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# East Breaks Slump, Northwest Gulf of Mexico

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## Abstract

The East Breaks slump in the northwestern Gulf of Mexico was mapped using 2D and 3D seismic and multibeam bathymetry data. Its morphology extends over a large area of the seafloor and comprises a tremendous volume of sediments. Detailed seafloor bathymetry shows a rough surface with evidence of friction-induced drag folds. Volume of the slumped material is 50-60 cubic kilometers with a maximum thickness of 70 meters. An eroded chute and accumulation zone extends 160 km down slope from the shelf break and encompasses an area of 3,200 km$^2$; the main depositional lobe is located 145 km downslope of the head scarp. This volume of displaced material would have generated a tsunami wave on the order of 7.6 meters above sea level that would have impacted the entire south Texas coast.

The occurrence of a slump of similar magnitude at the present shelf edge could become a hazard to deep-water hydrocarbon production facilities and coastal communities as a result of mass slope failure and tsunami impact of the coastline.

## Introduction

Evidence of large shelf edge slumps of recent age (past 30,000 years) is ubiquitous throughout the world. Large scale slumps described to date include the Walker-Massingill slump originating near the Mississippi River Delta and extending hundreds of kilometers across the Mississippi Fan (1), and the Storegga Slide offshore Norway (2). The presence of the East Breaks slump in the northwest corner of the GOM has been recognized since the 1960's when it was identified by the petroleum industry and subsequently surveyed by the U.S.G.S EEZ mapping program in 1985. While these initial studies recognized the feature as the product of mass wasting, no detailed mapping or sampling programs have yet been undertaken and the feature remains a mere curiosity. However, it has all the properties of induced mass gravity flows and slumps that could have serious impact on the petroleum industry's deep-water field development. In parallel with petroleum exploration activities, 3D seismic data sets have been acquired throughout most of the northern Gulf of Mexico and these data sets can provide an effective tool for investigating recent geological depositional features including mass slope failures.

This paper describes the dimensions and morphology of the East Breaks slump extracted from 3D seismic and looks at the effect slope failures might have on present day subsea production facilities and coastal towns.

**Previous Studies**

The presence of a large shelf edge slump in the northwest corner of the GOM has been recognized since the 1960's (5). Petroleum industry research labs mapped the slump's overall extent in the 1960's (3 & 4), and the USGS using sparker and the Gloria long-range side scan sonar systems in the mid 1980's (6). While these studies recognized the feature to be the product of slope failure and mass wasting, no detailed mapping with modern tools or sampling programs have been undertaken. Its head scarp is situated within the northwest corner of the Gulf of Mexico where it is identified by a 20 km indentation of the shelf edge along the 150-meter isobath (Fig. 1). The slump originates within the late Wisconsinian Colorado/Brazos River shelf edge deltaic system described and mapped by Berryhill et al. of the USGS (5), who estimated its age as early Holocene (10-5 kyBP). Slumped material originated within prograding deltaic deposits formed during the last sea level lowstand and glacial maximum between 10 and 20-thousand years before present (5). Drill core samples within and adjacent to the slump reveal the contorted nature of deposits and the presence of shelf-type faunal assemblages (3 & 4). Slump debris flowage was constricted by the paleo topography and filled an intra-slope basin surrounded by topographic highs produced by salt diapirism (Fig.1).

## Methodology & Data

Data sets used for mapping consisted of the NOAA multibeam bathymetry (7) for coverage of the excavated slump chute along the shelf edge (Fig. 1). Extracted seismic reflection lines from regional 3D exploration coverage by westernGeco were used to assess the overall dimensions by picking the seafloor reflector and slump base (Fig. 3). Exploration seismic data has a sampling rate of 4 milliseconds, which equivocates to a vertical resolution of 20-meters with a lateral bin sampling of 12.5 by 25 meters. A 100-$km^2$ area was mapped in detail from the full 3D seismic data cube to extract fine details of the slump's morphology within the central depositional lobe as outlined in Fig. 2. Seismic data sets were picked using computer workstations and the results contoured and mapped using PC software.

**Dimensions**

The East Breaks slump is oriented north to south and consists of a 20-km wide head scarp initiated along the 150-meter isobath, a 55 km long erosional chute, ending in a 95x30 km accretionary lobe (Fig 2). Total extent of the feature is 160 km from the shelf edge to a depth of 1,500 m. Two salt domes provided a barrier to the southward movement allowing only a thin lobe to be funneled between them and expand an additional 20 km downslope (Fig. 2). The slumped deposits extend over a 3,200-km2 area with a volume on the order of 50-60 $km^{3.}$ Compared to the Storegga slides, this slide is slightly smaller than the most recent slide in Norway designated as slide number three (2). Initial failure of the slump took place on very low angle slopes of less than two-degrees while present slump deposits have an average seafloor slope of one-degree along its 160 km length.

**Origin**

Although the precise triggering mechanism that caused the slump is unknown, it is most probably the result of failure along relatively low slopes within loose unconsolidated faulted prodeltaic deposits. The area along the failure zone is within the highly faulted Wanda Fault system (8) and contains numerous normal faults, down to the basin, which could have provided both the triggering mechanism and head scarp failure surfaces. One puzzling element of the failure is, its occurrence on a very low angle slope typical of the present shelf edge offshore Texas.

**Slump Morphology**

Extraction of the seafloor reflector from a 3D seismic cube covering a 100 $km^2$ area within the central portion of the accumulated deposits reveals a chaotic nature, intriguing relief, and bizarre amplitude patterns (Figs. 3-5). Seismic line, Figure 3, shows distorted slump deposits overlaying conformal undisturbed strata. The underlying horizons have been eroded in places by passage of the slump material (left in Figure 3) where deposits are more hummocky than those displayed to the right. Internal reflectors are present and permit classification of different portions of the slump deposits. Seismic reflection amplitudes extracted from the seafloor reflector (top of slump) are displayed for the 100 km2 area, Figure 4, and reveal a "worm-like" pattern of higher intensity lineaments. Observed high seafloor amplitudes on its surface coincide with curvilinear ridges several meters in height and up to 100-meters in width normal to the direction of flowage that extends several kilometers laterally. Furthermore, zones that display the highest density of these ridges appear to coincide with underlying topographic highs and hence are attributed to the slowing of the flow's velocity as it came to a halt producing frictional drag folds. A three-dimensional display of the 100 $km^2$ study area, Figure 5, shows the slump's upper chaotic surface, whereas, the lower zone depicts the eroded base of deposits.

**Tsunami Generation**

Based on the slump's overall dimensions, a preliminary calculation of the tsunami generated by the down draw produced by initial slump failure could have formed a wave height on the order of 7.6 meters. Propagation of a Tsunami would have traveled across the continental shelf and slammed into the adjacent coastline of south Texas. An imprint of its run-up inland of the coastline and debris should be accessible for visual identification and dating of the event. Information on the occurrence and effects of tsunamis would permit fine-tuning of mathematical models for further assessment of slope failures and verify the aptness of current predictive models.

## Conclusions

The East Breaks slump is the product of an extensive submarine failure along the shelf edge of northwestern Gulf of Mexico. Its age is in the range of 5-10 thousand years before present and would have had minimal impact on cultural activities on the south Texas coastline. However, the potential for the recurrence of a similar event is probable and catastrophic because it could devastate deep-water petroleum facilities and destroy the densely settled coastline. Therefore, it is important that further work be undertaken to assess the slump's details, model the historic tsunami wave and its impact on present offshore oil and gas facilities and coastlines.

### Acknowlwdgements

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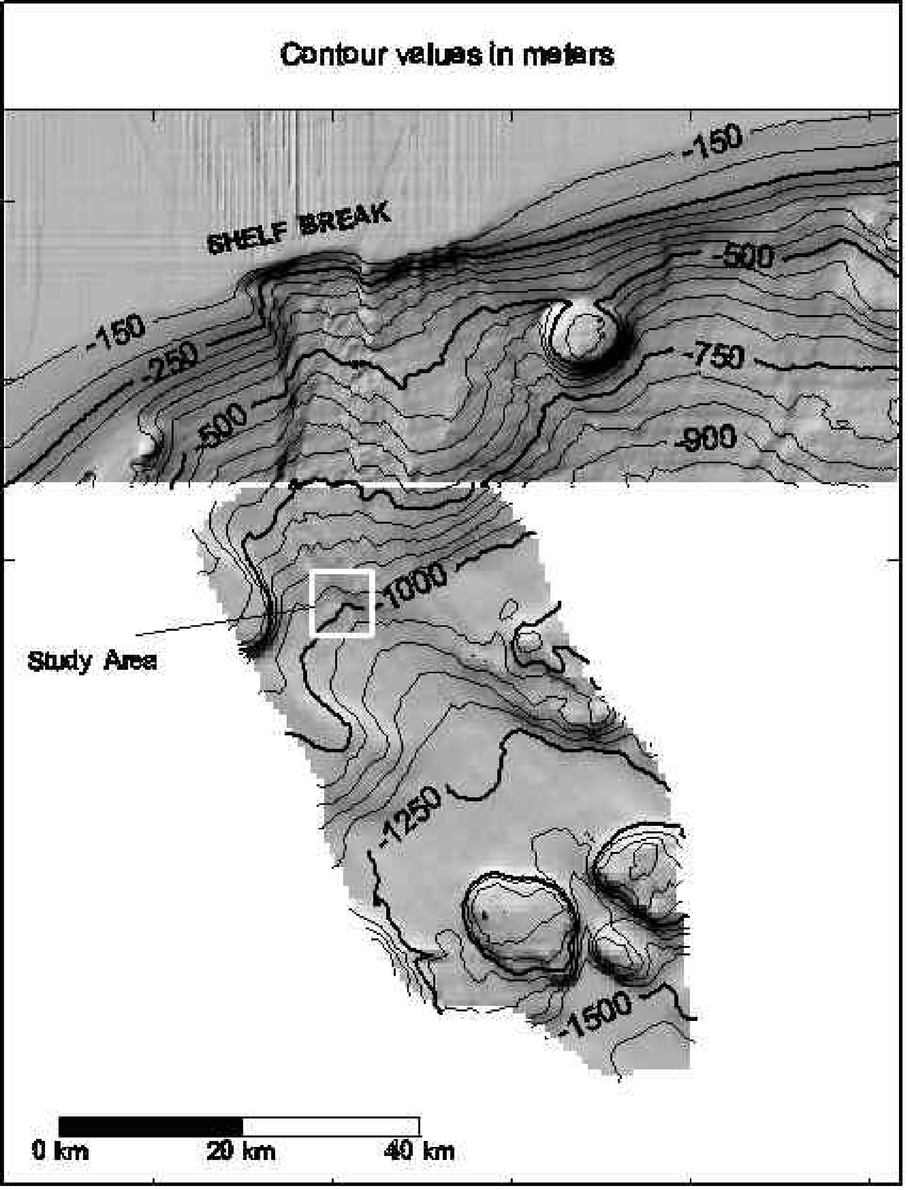


Fig 1. Bathymetry from NOAA & WesternGeco 3D data.

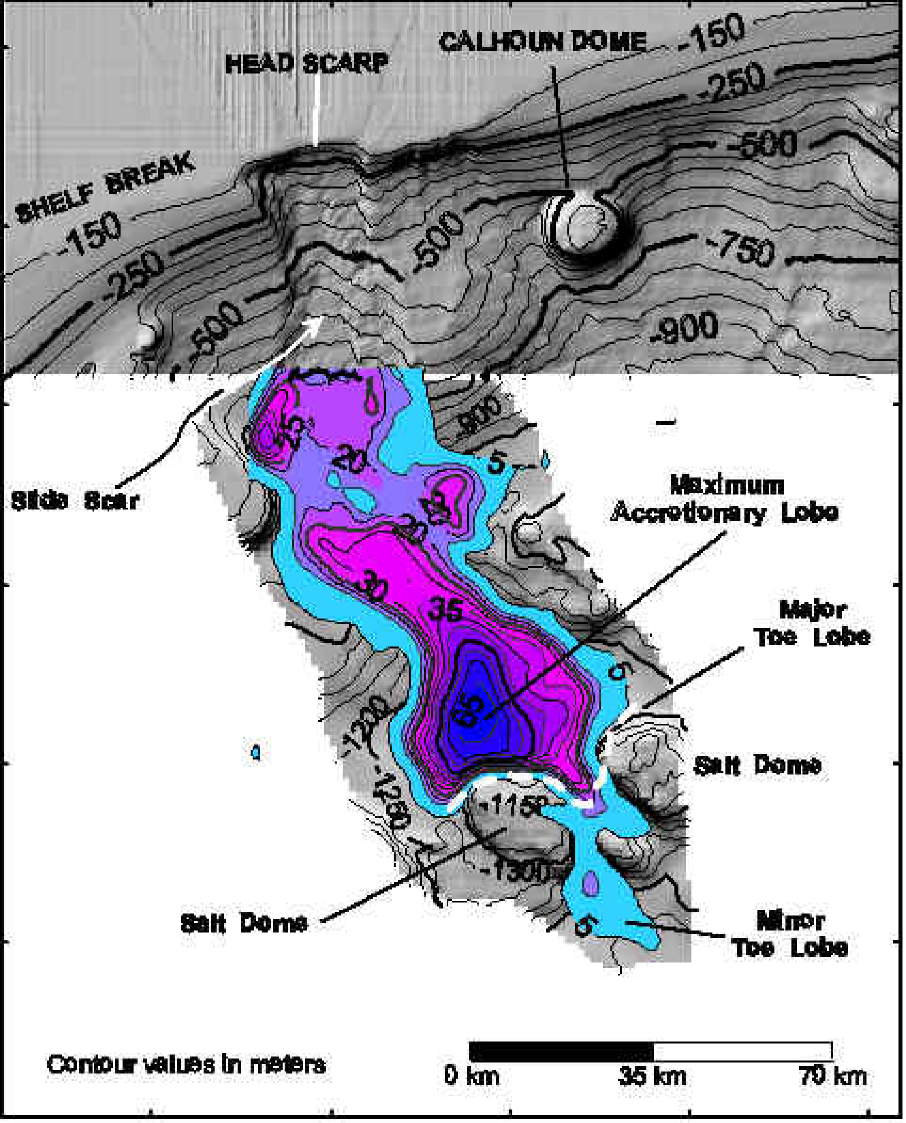


Fig 2. Bathymetry with slump overlay

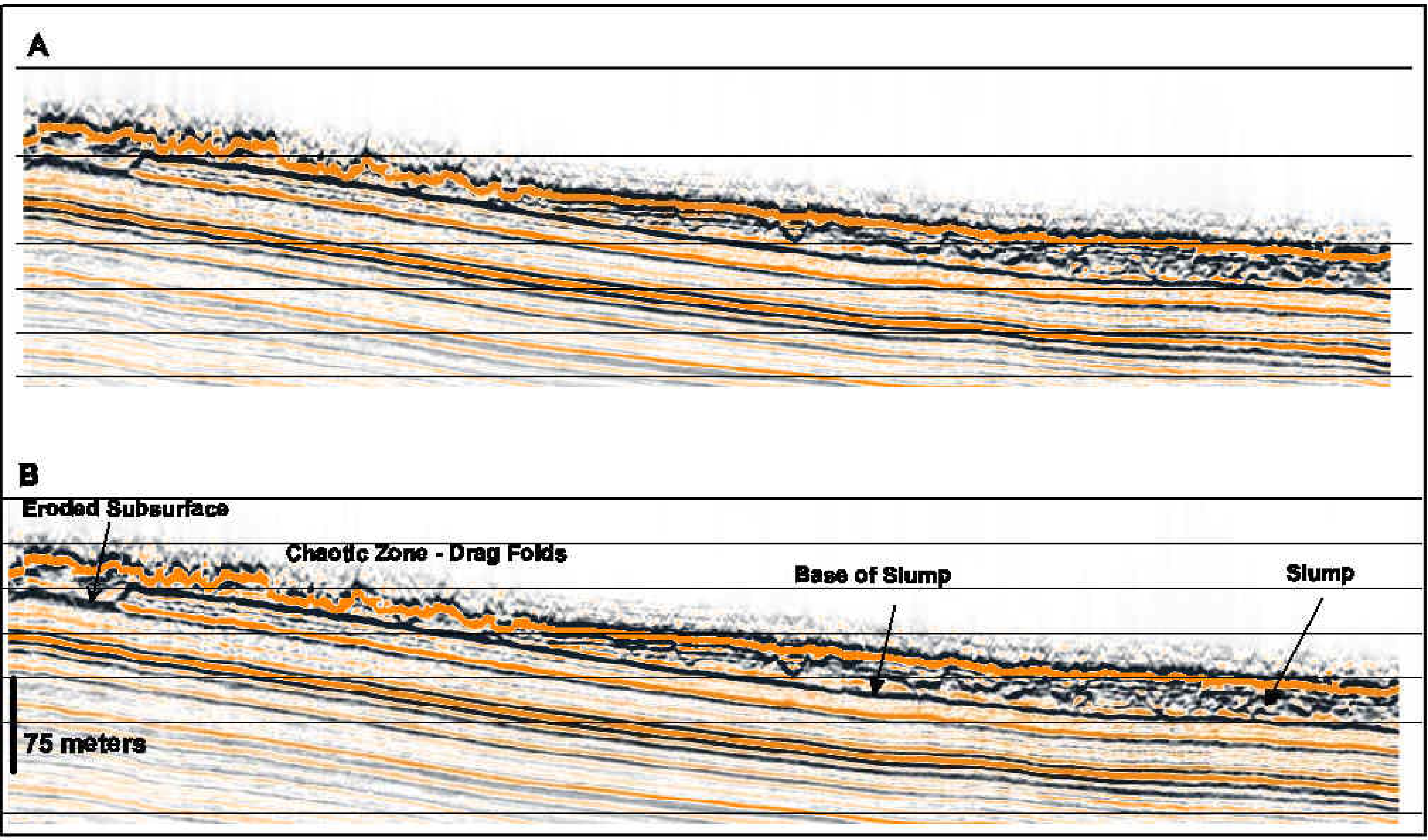


Figure 3 3D Seismic Section, A: Uninterpreted B: Interpreted

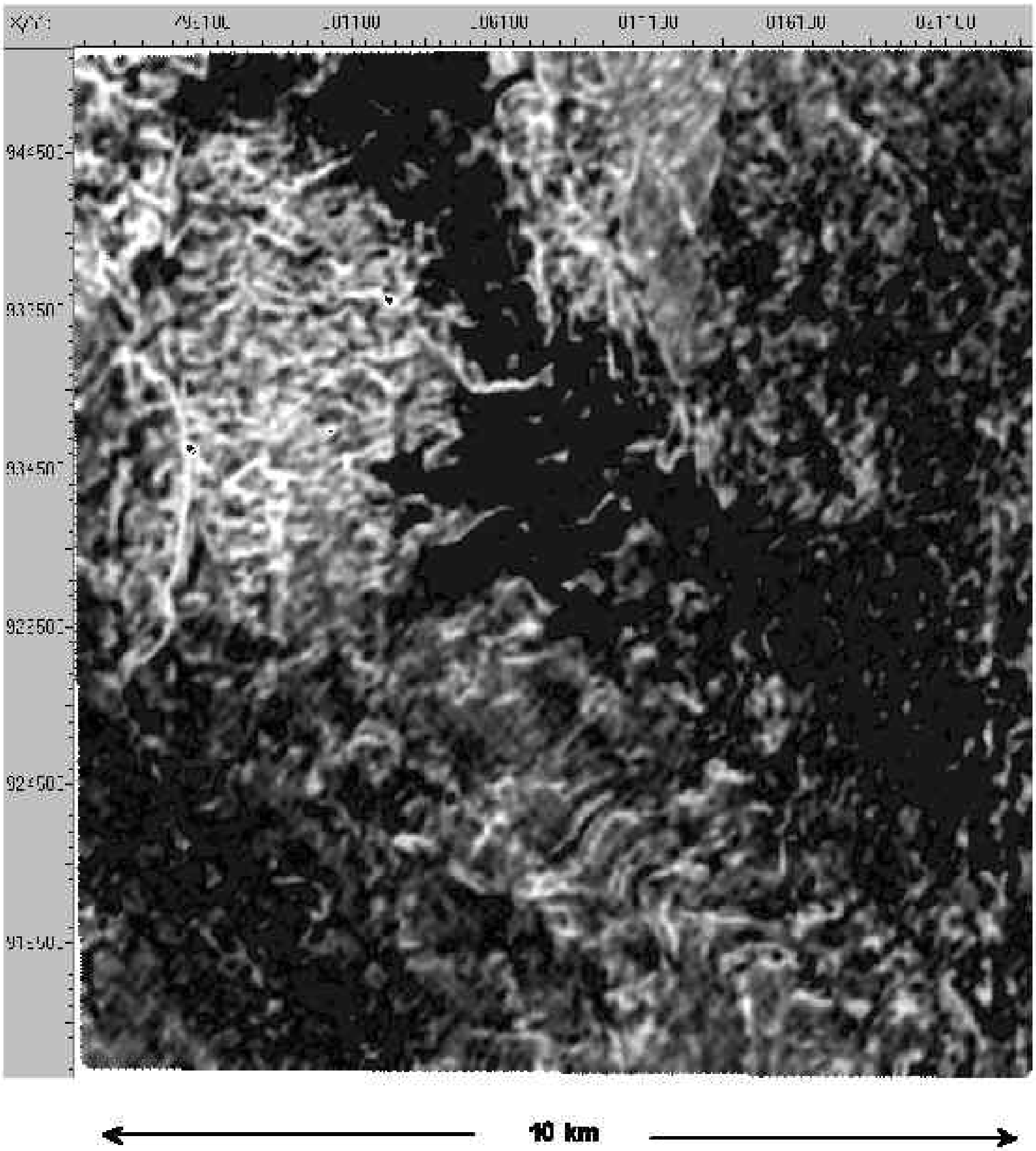


Fig. 4 Seafloor amplitudes from 3D seismic

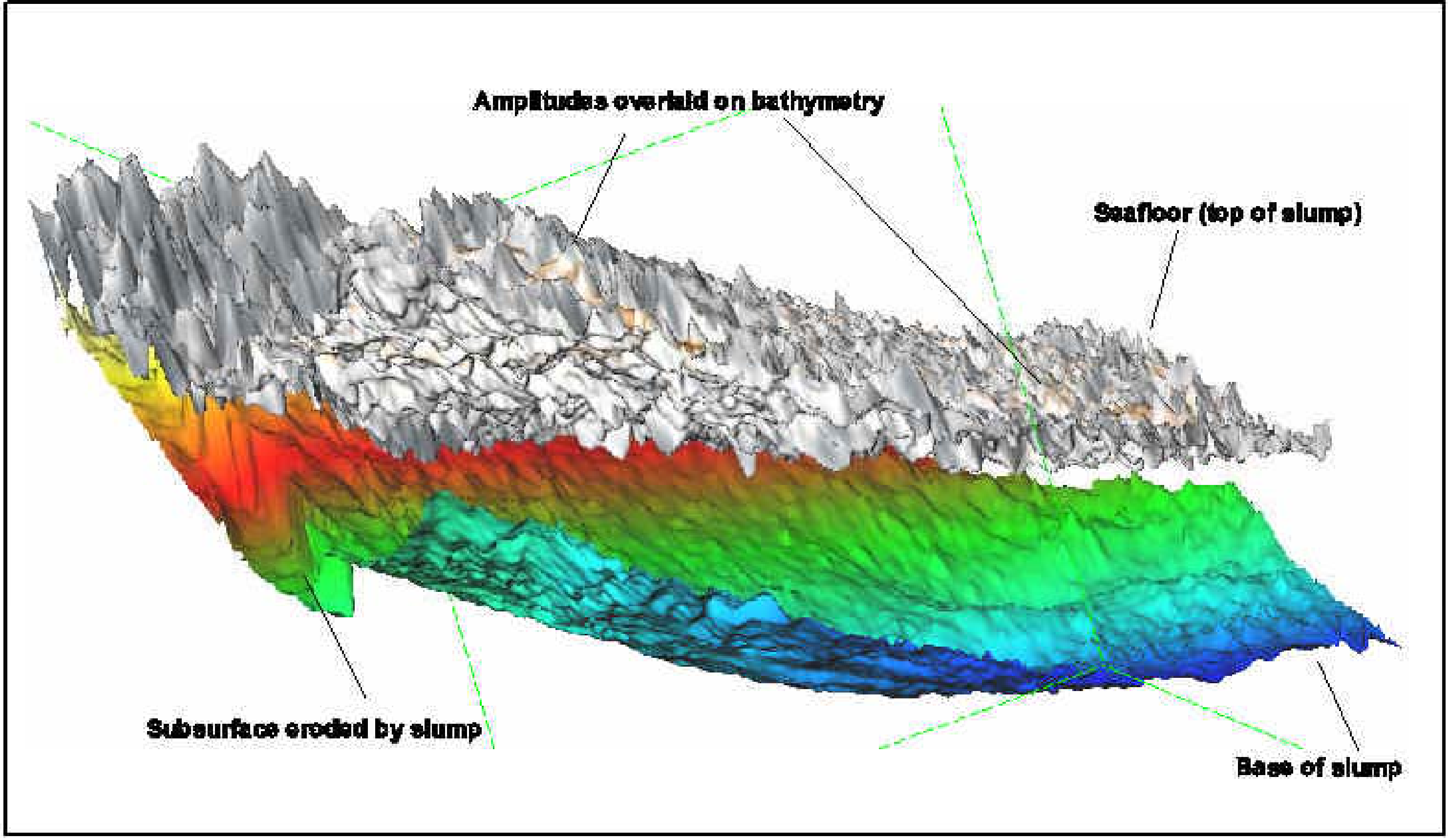


Fig 5. Detailed 3D Vue of 100 km area