Deep-water depositional characteristics and relationship with bottom currents at the intersection of Xi'sha Trough and Northwest Sub-Basin, South China Sea

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Abstract: *Simulated flow field characteristics at 2000m depth, at the intersection of the Xi'sha Trough and the Northwest Sub-Basin, show a major anticyclonic gyre. These westward flowing deep currents sweep the South China Sea northern margins until they encounter the Xi'sha Trough and the Xi'sha Uplift. Some of them flow into the Xi'sha Trough and continue going westwards; others change their heading towards to the south and sweep the Xi'sha Uplift eastern margins. In the eastern margins, current velocities could exceed 2cm.s^{-1} as a result of bottom current intensification (after being deflected by the uplifted morphology). Hydrodynamics over the remaining parts of the Xi'sha Uplift zone (south of the Xi'sha Trough) are complex. Fortunately, high-resolution 2D seismic data enable to reveal the depositional characteristics of bottom currents below 1800m depth in this area, whereas marginal troughs and confined drifts are recognized in the vicinity of the obstacle terrains. Major troughs formed north of those obstacles, indicating mainly westward flowing bottom currents in this area. This study focuses on the analysis of deep-water depositional products, created by bottom currents and the relationship with the South China Sea Deep Water Circulation.*

Key words: *contourites, bottom currents, flow field characteristics, Xi'sha Trough, South China Sea*

INTRODUCTION AND BACKGROUND

The intersection of the Xi'sha Trough and the South China Sea (SCS) Northwestern Sub-Basin (112.5°E to 114.5°E and 17.5°N to 18.5°N) represents a critical location in the SCS deep-water sedimentary dynamics, due to the convergence of the Xi'sha Trough, the SCS northwestern continental-oceanic transition zone and the abyssal plain (Fig. 1a, b). The major SCS Intermediate Water (350 to 1500m depth) sweeps the SCS northern margins from west to east, while the South China Sea Deep Water circulation (>1500m depth) is known to flow westward (Fig. 1a). Previous studies on deep-water depositional characteristics and relationship with bottom currents at the intersection of Xi'sha Trough and Northwest Sub-Basin are rare. This study focuses on the analysis of deep-water deposits created by bottom currents in this area, and their original relationship with the South China Sea Deep Water Circulation (>1800m depth) and the sea floor topography changes.

DATA AND RESULTS

The flow field characteristics at the intersection of Xi'sha Trough and Northwestern Sub Basin are derived from the HYCOM+NCODA Global 1/12° Analysis (GLBa0.08) data (Fig. 1b), which shows the circulation at 2000m depth as an anticyclonic gyre. The conductance-temperature-depth data and seawater temperature and salinity features indicate that these currents could belong to the westwards SCS Deep Water circulation (Chen et al., 2014). When encountering the Xi'sha Trough and the Xi'sha Uplift, some of these currents flow into the Xi'sha Trough and continue going westwards. Others change their heading towards to the south and sweep the Xi'sha Uplift eastern margins, with current velocities exceeding 2cm.s^{-1}. It is also noted that weak eastward currents flow along the southern wall of the Xi'sha Trough, and the hydrodynamic situation over the Xi'sha Uplift zone is complex.

High-resolution 2D seismic data enable to reveal the depositional characteristics of bottom currents below 1800m depth in the Xi'sha Uplift zone (A-A', B-B' and C-C' in Fig. 1). It mainly consists of marginal troughs and confined drifts that developed in vicinity of different obstacles (O1, O2, O3n and O3s in Fig. 1c1). Marginal troughs are 2-3 km wide and ~30m deep, showing non-depositional or erosive features. Drift deposits developed associated to the marginal troughs, flanking the troughs (Fig. 1A-A') or being confined between two obstacles (Fig. 1B-B', 1C-C'). The drifts show parallel, continues reflectors with mid-high amplitudes, and they have thickness of 30 to 50ms TWT). Small scale depressed features (furrows, depth <10m) can be observed on top of the drift deposits.

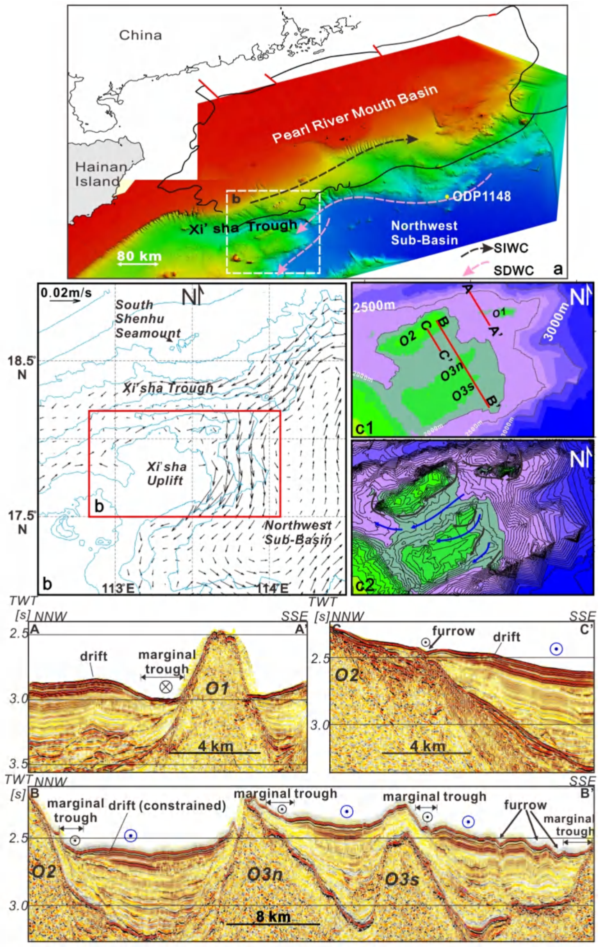

FIGURE 1. a=Bathymetry of the study area (SIWC=South China Sea Intermediate Water Circulation, SDWC=South China Sea Deep Water Circulation); b=Simulated flow field characteristics and velocity vectors at 2000m in the study area, the scale is $0.02m.s^{-1}$; c1=Bathymetry of the study area, showing the locations of the seismic profiles (the vertical scale was converted from two-way travel time to depth using a P-wave velocity of $1500m.s^{-1}$ for the water column), c2=possible pathways of bottom currents (black arrows represent intensified currents with erosion and blue arrows represent currents which allow sedimentation); AA', BB', CC'=NNW-SSE oriented profile showing the contourite drifts and marginal troughs; O1=obstacle1, O2=obstacle2, O3=obstacle 3.

DISCUSSION

Because of geostrophic balance, the along-slope current will be intensified as the cross-slope topographic gradient enlarges. In the northern hemisphere, the flowing currents would be intensified on the left-hand side of the obstacle or slopes, when looking downstream, which means and impinging flow to the southern flank of the uplifts (Hernández-Molina et al., 2006). This explains the occurrences of relatively accelerated SCS Deep Water currents, exceeding $2cm.s^{-1}$, east of the Xi'sha Uplift zone (and also, northeast of the Xi'sha Trough whereas is out of the study area).

The marginal troughs that formed along the southern flanks of O2, O3n and O3s, could be created by streams of separated and more vigorous westward flowing currents on the left side of those obstacles (black arrows in Fig. 1c2). Meanwhile, the drifts flanking the southern margin of O2 and those being confined between obstacles could be deposited by relatively distant westward flowing currents (blue arrows in Fig. 1c2). Such westward flowing directions could be consistent with the flow field characteristics of 2000m depth in the study area. Although the main direction of the flow is southwestward, the flow north and northwest of Xi'sha Uplift zone is just opposite. The marginal trough and drift deposits north of O1 may indicate a stream of eastward flowing currents (illustrated in black arrows in Fig. 1c2), which might be related to the weak currents along the northern wall of the Xi'sha Trough (Fig. 1b).

Thus, bottom currents in opposite flowing directions and under different hydro-dynamic conditions (e.g., being intensified to generate erosion or slowed down for deposition) have generated the different contourite features described above.

CONCLUSION

This study introduces the characteristics of deep-water deposits and simulated flows (>1800m depth) at the intersection of Xi'sha Trough and Northwest Sub-Basin, SCS. When passing the Xi'sha Uplift zone southwards, parts of the SCS Deep Water currents show a major westward direction, which generate marginal troughs and confined drifts in vicinity of the obstacle terrains.

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