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Crustal structures of the northernmost South China Sea: Seismic reflection and gravity modeling

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Abstract

The South China Sea (SCS) is a marginal sea off shore Southeast Asia. Based on magnetic study, oceanic crust has been suggested in the northernmost SCS. However, the crustal structure of the northernmost SCS was poorly known. To elaborate the crustal structures in the northernmost SCS and off southwest Taiwan, we have analyzed 20 multi-channel seismic profiles of the region. We have also performed gravity modeling to understand the Moho depth variation. The volcanic basement deepens southeastwards while the Moho depth shoals southeastwards. Except for the continental margin, the northernmost SCS can be divided into three tectonic regions: the disturbed and undisturbed oceanic crust (8–12 km thick) in the southwest, a trapped oceanic crust (8 km thick) between the Luzon-Ryukyu Transform Plate Boundary (LRTPB) and Formosa Canyon, and the area to the north of the Formosa Canyon which has the thickest sediments. Instead of faulting, the sediments across the LRTPB have only displayed differential subsidence offset of about 0.5–1 s in the northeast side, indicating that the LRTPB is no longer active. The gravity modeling has shown a relatively thin crust beneath the LRTPB, demonstrating the sheared zone character along the LRTPB. However, probably because of post-spreading volcanism, only the transtension-shearing phenomenon of volcanic basement in the northwest and southeast ends of the LRTPB can be observed. These two basement-fractured sites coincide with low gravity anomalies. Intensive erosion has prevailed over the whole channel of the Formosa Canyon.

Introduction

The northernmost South China Sea (SCS) is bounded by the Eurasian continental margin, the Taiwan orogenic belt and the Manila subduction system (Figure 1). There are several models proposing the evolution and formation of the oceanic crust of the SCS. For instance, Taylor and Hayes (1980, 1983) proposed that the SCS was formed during 32–17 Ma (magnetic anomaly C11–C5d). Based on the magnetic data compiled by Chen (1987), Briais et al. (1993) further elaborated that the ages of the SCS oceanic crust could be 32–15.5 Ma (magnetic anomaly C11–C5c). Nevertheless, due to lack of data, the northernmost area of the SCS was rarely studied. Recent marine magnetic data shows that the northernmost SCS contains several almost E–W trending magnetic lineations, belonging to oceanic crust and the age could be as old as 37 Ma (Magnetic anomaly C17) (Hsu et al., 2005) (Figure 1). Therefore, the existence of the oceanic crust of the SCS is extended northwards to north latitude N21°30′ in the offshore area of the southwest Taiwan.

Morphologically, the northernmost SCS is marked by the presence of the Formosa Canyon and some distributed seamounts (Figures 1 and 2) (Liu et al., 1998; Hsu et al., 2005). The northwestern, upstream portion of the Formosa Canyon has developed along a topographic escarpment with a vertical offset of about 300 m (Hsu et al., 2005). It is suggested as the northwestern portion of an extinct transform fault named the Luzon–Ryukyu Transform Plate Boundary (LRTPB) (Sibuet et al., 2002; Hsu et al., 2005). The LRTPB is supposed to be the southwestern termination of the former Ryukyu Trench (Hsu and Sibuet, 1995; Sibuet and Hsu, 1997, 2005). However, the crustal structures of the LRTPB and the northernmost SCS are still poorly known. In this paper, we use seismic reflection and gravity anomaly data to elaborate the crustal structures of the northernmost SCS and off southwest Taiwan.