

SUBMARINE LANDSLIDE POTENTIAL ON THE CONTINENTAL SHELF IN THE SOUTH CENTRAL VIETNAM

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ABSTRACT

Submarine landslide phenomena occurs strongly on the continental shelf in the south central Vietnam. They can be seen so clearly in all data of the seabed topography, multibeam, fault structures and reflected seismic profiles.

Besides, the analytical results in this area also showed that the landslide blocks on the continental slope can occur on circular failure mode and subsidence. The boundary of the circular failure blocks is assumed as parallel faults to continental slope and unconformable surfaces in sedimentary rock. The boundary of subsidence regions is assumed as parallel fault surfaces to continental slope. In addition, the occurrence of perpendicular fault systems to continental slope can break the slope structure and cause increasingly submarine landslide in this area.

KEYWORDS: Continental slope, Submarine landslide, Parallel fault, Perpendicular fault, Seafloor topography.

1. INTRODUCTION

The south central Vietnam continental shelf has topography that changes from 300 to 1500m deep (Fig. 1). The abrupt variation of seafloor depth formed the surfaces of steep terrain. Besides, together with the existence of fault system along 109°30' meridian, earthquake and volcanic activity caused mainly submarine landslides in this area.

The reseaches on submarine landslide phenomena and assessments of their risks in this area by analyzing tectonic structure and geo-dynamic, seismic reflection data were conducted by Tran Tuan Dung et al (2010) and Bui Cong Que et al (2010). The analytical results determined the factors in relation to submarine landslides phenomenon, delineated the map of potential submarine landslide and also gave warnings about this phenomenon.

However, the study papers about submarine landslides in this area is very few. Therefore, in this paper, we use the data combination of bathymetry, Multibeam and refelction seismic to analyze the status of submarine landslides and predict it's potential in the south central Vietnam continental shelf.

2. DATA AND METHODS

2.1. Data used

- Reflection seismic data;
- Multibeam data.

2.2. Methods used

- Analyzing 3D topography model;
- Analyzing reflection seismic data;
- Analyzing Multibeam data;
- GIS Intergrating.

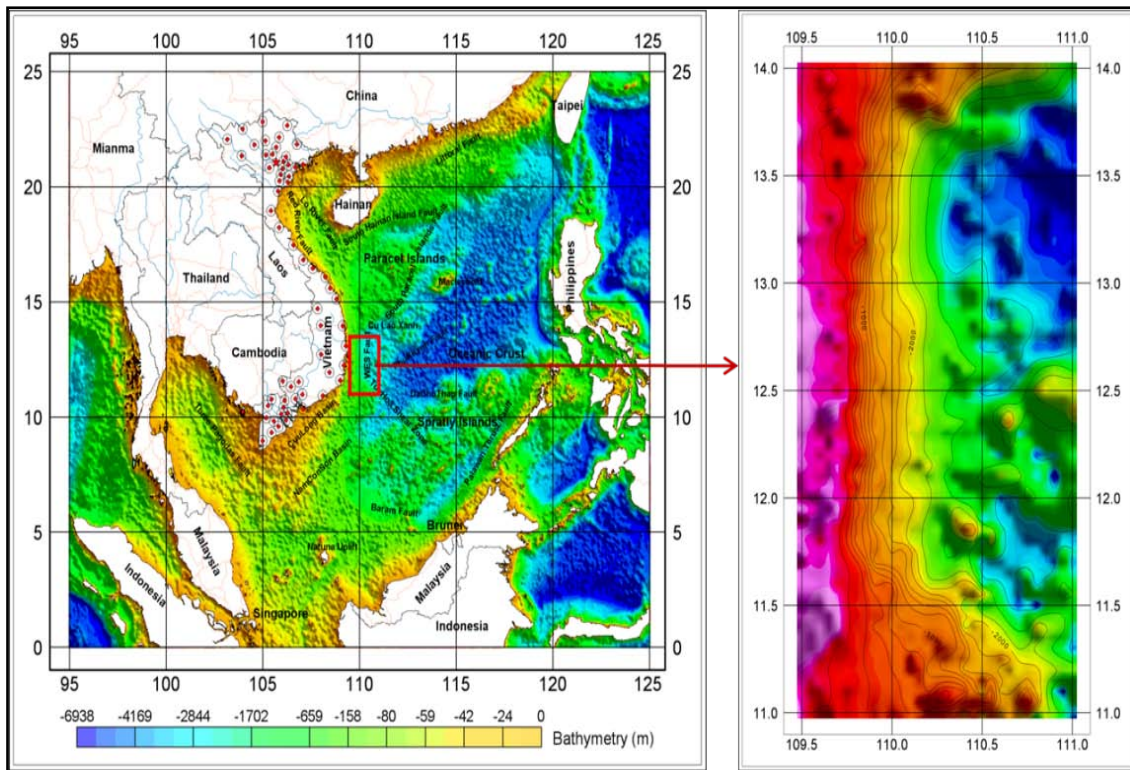


Figure 1. Location of study area

3. LANDSLIDE STATUS IN SOUTH CENTRE VIETNAM CONTINENTAL SHELF

3.1. Landslide evidences on the 3D topographical model

On the 3D topographical model, landslide evidences occurred from the parallel latitude of 11° to 14° are showed clearly according to two main directions, such as: sub-meridian and NW-SE. For the first one, landslide evidences showed as narrow steps at the depth of 700~800m, 1200~1300m và 1500~ 1700m (Fig 2b-d). For the former one, landslide evidences are also recognized in Figure 1a. These landslides may be affected by tectonic activity of above fault systems.

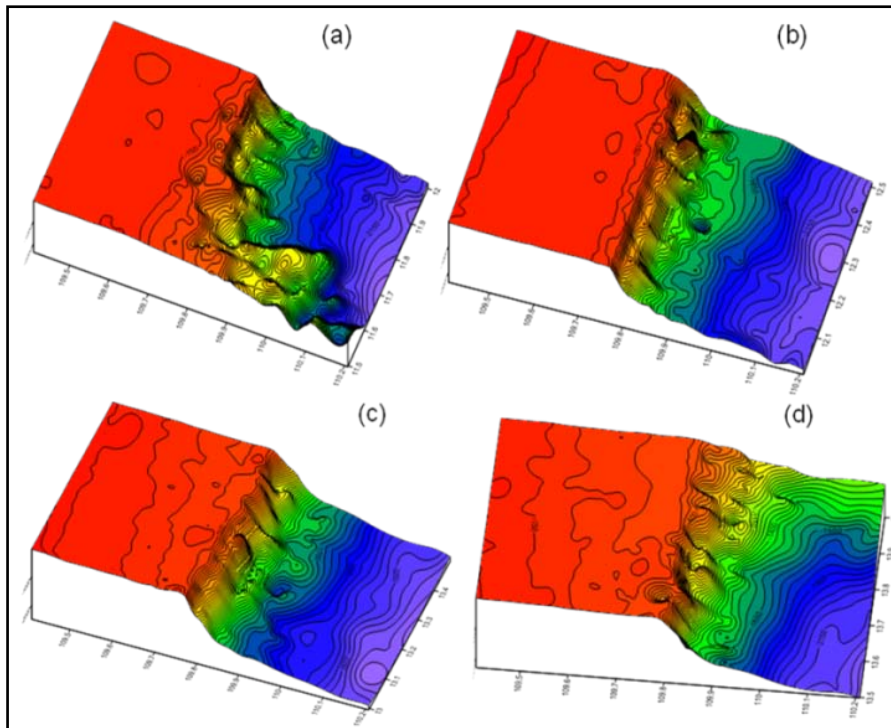


Figure 2. 3D topography model of lanslide status in the south central Vietnam continental shelf within coordinate intervals: a) 11.5-12^o and 109.4 -110.2^o; b) 12-12.5^o and 109.4-110.2^o c) 13-13.5^o and 109.4-110.2^o, d) 13.5-14^o and 109.4-110.2^o.

The lanslide evidences on the 3D topography model of Figure 2 are shown on the cross sections in Figure 3.

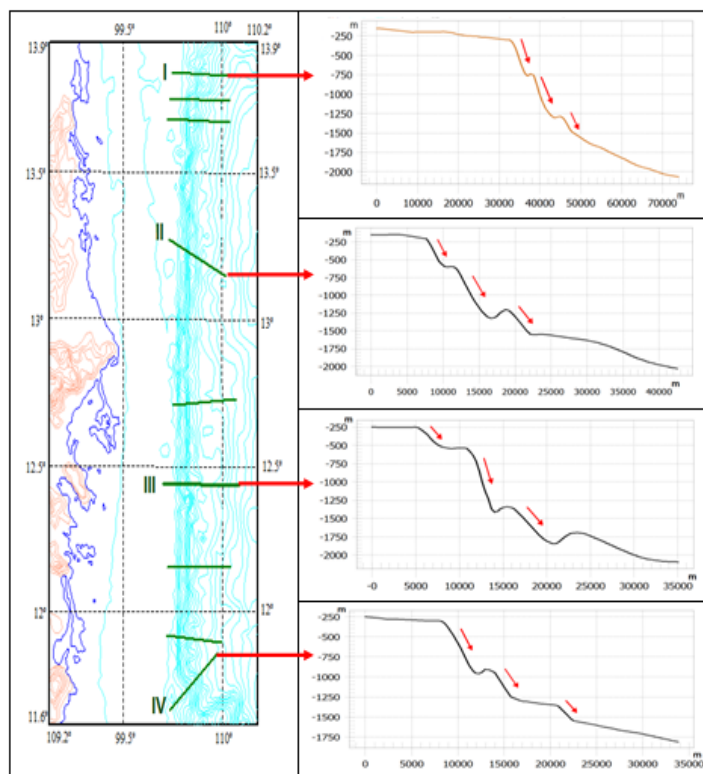


Figure 3. Location of cross sections in the south central Vietnam continental shelf

3.2. Landslide evidences on the Multibeam data

The landslide evidences are also occurred on the Multibeam data of the KC09.11/11-15 project. The analytical results from this data within the coordinate from $109^{\circ}47.62' - 11^{\circ}26.81'$ to $110^{\circ}07.52' - 11^{\circ}43.94'$ (Fig. 4) show clearly that the surface of seafloor topography is strongly splitted, formed landslide blocks corresponding to different color regions. The separation among them is narrow color strips and lighter. The variation of color regions of the diction from W to E and from SW to NE reflects the trend of landslide blocks.

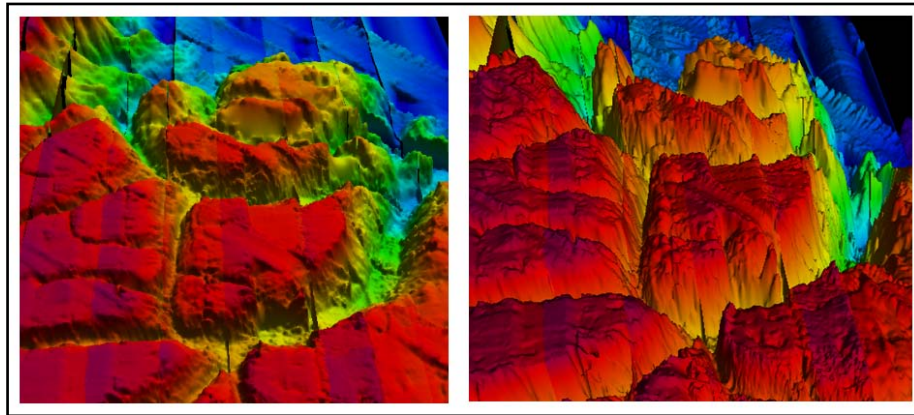


Figure 4. The movement of landslide blocks from W to E and from SW to NE on Multibeam data

3.3. Landslide evidences on the reflection seismic data

The landslide evidences occurred on most reflection seismic profiles in the south central Vietnam continental shelf and are shown in Figure 5a.

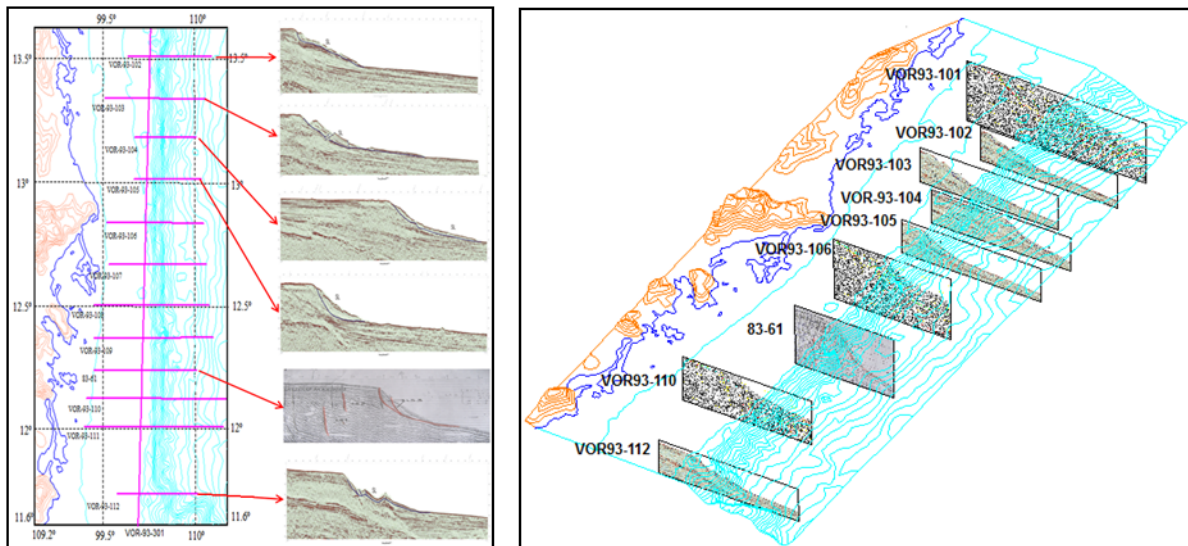


Figure 5. Landslide evidences on the reflection seismic profile VOR-93-102, VOR-93-103, VOR-93-104, VOR-93-105, 83-61, VOR-93-112

These cross sections are established in 3D space as Figure 5b to analyse landslide blocks as Figure 6a. The existence of perpendicular fault systems to landslide blocks could make broken and divide these blocks, increase potential of landslides on the slope (Fig. 6b).

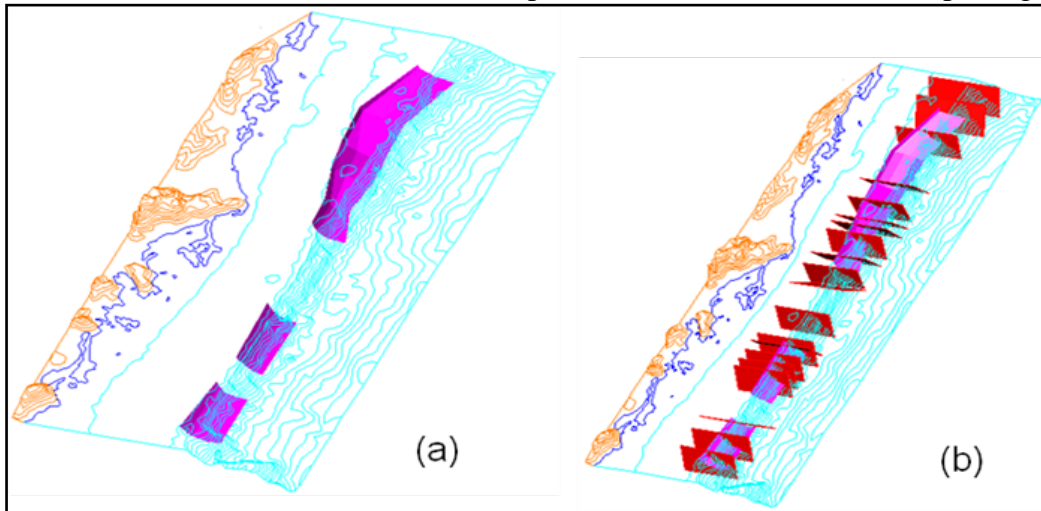


Figure 6. The boundary image of landslide blocks in 3D space

4. SUBMARINE LANDSLIDE POTENTIAL

4.1. Prediction of submarine landslide based on the reflection seismic profiles

The analytical results of landslides from the reflection seismic profiles showed that the south central Vietnam continental shelf can occur circular failure mode (Fig. 7). The boundary of these landslide blocks are determined as fault surfaces and unconformity surfaces in sedimentary rocks. The 3D boundary model of landslide blocks are also shown as Figure 6.

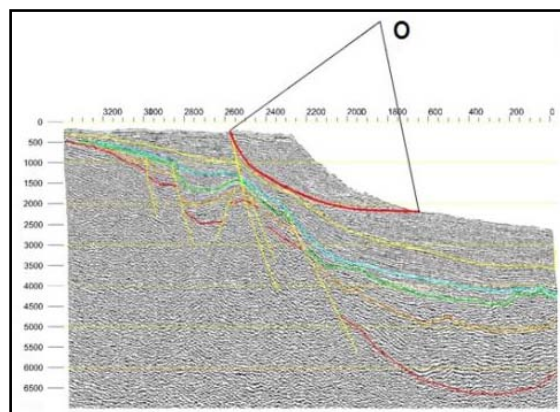


Figure 7. Illustration of circular failure mode on the reflection seismic profile

4.2. Assessment of landslide potential based on fault structure

The tectonic activity in the south central Vietnam continental shelf in Quaternary are described simply in the faults map of Figure 8. The analytical results of landslides from this map showed that this area hardly occur plane failure mode because the angle of fault planes

are always higher than the angle of slope surface and it can only occur subsidence. However, the existence of perpendicular fault systems to landslide blocks could also broke and divide these blocks, increase potential of landslides on the slope (Fig. 8c).

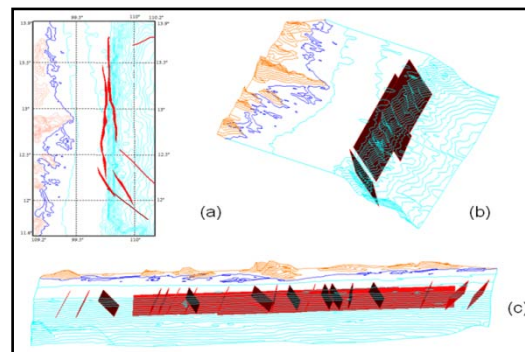


Figure 8. Fault map in Quaternary (a) and their images in 3D space (b - c)

5. CONCLUSIONS

- On the 3D topography and the reflection seismic profiles, landslide evidences are occurred as narrow steps, run along slope at three depth intervals 700~800m, 1200~1300m and 1500~1700m, may be affected by the fault systems of sub-meridian and NW-SE direction.

- The analytical results from reflection seismic profiles showed that in the south central Vietnam continental shelf could occur circular failure mode. In addition, the analytical results also showed that the existence of perpendicular fault systems to landslide blocks could also broke and divide these blocks, increase potential of landslides on the slope.

- The analytical results from Multibeam data showed that the surface of seafloor topography is strongly splitted, formed landslide blocks corresponding to different color regions. The separation among them is narrow color strips and lighter. The variation direction of the color regions from W to E and from SW to NE reflect the trend of landslide blocks.

- The analytical results from fault map showed that the landslides in the south central Vietnam continental shelf hardly occurs plane failure mode because the angle of fault planes are always higher than the angle of slope surface and it can only occur subsidence in this area.

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