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Geological controls on BSR occurrences in the incipient arc-continent collision zone off southwest Taiwan

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ABSTRACT

Bottom simulating reflectors (BSRs) observed on seismic sections are often considered as indicators for the existence of free gas, delineating the base of the gas hydrate stability zone. Abundant BSRs seen on seismic sections acquired off the SW coast of Taiwan indicate the likely and prevalent existence of gas hydrates in the study area. This study aims to characterize the occurrence of BSRs off SW Taiwan and to understand their relationship to topography, tectonic activity, and possible migration paths of gas-bearing fluids in this area.

The tectonic setting off SW Taiwan is during the initial stage of arc-continent collision between the Luzon arc and the northeastern continental margin of the South China Sea. A series of west-vergent, imbricated folds and emergent thrusts develop in the accretionary wedge. Each fold-and-thrust sequence corresponds to an elongated submarine ridge if its crest is not buried by flat-lying sediments. By contrast, normal faulting prevails in the northeastern margin of the South China Sea.

A correlation between distribution of BSRs, topography, and tectonic features can be observed. Four major occurrences of BSR types of ridge type, basin type, submarine-canyon type, and continental slope type, are recognized on the basis of the relationship of BSRs to topographic and structural features. Main characteristics of BSRs in the study area can be described as: (1) they occur mostly beneath topographic highs; (2) a discordant relationship between surfaces of the seafloor and underlying strata where BSRs are present; (3) BSRs are prevalent especially beneath the crest and flank of the upthrusting, large and inclined slope basins; and (4) in general, a series of high-amplitude dipping reflectors beneath BSRs can be found. These features indicate that gas hydrate may accumulate preferably beneath topographic ridges especially underneath four-way-dip topographic closures. This effect may exist because the buoyancy-driven, gas-bearing fluids tend to migrate upward and laterally toward structural highs and their corresponding topographic ridges.

The distribution of BSRs indicates that gas hydrates occur more commonly in the accretionary wedge than in the South China continental margin. We suggest that the more widespread occurrence of gas hydrates in the accretionary wedge is due to the existence of multiple fault zones, which may help to tap more deep-seated gas-bearing fluids, in addition to the shallow biogenic gas, in this region.

1. Introduction

Bottom simulating reflectors (BSRs) seen on seismic reflection profiles are conventionally interpreted as indicators for the base of gas hydrate stability zone (GHSZ) and hence indicate the possible presence of gas hydrate and free gas beneath the seafloor (Dillon and Paull, 1983; Miller et al., 1991). Gas hydrates and their associated BSRs have been retrieved or recognized either in accretionary wedges (e.g., Riedel et al., 2006; Ashi et al., 2002; Colwell et al., 2004) or in rifted continental margins (e.g., Holbrook et al., 1996; Paull et al., 1998). These two drastic different tectonic settings seldom exist in close proximity. Offshore southwest Taiwan (Fig. 1), an accretionary wedge has obliquely overridden the rifted South China continental margin (Liu et al., 1997). A few studies have documented the prevalent existence of BSRs off southwest Taiwan both in the accretionary wedge (e.g., Reed et al., 1992; Lundberg et al., 1992; Chi et al., 1998, 2006; Shyu et al., 1998; Schnurle et al., 1999; Chow et al., 2000; Liu et al., 2006) and in the South China continental slope (e.g., Chi et al., 1998; McDonnell

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