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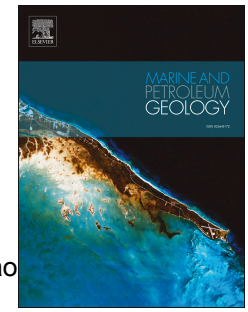

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Seismic Evidence and Formation Mechanism of Gas Hydrates in the Zhongjiannan Basin, Western Margin of the South China Sea

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Abstract:

An analysis of 3D seismic data from the Zhongjiannan Basin in the western margin of the South China Sea (SCS) reveals seismic evidence of gas hydrates and associated gases, including pockmarks, a bottom simulating reflector (BSR), enhanced reflection (ER), reverse polarity reflection (RPR), and a dim amplitude zone (DAZ). The BSR mainly surrounds Zhongjian Island, covering an area of 350 km^2 in this 3D survey area. The BSR area and pockmark area do not match each other; where there is a pockmark developed, there is no BSR. The gas hydrate layer builds upward from the base of the stability zone with a thickness of less than 100 m. A mature pockmark usually consists of an outside trough, a middle ridge, and one or more central pits, with a diameter of several kilometers and a depth of several hundreds of meters. The process of pockmark creation entails methane consumption. Dense faults in the study area efficiently transport fluid from large depths to the shallow layer, supporting the formation of gas hydrate and ultimately the pockmark.

Key words:

Seismic evidence; Gas hydrate; Pockmarks; Zhongjiannan Basin; South China Sea

1. Introduction

The occurrence of oceanic gas hydrate has been inferred from the observation of bottom-simulating reflectors (BSRs) (Shipley et al., 1979; Hyndman et al., 1992). The presence of gas hydrate in sediment pore space elevates the interval velocity in the gas hydrate stability zone (GHSZ) and may significantly reduce interstratal acoustic impedance contrasts, causing a marked decrease in the seismic amplitude above the BSR (Dillon et al., 1998) and resulting in a seismic anomaly known as amplitude blanking or a dim amplitude zone (DAZ). Gas hydrates, filling a portion of the pore space above the BSR, also effectively decrease the permeability of the sediment, thereby working as a trap for the underlying free gas (Hovland and Svensen, 2006). When the temperature and pressure of the free gas below the BSR are high enough, the BSR might elevate and intersect and coincide with the seafloor. At the same time, free gas might migrate upward through the GHSZ (Ginsburg and Soloviev, 1997; Wood et al., 2000; Liu and Flemings, 2006). Free gas migration is evidenced in numerous ways, for example, as negative relief pockmarks (e.g., Faure et al., 2006; Luan et al., 2005, 2006; Gay et al., 2012).

Previous Gas hydrate research in the South China Sea (SCS) has mainly been confined to the Northern South China Sea margin, including the first BSR reported in 1999, massive 2D and 3D seismic acquisitions, 22 BSR areas that have been delineated upon, and gas hydrates samples recovered by 4 gas hydrate drilling cruises (GMGS-1 in the Shenhu area in 2007, GMGS-2 in the Dongsha area in 2013, GMGS-3 again in the Shenhu area in 2015, and GMGS-4 in the Qiongdongnan area in 2016) (Zhang et al., 2007; Wu et al., 2011; Wang et al., 2014; Wang et al., 2016), whereas the other parts of the South China Sea have not been studied as much. In this study, we report seismic evidence of gas hydrates based on 3D seismic data in the Zhongjiannan Basin (ZJNB) on the Western South China Sea margin (Fig. 1).