



## Pliocene–Quaternary evolution of the continental shelf of central Vietnam based on high resolution seismic data



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### ABSTRACT

The continental shelf of central Vietnam is characterized by complex geological structures in a strike-slip setting and thus by unique morphology compared to other parts of the Vietnam shelf. Studying the Pliocene–Quaternary sediments in this area allows the processes that control the stratigraphic evolution to be highlighted. In this paper, we present new results derived from high resolution seismic data that reveal the geological evolution of the continental shelf of central Vietnam during the Pliocene–Quaternary. Our results demonstrate that the continental shelf of central Vietnam is narrow relatively to other parts of the Vietnam shelf. The evolution of the shelf during the Pliocene–Quaternary was controlled by the pre-Pliocene rifting process. However, fault systems below the present shelf were not strongly active during the Pliocene–Quaternary period, except for several listric faults in the slope. Nonetheless, Quaternary volcanic activities occurred widely both offshore and onshore, especially near the major faults. The Pliocene–Quaternary sedimentary deposits were subdivided into 7 units based on unconformities as result of marine regression corresponding to glacial cycles. Sedimentary environments during this period consist of coastal plain, fluvial, nearshore and shelf environments. Most of the Holocene sediments were trapped nearshore while the outer shelf is characterized by abundant lag gravels as a result of rapid sea level rise between ~20 and 8 ka.

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### 1. Introduction

Pliocene–Quaternary sediments are observed extensively along the continental shelf of Vietnam. These formations have been deposited under the influence of complex sea level and climate interactions during the last 5 Ma. This means that the Pliocene–Quaternary formations can be considered as a natural laboratory for understanding how paleoclimate change and coastal processes, as well as tectonic forces controlled the development of the continental margin stratigraphy. High resolution of age control, coupled with better defined sea level and climate reconstructions means that we are now able to separate the competing influences better for these strata compared to older units. In addition, the continental shelf and coastal area are very sensitive and vulnerable to both climate change and coastal degradation. Understanding the processes that have occurred in the geological past, especially during the Pliocene–Quaternary period is important because by

understanding how the coast and shelf have responded to earlier changes in the paleoclimate and coastal processes we may be able to predict models for natural hazard mitigation in the future.

The continental shelf of central Vietnam (Fig. 1) is narrow and elongated, with sea floor of stair-step shape, dipping eastward to the ocean. The Vietnam shelf consists of relatively thick and heterogeneous Pliocene–Quaternary successions that were deposited under different tectonic regimes (Hutchison, 2004; Tapponnier et al., 1986, 1982, 1990; Zhang and Zhong, 1996). It is unique compared to many continental margins because of the very narrow extension and the close proximity of mountains to the coast with high relief and relatively minor flood plains. Some of the Pliocene–Quaternary formations may host significant petroleum potential, which makes the area attractive for petroleum exploration, as well as other economical activities such as offshore engineering and transportation. A number of seismic surveys and exploration drilling campaigns have been carried out by petroleum companies during the last several decades. These works allowed geoscientists to define regional geology, stratigraphy and to reconstruct evolutionary history of sedimentary basins offshore

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Fig. 1. The research area in continental shelf of central Vietnam.

Vietnam. However, major focus was on pre-Pliocene sedimentary formations, where oil and gas were expected to be discovered. Therefore, geological structure and evolution of the younger Pliocene–Quaternary successions are still poorly understood. Because of the limited database, stratigraphic models for the evolution of the shelf are not very accurate. Because of these shortcomings striking scientific problems raised here are: (1) How have the continental shelf of central Vietnam and its sediments during the Pliocene–Quaternary? and (2) Can we use high resolution seismic data to study the Pliocene–Quaternary sediments and can the history of the continental during this period can be reconstructed thereby? Since well data and field observations are lacking, high resolution shallow seismic exploration can provide valuable geological information at higher resolution and hence it is an effective tool for studying subsurface geology. In this paper, we present some new results of the evolution of the Pliocene–Quaternary continental of central Vietnam based on high-resolution 2D reflection seismic data provided by various marine research groups (Institute of Marine Geology and

Geophysics, Center of Marine Geology and Mineral Resources, Institute of Marine Environments and Natural Resources, etc.). We further correlate and compare our results with the industrial multichannel 2D seismic data provided and interpreted by Petrovietnam in order to study the Pliocene–Quaternary sedimentary formations under the continental shelf of central Vietnam. The primary objectives of this work were:

- Defining the geological structure of the Pliocene, Pleistocene and Holocene formations off central Vietnam.
- Reconstructing the evolution of the continental shelf of central Vietnam during the Pliocene–Quaternary.

## 2. Database and methods

### 2.1. Seismic data

The application of high resolution seismic data (HRS) with correct acquisition and processing parameters is an effective and

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