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Topographic architecture and drainage reorganization in Southeast China: Zircon U-Pb chronology and Hf isotope evidence from Taiwan

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A B S T R A C T

The uplift of Tibet Plateau and the marginal sea spreading have had important influence on the tectonic, landform and drainage system in East Asia, although the marginal sea spreading in shaping the topography and drainage reorganization in East Asia has been still controversial. Here we present U-Pb age and Hf isotopic composition of detrital zircon grains from Cenozoic sedimentary rocks in Taiwan to understand how the provenance and river systems evolved. Our data show that the U-Pb age spectra of detrital zircon grains in Paleogene sandstones are dominated by Yanshanian (180–67 Ma) zircon grains and with subordinate or nil Proterozoic and Archean zircon grains. These results are in contrast to those in Miocene rocks that are dominated by the Indosinian (257–205 Ma) zircon grains together with Yanshanian, Proterozoic and Archean population. The initial Hf isotope ratios [εHf(t)] of the zircon grains also display systematic change in Paleogene and Neogene strata. Our data demonstrate that the Hsuehshan Range and Western Foothills in Taiwan have the same sedimentary sources. The source region of Paleogene strata was mainly located at the coast in southeast China and migrated inland over time. The source might have reached the Lower Yangtze region during early Miocene. Although the mechanism of transport of sediments from the Lower Yangtze region to Taiwan is unclear, we speculate that the Minjiang River might have been larger in Early Miocene than the present and might have delivered inland material along the boundary of Yangtze and Cathaysia Blocks to Taiwan. These were then captured by the Yangtze River systems at some time after Late Miocene. This change corresponds to the time of the drainage reorganization in East Tibet, such as Yangtze River, and the regional subsidence resulting from the opening of marginal sea. The combined effects of Tibet uplift and opening of marginal sea might have shaped the topography and river system reorganization in East Tibet. The evolution of topography and drainage systems in southeast China seems to be mainly controlled by the opening of marginal sea.

1. Introduction

The interaction among tectonics, landforms and drainage systems in East Asia has been the focus of several recent studies (Clark et al., 2004, 2005; Clift et al., 2006; Yan et al., 2011; Zheng et al., 2013; Robinson et al., 2014). The uplift of Tibet Plateau and the opening of marginal sea are among the major tectonic events in East Tibet area. The thermochronological data from the eastern margin of the plateau suggest an important period of plateau margin growth during Cenozoic (Wang et al., 2012). Meanwhile, large-scale rift systems developed in southeast China during Late Mesozoic-Early Cenozoic (Yao et al., 1994), which finally led to the formation of a series of rifted basins and culminated in the opening of marginal seas, such as South China Sea during the Paleogene (Taylor and Hayes, 1980; Briais et al., 1993; Lan et al., 2014). During the transition from rifting to seafloor spreading, a series of breakup unconformities develops in the rifted basins in northern margin of South China Sea (Zhou et al., 1995; Lin et al., 2003; Lan et al., 2014). The diachronous westward younging of these breakup unconformities is consistent with seafloor spreading propagating from east to west (Lan et al., 2014). Although the surface uplift of Tibetan Plateau is believed to have significantly influenced the tectonics, landforms and drainage systems during the Cenozoic in East Asia (Harrison et al., 1992; Burchfiel et al., 1995; Fielding, 1996; Wang, 1998; Li and Fang, 1999; Wang, 2004), the role of marginal sea spreading in shaping the topography of East Asia has yet to be further studied.

The evolution of large drainages such as the Yangtze River has been used to constrain the establishment of topography in large area (Clark et al., 2005; Clift et al., 2006). The evidence of Nd isotope and the detrital zircon grains from the Hanoi Basin, Central Myanmar and lower Yangtze

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suggest that the establishment of the modern drainage systems in East Tibet prior to 23 Ma (Clift et al., 2006; Zheng et al., 2013; Robinson et al., 2014), even though some workers consider that the Yangtze River is younger than 5 Ma (Li et al., 2001; Yang and Youn, 2007; Jia et al., 2010). However, the evolutionary features of river systems in southeast China, such as the Minjiang River (Fig. 1), are scarcely taken into consideration. What was their relationship with Yangtze River, and how did the opening of marginal seas affect their evolution are still ambiguous.

The changes in river discharge must have had a major influence on the offshore sedimentary rocks in passive continental margin of southeast China, which can provide spatial and temporal constraints on the development of regional drainage systems (Clift et al., 2002; Li et al., 2003; Richardson et al., 2011). However, the difficulty in obtaining samples inhibits a better understanding. Based on the study of Nd isotopes of sediments in the northern margin of South China Sea (ODP Site 1148) (Fig. 1), Clift et al. (2002) interpreted the provenance of northern margin of South China Sea as the northern source accompanied by

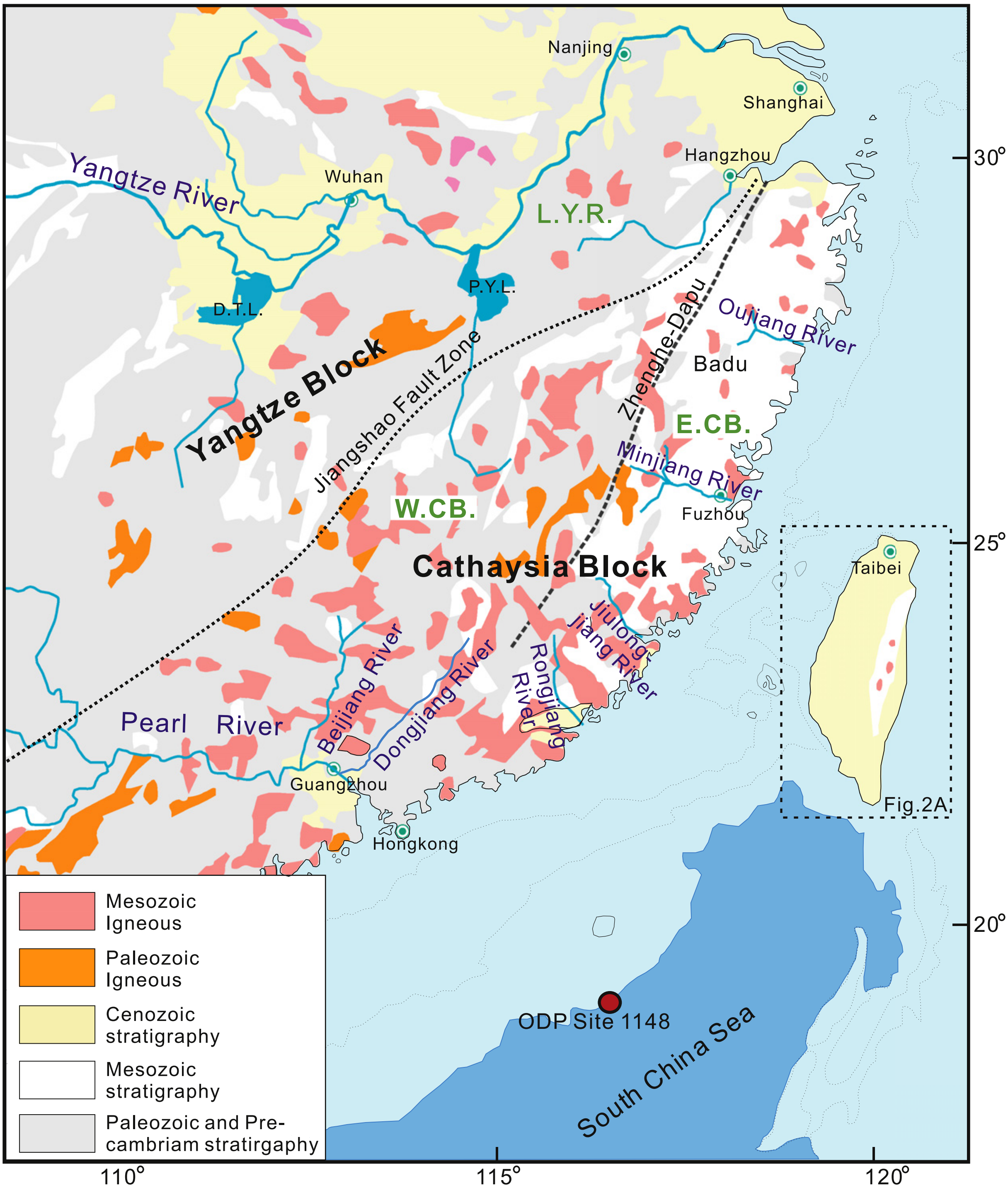

Fig. 1. Simplified geological map of southeast China and distribution of main river systems. The Cathaysia Block has been broadly subdivided into the western and eastern parts along the Zhenghe-Dapu fault according to Chen and Jahn (1998) and Xu et al. (2007). Abbreviations: L.Y.R.: Lower Yangtze Region. E.Ca. and W.Ca: East and West Cathaysia Block. P.Y.L.: PoYang Lake. D.T.L.: Dong Ting Lake.