Spatial distribution of deepwater depositional systems and relationship with bottom currents on the northwestern lower slope of the Northwest Sub-Basin, South China Sea

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Abstract: *Using 2D seismic data, a complex of deepwater depositional systems consisting of submarine valleys/canyons, wave-shaped sliding deposits, contourite erosive features and sheeted drifts, are developed within the Quaternary strata on the northwestern lower slopes of the Northwestern Sub-Basin, South China Sea. Alongslope aliened erosive features and non-depositional features are observed on the eastern upper gentle slopes (<1500m-depth), where a V-shaped downslope valley presents an apparent ENE migration. These indicate a major eastward bottom current, possibly within the South China Sea Intermediate Water Circulation. Contourite sheeted drifts are also present on the eastern gentle slopes, with water depth >2500m, referring to a wide unfocused bottom current, which might be related to the South China Sea Deep Water Circulation. Sliding deposits are developed on steeper slopes (>2^o), where alongslope current deposition is missing. This suggests a domination of downslope depositional processes on unsteady slopes. The NNW-SSE oriented slope morphology changes from a three-step terraced outline (gentle-steep-gentle) in the east of the investigated area, into a two-step terraced (gentle-steep) outline in the middle, and into a unitary steep slope in the west. Such morphological changes possibly lead to the westwards simplifying assemble patterns of the deepwater depositional systems on this margin.*

Key words: *deepwater system, contourite, turbidite deposits, northwest sub-basin, South China Sea.*

INTRODUCTION

Deepwater depositional systems, including downslope and alongslope current deposits, could record a wealth of information on palaeoceanographic, climate, and tectonic changes (Rebesco et al., 2014). The northwestern lower slope of the Northwest Sub-Basin with a water depth ranging from 1000 to 3500m from the South China Sea (SCS) represents a critical oceanic-continental transition zone in the SCS deepwater area (Fig. 1a). The SCS oceanic circulation is subdivided into 3 main levels: the surface water (0-350m), intermediate water (350-1500m) and deep water (>1500m) circulations. The SCS Intermediate Water sweeps the SCS northern margins, mainly from west to east, while the westward South China Sea Deep Water circulation is known to have an average current velocity of 0.15m.s^{-1} across the Luzon straight and 0.02–0.05m.s^{-1} around the drilling location of ODP1144 (~1900m-depth) (Chen et al., 2014). In this study, we deal mainly with the spatial distribution of deepwater depositional systems, and also focus on the implications of the morphologies based on high-resolution seismic data. The purpose of this study is to elucidate the dominant controlling factors in the formation and evolution of deepwater depositional systems in northern margins of South China Sea.

RESULTS

Varied deepwater depositional systems are present, such as the downslope gravity flow deposits and alongslope contourite deposits, due to the complex paleogeographical relief (Figure 1b). The W-E oriented Xi'sha Trough (>3000m-depth) is located in the southwest study area, as a remarkable morphologic feature (Fig. 1a, b). Series of downslope submarine canyons are observed on slopes lower than 1500m in the northwest. At ~1350m in water depth (slope <1°), a NNW-SSE oriented valley shows an asymmetric V-shaped morphology. Successive incising bases, with obvious ENE migrations, can be identified, showing continuous and high amplitude seismic reflections.

Mass-wasting deposits are restricted between 1500m and 2000m water depth (slope >2°) in the east; their spatial distribution is expanding to from 1400 to 2100m in the west. These deposits show parallel to sub-parallel and moderate to high amplitude seismic reflections, and their configuration displays a sine curve-like geometry. Successive slide scars and failure surfaces are observed between these displaced mass-wasting deposits.

Sheeted drift deposits observed are draping relatively deep (>2500m) and gentle (~1.5°) slopes in the southeastern part of the study area, with an average thickness over 70ms TWT. Their morphologies are mostly flat and smooth, and show fairly continuous, parallel to sub-parallel seismic reflectors of moderate amplitudes. The development of sheeted drifts gradually reduces to the west, in consistent with the disappearance of the lower gentle shapes.

Seamount-related contourite depositional features (moats and elongated-mounded drifts), small-scale alongslope aligned channels (0.5–2km wide and 10-20m deep) and non-depositional features are present on the northeastern slopes, at water depth of 1500m and above (slope <1.2°). Following the contour line of 1500m to the west, they gradually disappear, and slope failures are developed instead.

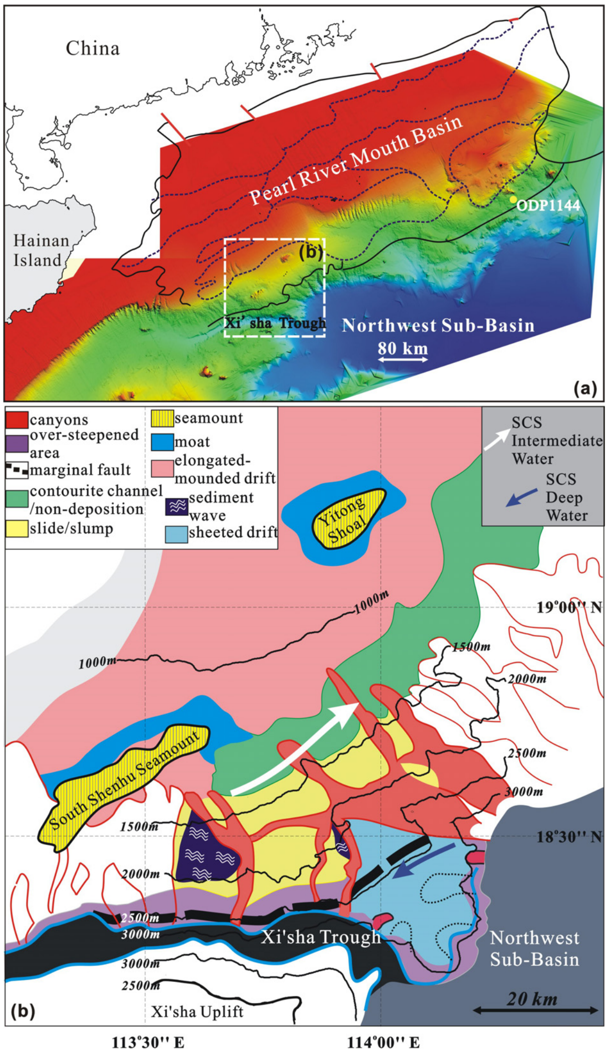

FIGURE 1 (a) Bathymetry of the study area; (b) Block diagram showing the distribution pattern of the deep-water sedimentary systems that developed over the Pliocene-Quaternary in the study area

CONTROLING FACTORS IN FORMATION AND EVOLUTION OF DEEPWATER DEPOSITIONAL SYSTEMS

The slope morphology of the eastern study area is shown as a three-stepped terraced outline, of which the upper part (depth <1500m) and the lower part (depth >2500m) are both gentler slopes (average gradient of less than 1.5°) and the middle part is much steeper (slope >2°). It changes into a two-stepped terraced outline in the middle, and finally into a unitary steep slope in the west. On one side, alongslope channels and sheeted drifts generated by bottom currents are developed on the gentle slopes (in the east), while landslidings dominate the whole steep region. Downslope slumps or slides are the representative products of unstable continental slopes, whereas alongslope depositional records are commonly missing due to the failure of intermediate bottom currents to erode/deposit sediments, and/or the fact that alongslope depositional records are strongly affected by frequent downslope processes. On the other side, the morphological changes, as mentioned above, possibly led to a westward simplification of composite deepwater depositional systems, from a complex of contourite deposits and mass-wasting deposits in the east, to only mass-wasting deposits in the west.

As parts of the SCS Intermediate Water Circulation, the eastward flowing bottom currents generate alongslope erosive or non-depositional features near 1500m-depth. It could push the submarine valley to consistently migrate eastwards, where the hydrodynamics of alongslope currents are locally strong. The SCS Deep Water bottom currents (>2000m-depth) might evolve into non-focused current with decreased velocity when encounter the gentle-flat lower slopes in the west (our study area), generating the slope sheeted drifts. Thus, the different flow directions, hydrodynamics and occurring depths between the SCS Intermediate Water and Deep Water could lead to various depositional processes and products.

CONCLUSIONS

High-resolution 2D seismic data reveal that deepwater depositional systems changed from a complex of contourite erosive/depositional features, slope failures and canyons in the east towards solely mass-wasting and canyon depositions in the west in the study area. The fact indicate that internal architectures and development of deepwater depositional systems are in close association with the steepening of slope morphologies from east to west on one side, and the different flow directions and hydrodynamics of the SCS vertically stratified water masses on the other side.

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