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The Mississippi Margin: A Comparison of Continental Margin Geomorphologic Features

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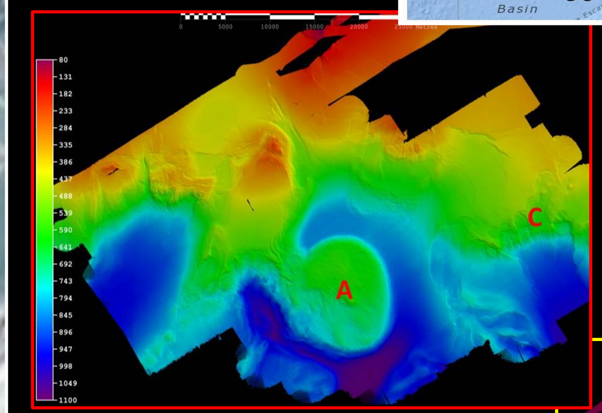
Abstract

The Mississippi Margin is located on the continental shelf and slope off the Mississippi and Louisiana coasts in the Gulf of Mexico. The two sites for this study consist of a deltaic region located 45 km south of the Mississippi Main Pass and a non-deltaic region located 160 km south of Atchafalaya Bay. The study area located south of the Mississippi Main Pass has a gradual slope, contains various erosional features, and salt domes. The study area south of the Atchafalaya Bay includes a large salt dome with various slump deposits and evidence of turbidity currents. Salt dome dimensions, relief, and gradient were unaffected by their location along the margin. However, continental margin relief and gradient in areas where salt domes are not present is much greater in deltaic-regions versus non-deltaic regions, likely due to influx of terrestrial sediments from the Mississippi River into the deltaic region.

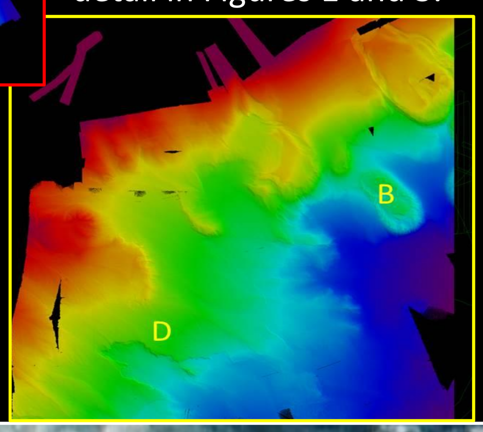
Introduction

The Mississippi Margin is a passive continental margin located in the Gulf of Mexico off the coasts of Mississippi and Louisiana, United States. A continental margin is the morphologic link between continental crust and oceanic crust (Laughton and Roberts, 1978). The specific margin in the study area is considered a passive continental margin, originally formed by the splitting of the continental crust (Laughton and Roberts, 1978). The focus of this study is concentrated on the various features along the continental margin in a non-deltaic region versus a deltaic region. The deltaic region is located near the Mississippi River delta, which is a river-dominated delta system (Coleman et al., 1998). The delta front extends to the deep water edge of the outer continental shelf and is comprised of silt and clay sediments that are input from the Mississippi River (Coleman et al., 1998). Salt domes, or diapirs, are another prominent type of feature of the Mississippi Margin. Salt domes are formed from salt deposits being overlain by denser sediments, causing the lower-density salt to rise and warp overlying sedimentary layers (Martinez, 1991). Salt domes in the Gulf of Mexico have great sizes, some 12.9 km in relief with an average diameter of 3.2 km (Martinez, 1991). The salt domes in the Gulf of Mexico were believed to have been formed in the Jurassic Period from a shallow, highly evaporative sea that was created from two continental plates being pulled apart (Martinez, 1991).

Location of Study Site



The red box (above and left) shows the Non-Deltaic region that is located south of Atchafalaya Bay. Sites A and C are shown in detail in Figures 1 and 3.



The yellow box (above and right) shows the Deltaic Region located at the Mississippi Main Pass. Sites D and B are shown in detail in Figures 2 and 4.

Site A: Non-Deltaic Region Salt Dome

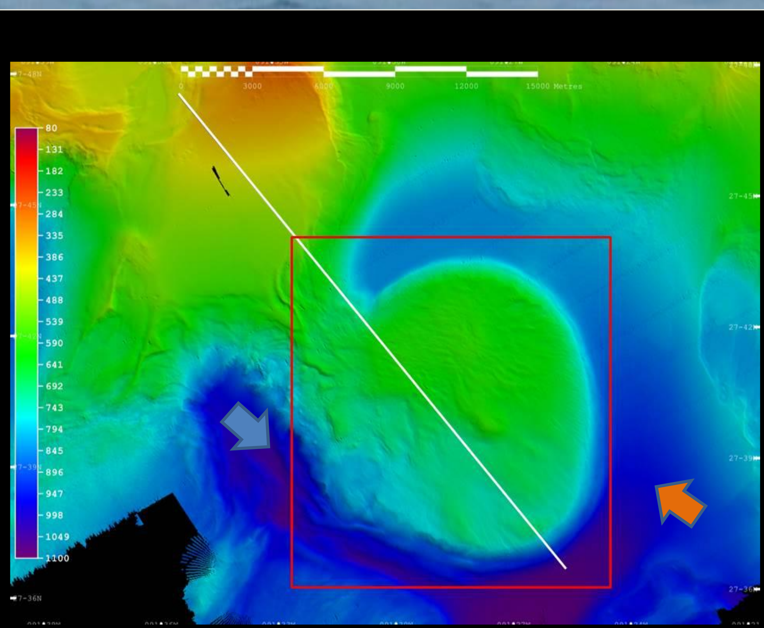


Figure 1a. South of Atchafalaya Bay. The salt dome is represented by the red square. The white line shows the location of the profile used in figure 1b. Block arrows show the view direction for 3D images 1c and 1d.

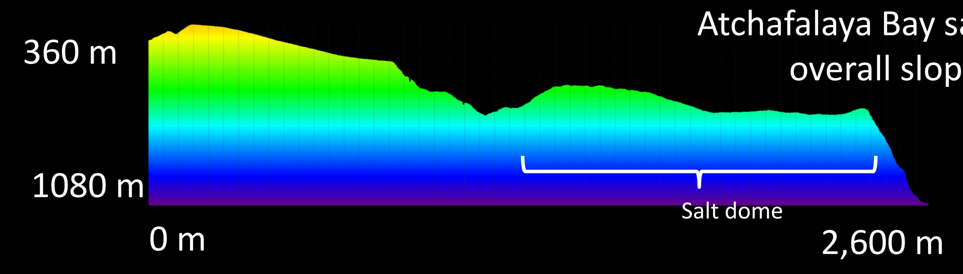


Figure 1b. Profile view of south of Atchafalaya Bay salt dome with an overall slope of 0.027.

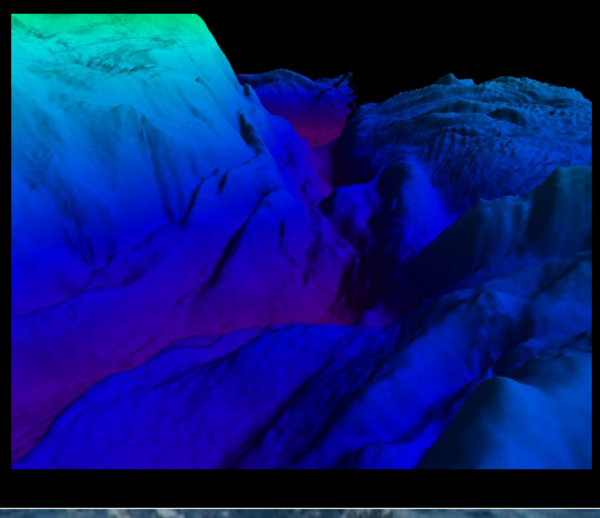


Figure 1c. 3-D view of slump deposits adjacent to the salt dome, located south of Atchafalaya Bay (9x V.E). View is shown by the light blue arrow on Figure 1a.

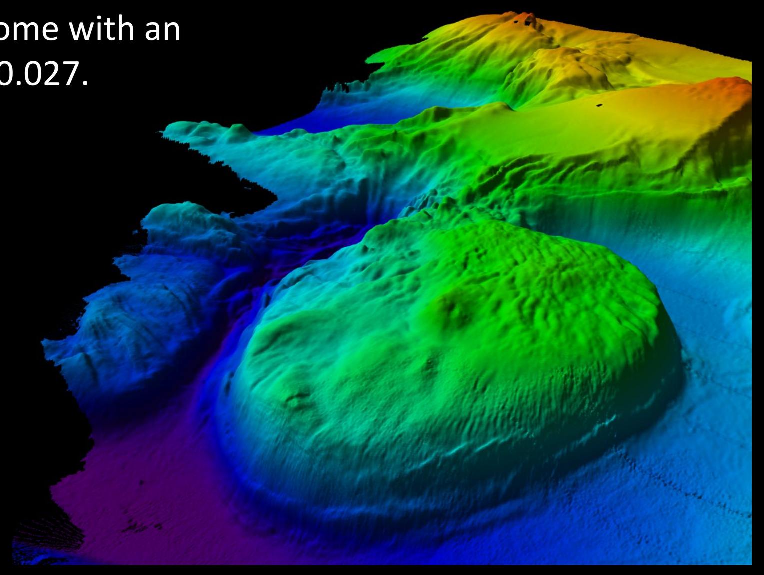


Figure 1d. 3-D representation of the southeast portion of the Atchafalaya Bay salt dome, viewed looking northwest, shown by the orange arrow on Figure 1a (9x V.E.).

Site B: Deltaic Region Salt Dome

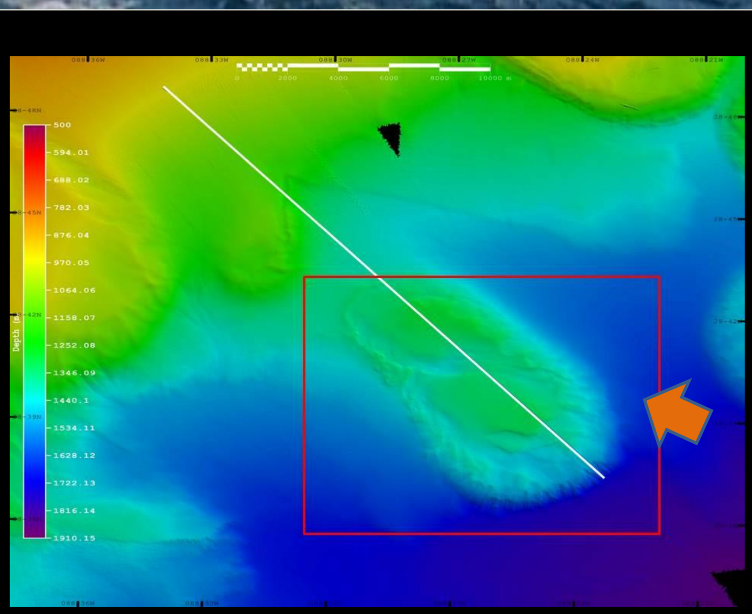


Figure 2a. Salt dome (red box) in the deltaic region south of the Mississippi River on the Mississippi Main Pass. The white line represents the profile in figure 2b. The orange arrow shows the view direction of figure 2c.

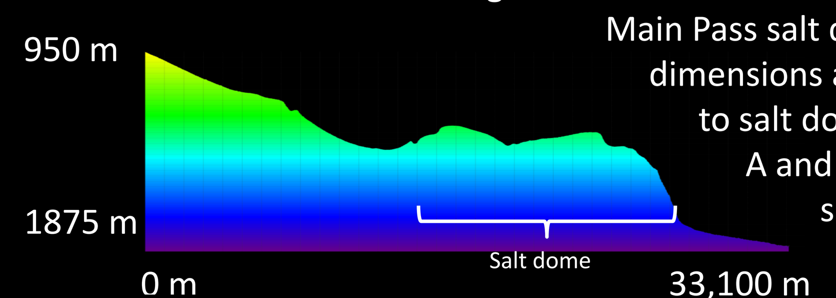


Figure 2b. Profile of the Mississippi Main Pass salt dome. The dimensions are similar to salt dome in Site A and it has the same slope of 0.027.

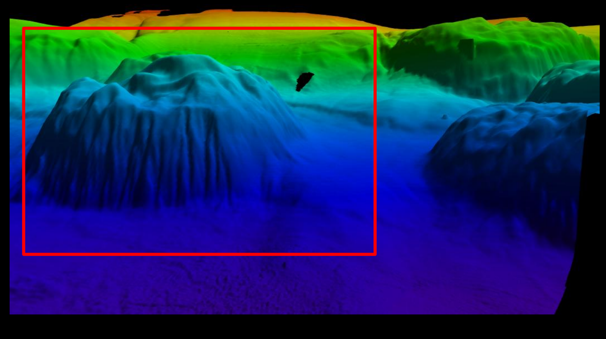


Figure 2c. 3-D offshore view from the deep ocean (10x V.E.). The red box represents the featured salt dome. The shelf is represented by the raised region in the background.

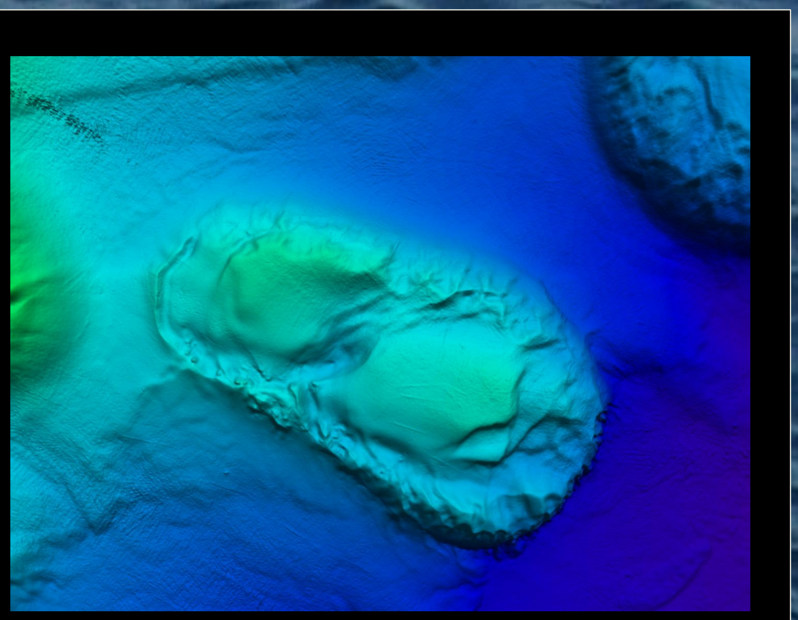


Figure 2d. 3-D bird's eye view representation of the Mississippi Main Pass featured salt dome. (10x V.E.)

Site C: Non-Deltaic Continental Margin

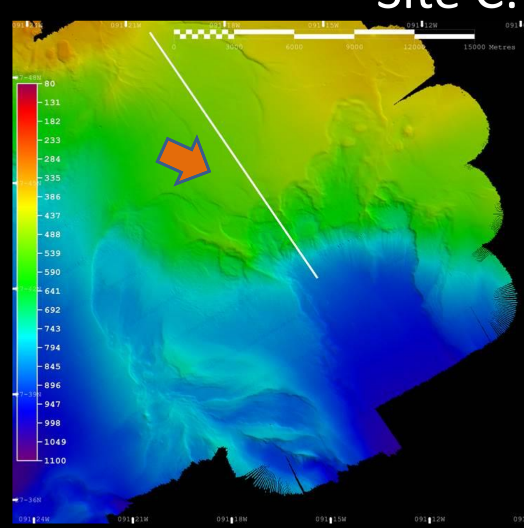


Figure 3a. The passive continental margin's shelf and slope south of Atchafalaya Bay, which shows a large slump feature. The white line shows the profile (Fig. 3b), and the orange arrow shows the view direction of Fig. 3c.

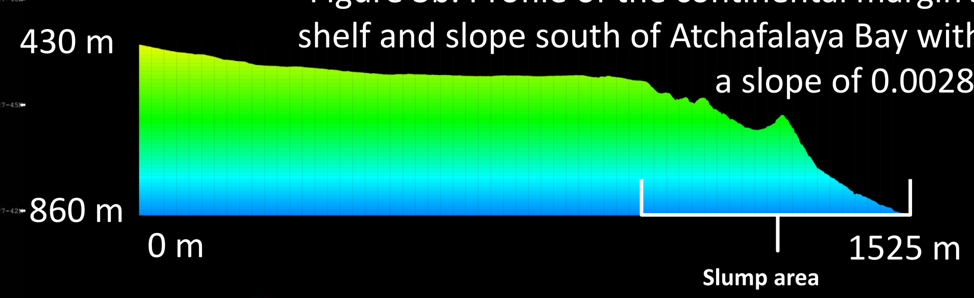


Figure 3b. Profile of the continental margin's shelf and slope south of Atchafalaya Bay with a slope of 0.0028.

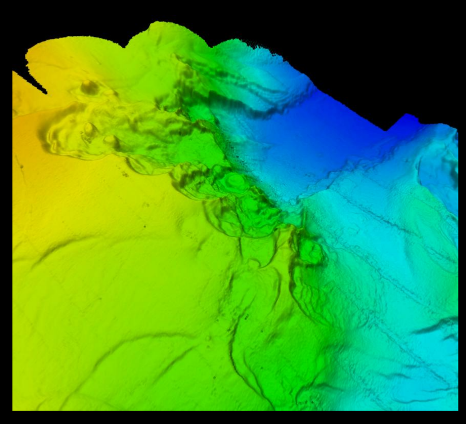


Figure 3c. 3-D bird's eye view of the continental shelf and slope south of Atchafalaya Bay (9x V.E.). There is a large slump that is represented by the erosional features on the shelf edge.

Site D: Deltaic Continental Margin

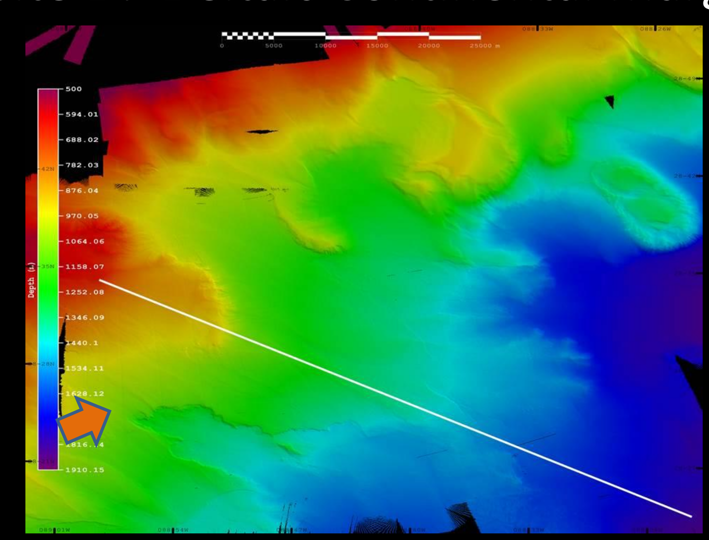


Figure 4a. The continental shelf and slope on the Mississippi Main Pass. The white line shows the profile line (fig. 4 b), and the orange arrow shows the view direction of fig. 4c.

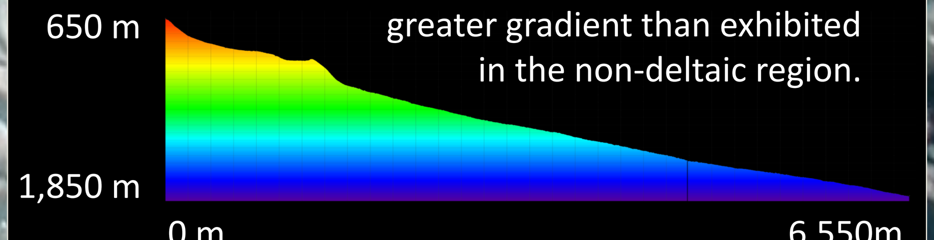


Figure 4b. Profile shows 6.5x greater gradient than exhibited in the non-deltaic region.

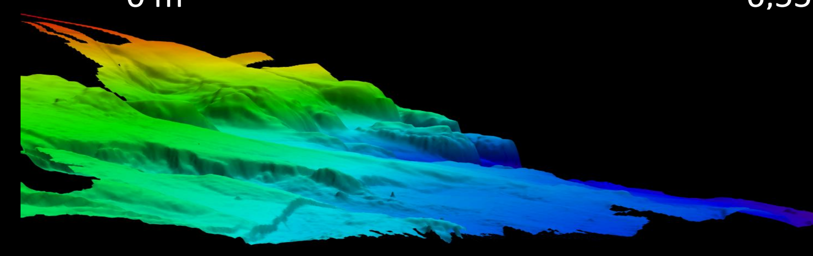


Figure 4 c. 3-D view of the continental margin south of the Main Pass (20x V.E.), showing various morphological features caused by sediment accretions and erosion. The main sediment accretion is on the shelf and is represented by the shallow regions. Erosional features occur where the shelf drops to the continental slope. Turbidity currents and slumping are responsible for the areas heavy in erosion.

Results

- Although the salt domes were located in two different regions (deltaic vs. non-deltaic), they were very similar in length, relief, and slope (Table 1). The two domes' total relief varied by 182 m, however, the slopes (gradients) of both domes were the same: 0.027.
- Vertical relief from the continental shelf to the peak of each salt dome was very similar with only 3 m difference in relief and 0.007 in gradient.
- The two salt domes' slopes to the deep ocean vary by 0.102 and by 36 m of relief.
- The two sections of the continental margin without salt domes varied greatly in relief and gradient (Table 2). The total relief of the two continental margin sections differed by 737 m with the deltaic region containing the greater relief.
- The deltaic region had a 6.5x greater overall gradient than the non-deltaic region.

Methods

- The survey was conducted by the NOAA Ship *Okeanos Explorer* on cruises EX1202L2, EX1202L3, and EX1203 of March and May in 2012, using a Konsberg EM302 transducer.
- Raw data were downloaded from the NOAA NGDC website and post-processed with CARIS HIPS 8.1.
- The relief and gradients of various features of the continental margin were calculated through slope profiles extracted from CARIS HIPS 8.1.

Table 1. The salt domes' (Figs. 1 & 2) dimensions and various aspects of relief.

	Total Relief from Continental Shelf to Deep Ocean (meters)	Gradient	Length of Dome (meters)	Largest Width of Dome (meters)	Vertical Relief from Shelf to Dome (meters)	Gradient	Relief of Dome to Deep Ocean (meters)	Gradient
Atchafalaya Bay Dome	708	0.027	12,500	11785.41	119	0.043	360	0.190
Mississippi Main Pass Dome	890	0.027	12,650	8036.91	122	0.036	396	0.088

Table 2. Represents the continental shelf's' (Figs. 3 & 4) variations in relief and slope.

	Total Relief Shelf to Deep Ocean (meters)	Gradient	Relief of Shelf to Slope (meters)	Gradient	Relief of Slope to Deep Ocean (meters)	Gradient
Atchafalaya Bay Continental Margin	422	0.0028	176	0.014	246	0.100
Mississippi MainPass Continental Margin	1159	0.0180	424	0.027	740	0.015

Discussion & Conclusions

- Salt dome dimensions, relief, and gradients are not affected by their region's location on the continental shelf in the Mississippi Margin. Therefore, the presence of the Mississippi River delta did not affect the processes that shaped the salt domes. This may be due to salt domes of the Gulf of Mexico having similar formational processes, which can be tied to the Jurassic Period. Additionally, the salt domes' concurrent growth with overlaying layers could allow for the salt dome's dimensions to remain unaffected by morphologically different regions along the continental margin where sediment input may vary (i.e., deltaic versus non-deltaic) and result in similar salt dome morphologies.
- However, differences are observed in deltaic versus non-deltaic regions in the amount of relief and slope (gradient) along the continental margin where salt domes are not present. The total relief of the deltaic region is 737 m greater than the non-deltaic region. Similarly, the slope in the deltaic region is 6.5x steeper. The steeper slope and greater relief in the deltaic region could be attributed to the larger surplus of sediment supplied to the shelf that is obtained from the influx of terrestrial sediments from the Mississippi River.

Acknowledgements

We thank College of Charleston BEAMS Program; CARIS for the support in training; HighlandGeo for software license support; Dept. of Geology and Environmental Geosciences, School of Sciences and Mathematics; Crew of the NOAA Ship *Okeanos Explorer.*

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