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New bathymetry and magnetic lineations identifications in the northernmost South China Sea and their tectonic implications

Shu-Kun Hsu, Yi-ching Yeh, Wen-Bin Doo and Ching-Hui Tsai
Institute of Geophysics, National Central University, Taiwan (E-mail: hsu@oc.gep.ncu.edu.tw)

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Abstract

The seafloor spreading of the South China Sea (SCS) was previously believed to take place between ca. 32 and 15 Ma (magnetic anomaly C11 to C5c). New magnetic data acquired in the northernmost SCS however suggests the existence of E–W trending magnetic polarity reversal patterns. Magnetic modeling demonstrates that the oldest SCS oceanic crust could be Late Eocene (as old as 37 Ma, magnetic anomaly C17), with a half-spreading rate of 44 mm/yr. The new identified continent–ocean boundary (COB) in the northern SCS generally follows the base of the continental slope. The COB is also marked by the presence of a relatively low magnetization zone, corresponding to the thinned portion of the continental crust. We suggest that the northern extension of the SCS oceanic crust is terminated by an inactive NW–SE trending trench-trench transform fault, called the Luzon–Ryukyu Transform Plate Boundary (LRTPB). The LRTPB is suggested to be a left-lateral transform fault connecting the former southeast-dipping Manila Trench in the south and the northwest-dipping Ryukyu Trench in the north. The existence of the LRTPB is demonstrated by the different patterns of the magnetic anomalies as well as the different seafloor morphology and basement relief on both sides of the LRTPB. Particularly, the northwestern portion of the LRTPB is marked by a steep northeast-dipping escarpment, along which the Formosa Canyon has developed. The LRTPB probably became inactive at ca. 20 Ma while the former Manila Trench prolonged northeastwards and connected to the former Ryukyu Trench by another transform fault. This reorganization of the plate boundaries might cause the southwestern portion of the former Ryukyu Trench to become extinct and a piece of the Philippine Sea Plate was therefore trapped amongst the LRTPB, the Manila Trench and the continental margin.

Introduction

The South China Sea (SCS) is a wedge-shaped marginal sea, whose oceanic crust is largely distributed in the eastern half of the basin and diminishes toward the southwest (Figures 1 and 2). The formation of the SCS oceanic crust was suggested to be linked to pull-apart basins by left-lateral strike-slip faulting associated with the India-Asia collision (Tapponnier et al., 1982, 1986), a proto-SCS subduction beneath Palawan and northern Borneo (Taylor and Hayes, 1980, 1983; Lee and Lawver, 1995; Hall, 1996; Rangin et al., 1999) or a combination of above two mechanisms (Morley, 2002). Whatever model is preferred, the understanding of the formation age and the distribution of the SCS oceanic crust can provide crucial information on the tectonic evolution of the SCS.

The magnetic lineations in the SCS basin were first recognized by Ben-Avraham and Uyeda (1973). The ages of the SCS oceanic crust have later been identified between 32 and 15 Ma (i.e. magnetic anomaly C11–C5c) by using marine magnetic reversal timescales (Taylor and Hayes, 1980; Hayes and Taylor, 1983; Briais et al., 1993). As shown in Figure 2, the SCS oceanic crust is generally outlined by relatively low gravity anomalies. The mid-ocean ridge of the southwestern basin is also revealed by a relatively low gravity anomaly zone (Figure 2). Relative to the continent–ocean boundary (COB) defined by Briais et al. (1993), the SCS oceanic crust probably extends southwestwards to about 109° E and 8° N, where a N–S trending shear zone probably exists (Figure 2) (Nissen et al., 1995). The COB define by Briais et al. (1993) is generally between the bathymetric depths of 2500 and 3000 m,