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The linkage between longitudinal sediment routing systems and basin types in the northern South China Sea in perspective of source-to-sink

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ABSTRACT

Using bathymetric and seismic data, this study describes the morpho-sedimentary features in Qiongdongnan basin and southwest Taiwan collision basin, northern South China Sea and reveals the linkages between sediment routing system and basin types. The modern Central Canyon in the Qiongdongnan basin is located along the rift margin, and subparallel to the shelf-break southeast of Hainan Island. The modern Central Canyon develops along the basin axis (i.e., Xisha Trough) and longitudinally transports sediments eastward which are mainly supplied by northern continental slope. The Penghu Canyon in the southwest Taiwan collision basin is located along the collision boundary parallel to the strike of the adjacent uplifted Taiwan orogen. The Penghu Canyon develops along the tilting basin axis transporting sediments longitudinally southward to the deep-sea basin and Manila Trench. The Penghu Canyon is supplied with sediments from both flank Kaoping and South China Sea slopes where tributary canyons and channels transport sediments down-slope and feed the axial canyon.

The certain basin types may be occupied by particular styles of sediment routing system. By comparing the morpho-sedimentary features and basin characteristics associated with the modern Central Canyon to that of the Valencia Channel in NW Mediterranean Sea, the longitudinal sediment routing system in rift basin type can be determined. In contrast, the longitudinal sediment routing systems in collision setting can be represented by the comparable examples of Penghu Canyon in southwest Taiwan collision basin and Markham Canyon in western Solomon Sea. The rift type sediment routing system is characterized by an axial canyon with a single sediment supply from land drainage margin. In contrast, sediment routing system in collision type basins consists of an axial canyon and dual sediment supplies from flank adjacent slopes. The axial canyons in collision basins are more active than that of the rift basin due to abundant sediment supply and active tectonics. The results demonstrate the role of longitudinal sediment transport in delivering terrestrial sediments for a long distance from land drainages (source) to far-field deep-sea basin (sink). This study has implication for better understanding of the linkages between basin mechanics, sediment routing systems and sedimentary processes.

1. Introduction

The South China Sea is the largest marginal sea with an area about 350,000 km^2 in the western Pacific (Tamaki and Honza, 1991). It is characterized by a rhombic shape with an oceanic basin in the center surrounded by a passive margin to the north, convergent margins to the east and south, and a transform margin to the west (Hayes and Nissen, 2005; Yan et al., 2006; Zhou and Yao, 2009; Franke et al., 2011) as shown in Fig. 1. Its geological evolution and tectonic history have been the foci among studies of marginal sea basins since the pioneering works of Holloway (1982), Taylor and Hayes (1983) and Briais et al. (1993). Some previous works in sedimentation in the northern South China Sea are included here for regional background of source-to-sink studies. For examples, sediments transports in the Kaoping River-Canyon systems in the northern South China Sea (Liu et al., 2009), sediment flux and transport in Taiwan Strait (Liu et al., 2008b), transport of clay mineral species in the northeastern South China Sea

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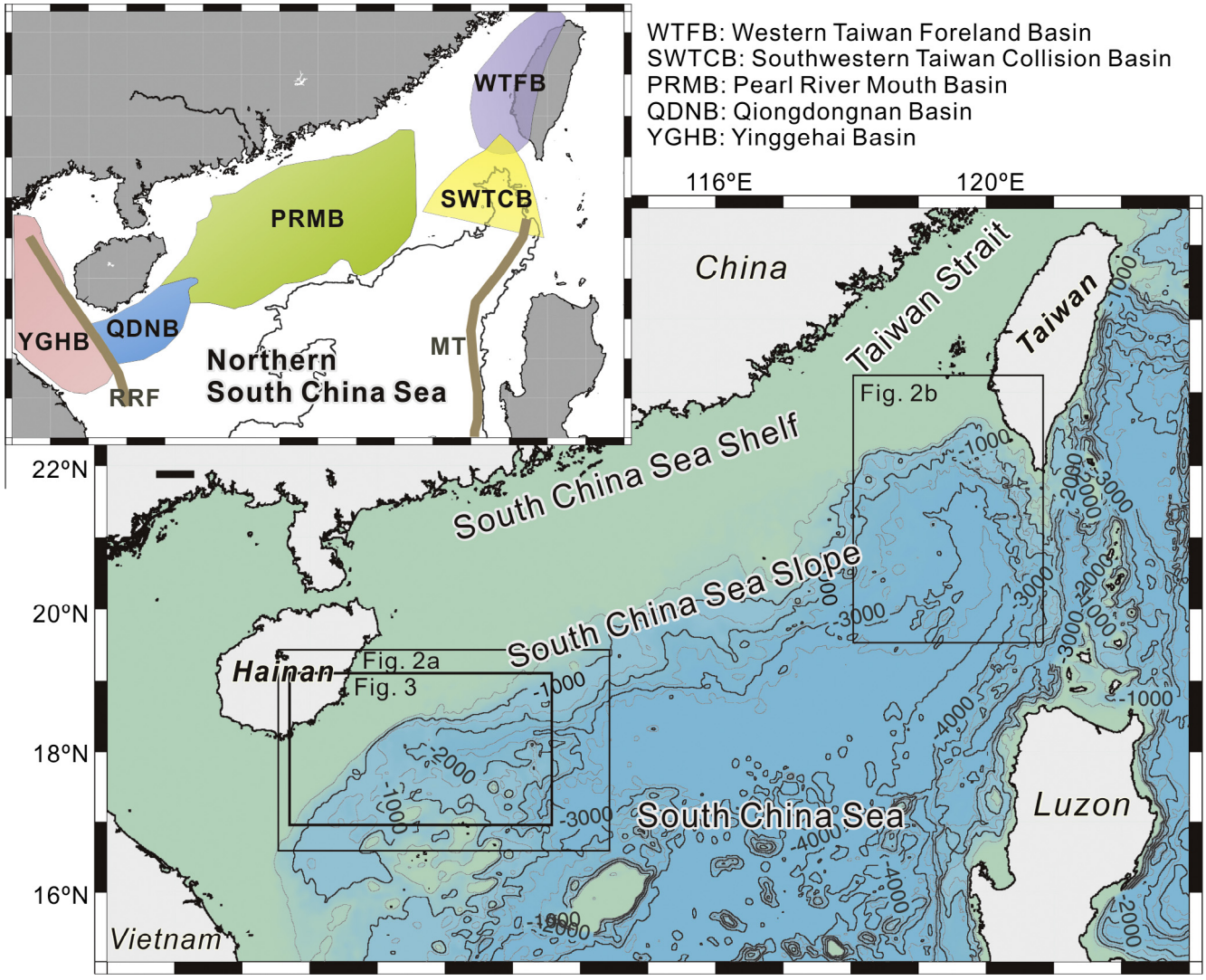

Fig. 1. The basin setting map shows distribution of major Cenozoic sedimentary basins, including the West Taiwan Foreland Basin (WTFB), Southwest Taiwan Collision Basin (SWTCB), Pearl River Mouth Basin (PRMB), Qiongdongnan Basin (QDNB) and Yinggehai Basin (YGHB). Two boundaries are shown in the brown lines, including the Red River Fault system (RRF) and the Manila Trench (MT), respectively. Regional bathymetric map shows the northern continental margin of the South China Sea between the Hainan Island and Taiwan, including the wide shelf and slope up to 4000 m in water depth. Two boxes are study areas including the Qiongdongnan rift basin (Fig. 2a) and the Taiwan collision basin (Fig. 2b). Contour interval at 500 m. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

(Liu et al., 2008a, 2010), terrigenous supply from Taiwan to the northern South China Sea (Wan et al., 2010). Unfortunately, not much work on the sediment routing system in the South China Sea has been undertaken although they are equally important as analyses of tectonics and structures both in academic interests and petroleum exploration. In general, the oceanic basins including marginal sea basins are chief repositories of sediment mainly derived from inland drainage areas. For the margin of the northern South China Sea sediments derived from drainage basins inland are mainly transported transversely across the shelf and slope and deposited in the Pearl River Mouth basin (Fig. 1). For examples, Clift et al. (2002) suggested that the sediments derived solely from the South China Block have been delivered to the northern South China Sea margin since 32 Ma. Li et al. (2003) performed Nd isotopic analysis of sediments from the ODP Site 1148 in northern South China Sea and suggested that sediments were derived from the South China Block later than 27 Ma. On the basis of apatite fission track data Yan et al. (2009) linked denudation history of South China Block and sediment supply to northern South China Sea margin. Although the Tibetan plateau uplifted in late Cenozoic (Clark et al., 2005) would change regional drainage systems (i.e., Pearl River drainage system) and affected source and delivery of sediments into the South China Sea, the South China Block is considered the major sediment supply to offshore basins in northern South China Sea margin.

On the other hand, the collision basin off southwest Taiwan and Qiongdongnan basin are quite different in terms of source to sink, especially in the longitudinal sediment routing mode. Sediments derived mainly from the Taiwan orogen are dispersed and transported longitudinally along the Taiwan-Luzon convergent margin and ultimately deposited in the northern Manila Trench (Lewis and Hayes, 1984; Kalbas et al., 2007; Hsiung and Yu, 2011, 2013) (Fig. 2b). Meanwhile, in the westernmost margin of the South China Sea, sediments mainly from the Indo-China drainage basin (mainly Red River drainage basin) are transported down-slope southeastwards to the Yinggehai basin and then drastically changed the sediment routing to the east due to the boundary fault activity (i.e., the Red River Fault). Mixed with the deposits delivered from the northern continental slope, these sediments are transported along Central Canyon in the Qiongdongnan basin