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Characteristics of the bottom simulating reflectors near mud diapirs: offshore southwestern Taiwan

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Abstract Single-channel seismic recording was carried out off the southwestern coast of Taiwan. Six characteristic seismic facies associated with bottom simulating reflectors (BSRs) and mud diapirs are identified. The existence of reflections which mimic the seafloor, the reverse polarity, weak amplitude blocks, and strong diffraction patterns around the mud diapirs all suggest that gas hydrates exist in the deep-water regions. The bases of the hydrate stability zones upturn in the vicinity of mud volcanoes. The high heat flows of mud volcanoes provide heat sources which destabilize the gas hydrates and upturn the BSRs.

Introduction

Deep-sea gas hydrates are ice-like solids (Singh et al. 1993) which are formed from water and naturally occurring gases, particularly methane species (Hyndman et al. 1992; Dickens et al. 1997). Gas hydrates usually occur in open-ocean waters at depths greater than 500 m in feather-edged, surface-parallel horizons up to 1100 m thick (Booth et al. 1995).

Hydrates in deep-sea sediments have been sampled by remotely operated vehicles in the Ocean Drilling Program (Brewer et al. 1997; Paull et al. 1998). However, the presence of gas hydrates in sediments has usually been inferred from bottom simulating reflectors (BSRs) in seismic sections (e.g., Neben et al. 1998). The high amplitude associated with BSRs indicates seismic characteristics of bright spots in petroleum exploration (Sheriff 1975; Hutchison et al. 1981).

The analysis of seismic reflection profiles acquired during cruises 320 and 329 of the R/V Ocean Researcher I (Fig. 1) indicates the existence not only of gas hydrates and BSRs, but also of submarine mud volcanoes offshore from southwestern Taiwan. This paper describes in detail (1) the general seismic facies in the vicinity of BSRs associated with mud diapirs; (2) the characteristics and existence of BSRs; (3) the relationship between the BSR burial depth and water depth; (4) the upturning of BSRs in the vicinity of mud diapirs; and (5) the existence of pockmarks.

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Geological setting

The island of Taiwan was formed by the collision of the Luzon arc with the Chinese continental margin (Ho 1986; Teng 1990). The geological framework of the southwestern Taiwan region, including offshore areas, evolved during the Pliocene–Quaternary (Covey 1984). The arc-continent collision has resulted in the formation of a foreland basin filled with orogenic sediments up to 6000 m thick in southwestern Taiwan (Covey 1984).

The area offshore from southwestern Taiwan consists mainly of a narrow shelf and a deep broad slope (Yu and Wen 1992). Submarine mud diapiric intrusions and mud volcanoes are recognized as the most prominent undersea features in the deep-water region (>700 m; Sun and Liu 1993; Chow et al. 1996).

General seismic facies around BSRs

A general interpretation of the seismic profiles provided essential information on the sedimentary envi-