). Two ages shown in core are optically stimulated luminescence (OSL) ages. An additional 21 OSL ages in progress will provide a high-resolution age model down-core.

The laboratories at our university are well equipped to measure the δO18 of the ostracods. The MAT 253 Isotope Ratio Mass Spectrometer with an online coupled to Kiel Carbonate Device IV is able to a prepare sample size ranges expected from ostracod samples between 20 ug to 100 ug. The δO18 of the gypsum hydration water will be measured at UCLA

Purpose

Our project will be the first study to examine the affects of changing sea level and climate on incised-valley stratigraphy using high-resolution paleoclimate and sea-level records obtained in close-proximity. This project will also provide high-resolution records of drought and sea-level change for the Northwestern Gulf of Mexixo. Funding from the Ed Picou Fellowship will fund geochemical analyses of the ostracods for reconstructing the paleoclimate record. More broadly our results will increase our understanding of coastal stratigraphic response to changes in climate and sea level. Our research will be disseminated through a brochure regarding Texas wetlands and estuaries awareness for the Coastal Bend Bays and Estuaries Program (CBBEP). Approximately 1,000 brochures will be disseminated through the CBBEP to Texas K-12 public schools to increase public awareness of the coastal environment.

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