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Seismic imaging of the transitional crust across the northeastern margin of the South China Sea

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Abstract

Crustal structure across the passive continental margin of the northeastern South China Sea (SCS) is presented based on a deep seismic survey cooperated between Taiwan and China in August 2001. Reflection data collected from a 48-hydrophone streamer and the vertical component of refraction/reflection data recorded at 11 ocean-bottom seismometers along a NW–SE profile are integrated to image the upper (1.6–2.4 km/s), lower (2.5–2.9 km/s), and compacted (3–4.5 km/s) sediment, the upper (4.5–5.5 km/s), middle (5.5–6.5 km/s) and lower (6.5–7.5 km/s) crystalline crust successively. The velocity model shows that the thickness (0.5–3 km) and the basement of the compacted sediment are strongly varied due to intrusion of the magma and igneous rocks after seafloor spreading of the SCS. Furthermore, several volcanoes and igneous rocks in the upper/middle crust (7–10 km thick) and a high velocity layer (0–5 km thick) in the lower crust of the model are identified as the ocean–continent transition (OCT) below the lower slope in the northeastern margin of the SCS. A thin continent NW of the OCT and a thick oceanic crust SE of the OCT in the continental margin of the northeastern SCS are also imaged, but these transitional crusts cannot be classified as the OCT due to their crustal thickness and the limited amount of the volcano, the magma and the high velocity layer. The extended continent, next to the gravity low and a sag zone extended from the SW Taiwan Basin, may have resulted from subduction of the Eurasian Plate beneath the Manila Trench whereas the thick oceanic crust may have been due to the excess volcanism and the late magmatic underplating in the oceanic crust after seafloor spreading of the SCS.

Keywords: High velocity layer (HVL); Magma intrusion; Ocean-bottom seismometer (OBS); Ocean–continent transition (OCT); Passive rift; Seafloor spreading

1. Introduction

Transitional crust between the continent and the oceanic crust, namely the ocean–continent transition (OCT), has been found in many passive non-volcanic continental margins, e.g., Newfoundland (Keen and de Voogd, 1988; Reid, 1994), Iberia (Whitmarsh et al., 1990; Pinheiro et al., 1992; Pickup et al., 1996; Discovery 215 Working Group, 1998; Chian et al., 1999; Dean et al., 2000), Labrador Sea (Chian, 1995; Louden and Chian, 1999) and the northern South China Sea (SCS and Yan et al., 2001; Qiu et al., 2003). The OCT is usually characterized by a crustal thinning due to the continental extension and a high velocity layer (HVL) in the lower crust resulting from serpentinization of the upper mantle or magmatism released by partial melting.

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In the conjugate margins of Newfoundland and Iberia, HVL (7–7.8 km/s) with a low velocity gradient (less serpentinization of peridotites) was imaged and inferred due to mantle serpentinization by the pure shear extension (Pickup et al., 1996; Discovery 215 Working Group, 1998; Dean et al., 2000). On the other hand, in the conjugate margins of Labrador Sea across the North Atlantic (Chian, 1995; Louden and Chian, 1999) and the northern SCS (Yan et al., 2001), the magmatism by the simple shear extension resulted in a HVL (7–7.5 km/s) with a high velocity gradient (basalt, gabbro or mafic gneisses) in the lower crust. However, there is

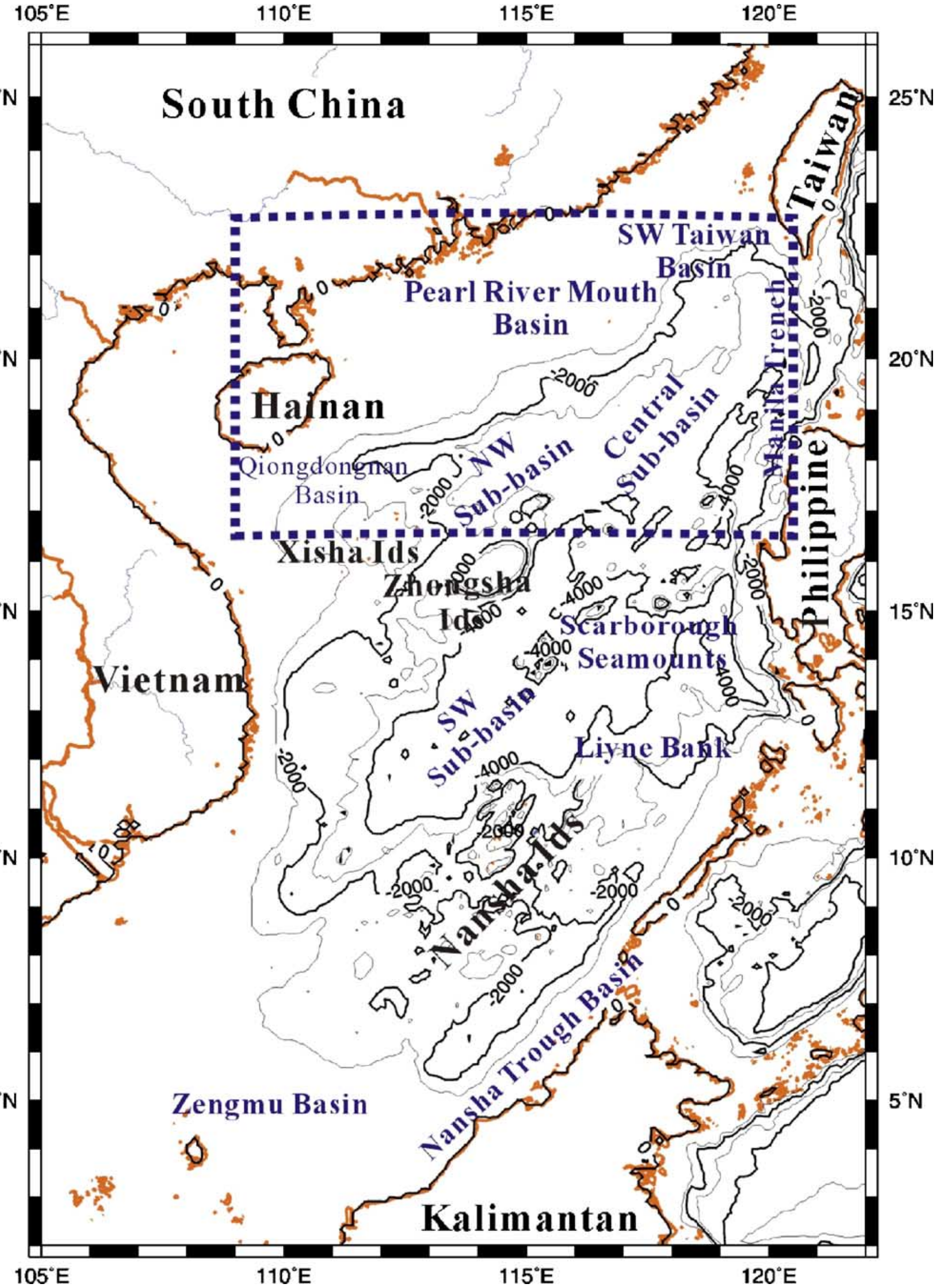

Fig. 1. Tectonic structures and bathymetry (contour interval of 1000 m) of the South China Sea (SCS). SW Taiwan Basin, Pearl River Mouth Basin and Qiongdongnan Basin are located at the northern margin of the SCS. Central oceanic basins include Central Sub-Basin, NW Sub-Basin and SW Sub-Basin. Nansha Islands, Nansha Trough Basin and Zongmu Basin are at the southern continental margin. The dashed box shows the location of Fig. 2.