Bathymetric and Morphologic Analysis of the Mississippi Slope

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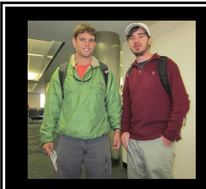
Abstract

Multibeam sonar and backscatter data were collected in August, 2011 aboard the NOAA Ship *Okeanos Explorer* along the Mississippi continental slope, 70 km southeast of the Mississippi River Delta. Data were collected using a Kongsberg EM302 and were processed with CARIS HIPS 7.1. This region has been heavily investigated by the petroleum industry and academia due to its archetype marine petroleum-bearing basin. Bathymetric data yielded high resolution images of several geomorphologic features, including wave-cut terraces, salt diapirs, large scale slumps, gas vents, sediment fan lobes and other structures formed during the Late Pliocene. Evidence of salt piercement was found on the Biloxi Dome while a large slumping mass can be identified on the southern margin of the Mitchell Dome. The southern margins of several other domes exhibit small amounts of slumping.

NOAA Ship
Okeanos Explorer



Harris Pantlik (left) and Matthew Hughes (right)

Introduction

The Mississippi Slope is located in the northern Gulf of Mexico. It is part of a passive continental margin with a remarkably complex heterogeneous continental slope, due to widespread salt tectonism, salt diapirism, differential Pleistocene sediment loading, and consequent large variation in sediment patterns (Hutchison et al., 2008). Visible outcroppings of gas hydrates, faulted carbonate "hard-grounds" and pockmark features consistent with gas and petroleum seepage extensively cover the northern Gulf of Mexico (Ingram et al., 2010).

The bathymetry of the Gulf of Mexico continental slope is heavily influenced by the extensive subsurface salt dome formations (Ingram et al., 2010), where deformation of the salt through time has contributed to the present-day hummocky bathymetry of the northern Gulf of Mexico slope (Ingram et al., 2010). As a consequence, there are numerous deep-water petroleum seeps, gas vents, methane cold seeps and thermogenic gas-hydrate fields within the Gulf of Mexico (Ingram et al. 2010).

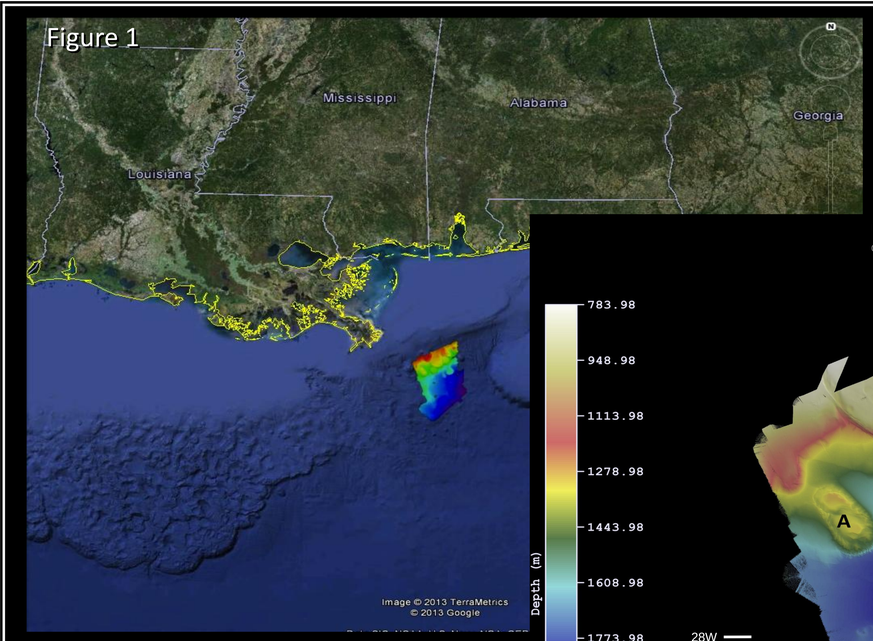


Figure 1: Google Earth image with .kmz overlay of research area.

Figure 2: CARIS rendered image of research area. Salt domes are labeled as follows: A) Biloxi Dome, B) Whiting Dome, C) Gloria Dome, D) Mitchell Dome, E) Farnella Dome, F) Horn Dome, G) Petit Bois Dome, H) Dauphin Dome, I) Mobile Dome, J) Pascagoula Dome. Other features are K) Dorsey Canyon, L) gas vent.

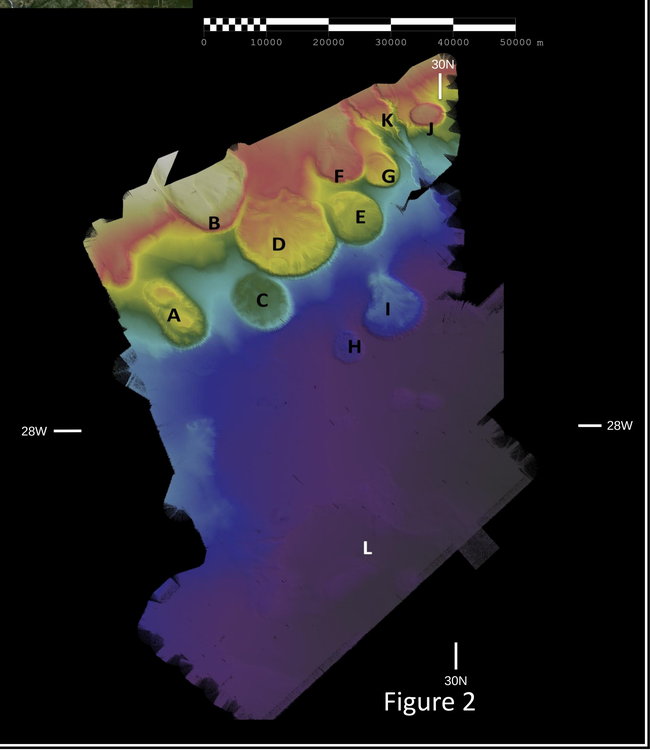


Figure 2

Methods

- A sonar survey was conducted by the NOAA Ship *Okeanos Explorer* during August and September of 2011 to assess the feasibility of using water column backscatter data to locate gasses within the water column.
- Multibeam data were obtained with a Kongsberg EM302 sonar system and used to map the bathymetry.
- Seafloor Information System (SIS) was used to acquire data.
- CARIS HIPS & SIPS 7.1 was used to create a 5 m resolution CUBE surface.
- The dimensions of the diapirs were measured using the shoreline as a reference point. and Length (Shore Parallel) was divided by Length (Shore Normal) to create a ratio to describe dome morphology and orientation.

References

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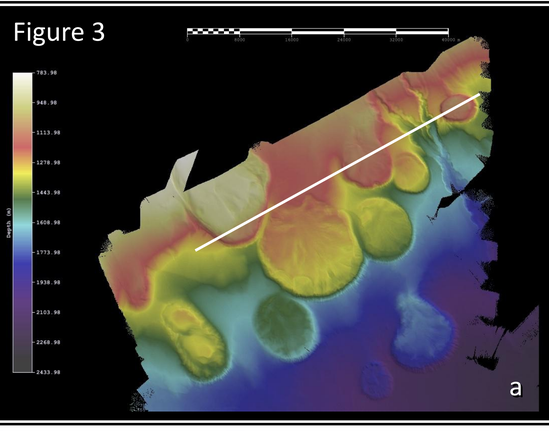

Figure 3a: 2D image of salt domes with Dorsey Canyon in the northeastern section. White line indicates location of profile in Fig 3c.

Figure 3b: 3D image of domes.

Figure 3c: Profile image across the domes and Dorsey Canyon.

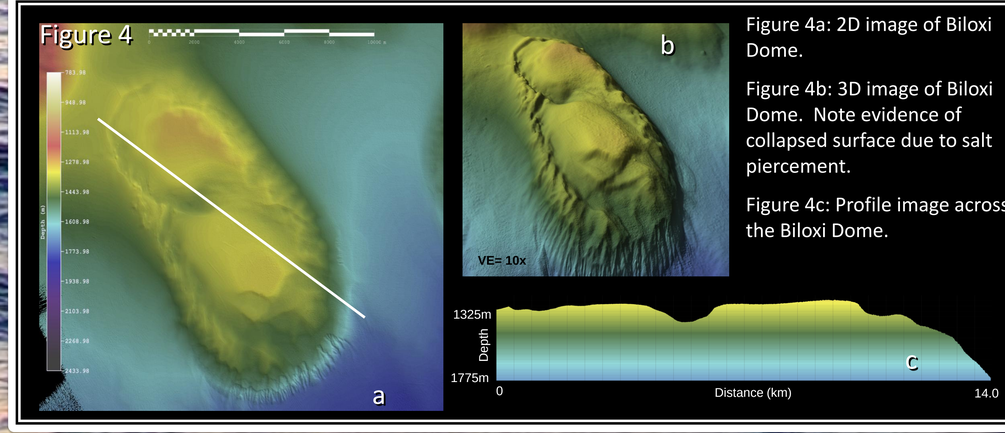

Figure 4a: 2D image of Biloxi Dome.

Figure 4b: 3D image of Biloxi Dome. Note evidence of collapsed surface due to salt piercement.

Figure 4c: Profile image across the Biloxi Dome.

Table 1: Salt Dome morphology, including, horizontal and vertical sizes, and of the 10 domes present in the research area.

	Feature Name	Length (shore normal, m)	Length (shore parallel, m)	Ratio	Heading (LSN, N-S)	Heading (LSP, E-W)	Depth Top (m)	Depth Bottom (m)	Relief (m)
A	Biloxi Dome	14749	7662	1.92	140.03	50.91	1265	1779	514
B	Whiting Dome	21167	12878	1.64	136.06	48.76	849	1415	566
C	Gloria Dome	12116	8690	1.39	139.71	47.23	1434	2372	938
D	Mitchell Dome	16147	15106	1.07	141.63	45.22	1184	1721	537
E	Farnella Dome	11190	7960	1.41	138.77	48.76	1304	1708	404
F	Horn Dome	7799	7021	1.11	140.5	48.53	966	1467	501
G	Petit Bois Dome	7219	5480	1.32	141.85	51.31	1226	1610	384
H	Dauphin Dome	5904	4999	1.18	141.5	49.29	1832	2372	540
I	Mobile Dome	10645	10906	0.98	165.82	74.37	1636	2166	530
J	ascagoula Dome	4039	7047	0.57	177.13	86.18	1037	1376	339

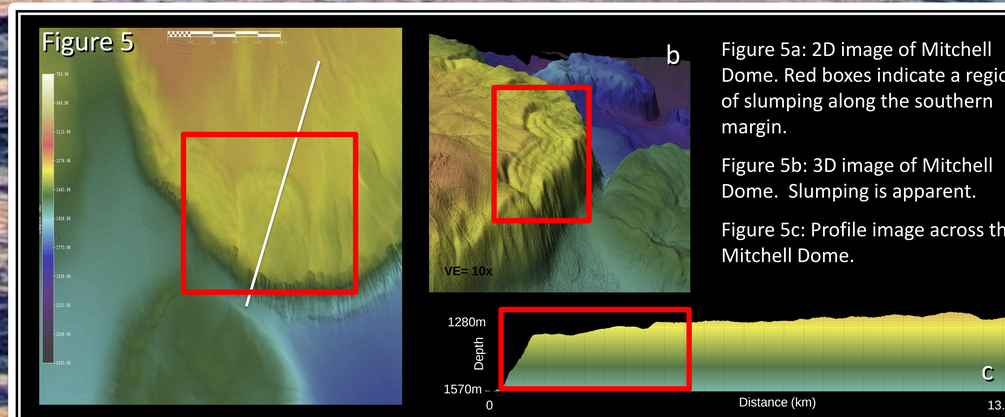

Figure 5a: 2D image of Mitchell Dome. Red boxes indicate a region of slumping along the southern margin.

Figure 5b: 3D image of Mitchell Dome. Slumping is apparent.

Figure 5c: Profile image across the Mitchell Dome.

Observations

- Bathymetric data produced images of distinct structures of the Mississippi Slope including: salt diapirs, gas vents and canyons (Fig. 2).
- The dimensions of the domes were measured and domes A-H had similar trending (Length Shore Normal) and (Length Shore Parallel) orientations with ratios >1.
- Domes I and J experienced ratios <1 due their orientations.
- Slumping features are observed on the diapirs, most notably the Biloxi and Mitchell Domes (Fig. 4 and Fig. 5).
- A large slumping mass was discovered on the south side of the Mitchell Dome along with smaller occurrences of slumping of several other domes (Fig. 5b).
- A pronounced outer ridge of the Biloxi Dome is evidence of a collapse.
- A gas vent approximately 39 m tall was observed in the southern portion of the study area (Fig.6).

Interpretations

- The slumped areas of the salt domes are experiencing a process referred to as salt "piercement". Further geophysical exploration is needed to determine whether these domes are active, passive and/or reactive.
- Further study is needed to determine if there is a presence of asphalt volcanism and/or the formation of large brine pools on the Biloxi Dome.
- Further study is also needed to determine the depth from the top sediment layer to the salt in the slumping portions of the Mitchell Dome along with slumping rates as this would allow for a calculation of time until a large brine release.
- The gas vent is likely to expel thermogenic and/or hydrocarbon based gasses.

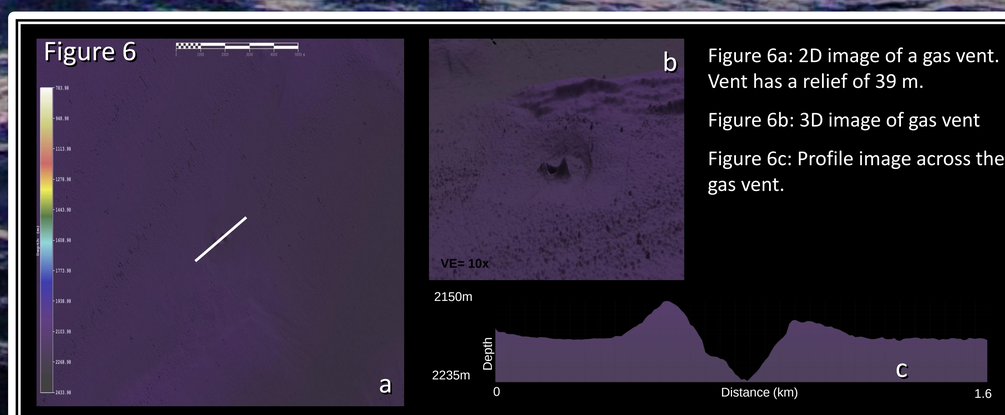

Figure 6a: 2D image of a gas vent. Vent has a relief of 39 m.

Figure 6b: 3D image of gas vent

Figure 6c: Profile image across the gas vent.

Aknowledgements

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