Paper 63

The geophysical characteristics and evolution of northern and southern margins of South China Sea

XIA KANG-YUAN & ZHOU DI

South China Sea Institute of Oceanology, Academia Sinica

Data of about 40000 km gravity and magnetic measurements, 10000 km multi-channel seismic lines, 20 sonobuoy refraction seismic stations, and 5 heatflow stations have been obtained by our institute in the South China Sea (SCS) during the last ten years. Based on these and other data, the present paper discusses the tectono-geophysical characteristics and evolution of SCS.

On the northern margin of SCS, active explorations for oil and gas have been carried out by Chinese and foreign companies for the past decade. From the continental shelf to the slope, five parallel structure zones have been recognized and named, from north to south, the Wanshan fault-terrace, Northern depression, Central uplift, Southern depression, and Slope volcanic zone. The basement of the margin is the extension of onland Southeast China and consists of the Hercynian foldbelt east of the seaward extension of the NE-trending Lishui-Haifeng fault and the Caledonian foldbelt west of the fault. Both foldbelts were extensively disturbed by Yanshanian magmatic activity. More than 40 exploration wells in the Northern depression and Central uplift zones have encountered this pre-Tertiary basement.

Based on gravity data, the crustal thickness is 25-26 km for the Northern depression, greater than 29 km for the Central uplift, and 22 km for the Southern depression zone. A gradient belt of Moho surface is observed along the lower continental slope. The two seismic lines of Sino-American cooperative two-ship experiment in this sea area gave similar results. The most important finding was a northward dipping fault that exists in the basement along the lower continental slope. This fault is regarded as a detachment fault by Hayes (1989) but as an extinct suture zone by Chinese scientists.

We found a high magnetic anomaly zone extending from the Dongsha Uplift NE-ward to the Penghu Islands and a magnetic quiet zone extending along the lower slope and the edge of the deep-sea basin NE-ward to the northward extension of the Manila Trench at about 21°N. The high magnetic zone is interpreted as the manifestation of a basalt belt. Four wells in the Dongsha Uplift encountered alkali basalt of 45.1–17.1 Ma in age, and in the Penghu Islands alkali tholeiitic basalt and alkali basalt of 16.2-8.2 Ma age are observed. These intraplate eruptions suggest that the northern margin of SCS was an extensional passive margin in the Cenozoic era. In contrast, large amount of Yangshanian granites along the South China coast are of I-type, and Late Yanshanian granites (76-130 Ma) in the basement on the shelf are likely of a similar type. These granites and associated volcanic rocks comprise a magmatic arc associated with the Mesozoic active continental margin along East Asia. The lithospheric fault was probably a segment of the Mesozoic subduction zone, while the thick crust in the Central uplift zone was formed by accretion along this subduction zone. The

Warta Geologi (Newsletter of the Geological Society of Malaysia), Vol. 18, No. 6, November-December 1992

magnetic quiet zone might indicate the remains of the oceanic crust of the Paleo-Pacific.

The southern margin of SCS contains the Nansha block which includes the Liyue Bank (the Reed Bank) and the reef-and-shoal area to the west (the Dangerous Grounds), the Nansha Trough (the Palawan Trough), and the Palawan block. Our multichannel seismic profiles revealed a thick Paleogene sequence lying above thick Mesozoic strata. This Paleogene sequence consists of neritic clastics with clear stratification and widespread distribution. This sequence was later strongly deformed into asymmetric folds and eroded. The unconformity above this sequence has been recognized in several seismic profiles in the reef-and-shoal area. According to a correlation with limited and distant wells, this unconformity is tentatively dated Late Eocene. We name this deformation event the Nansha movement, which was contemporaneous with the first phase of the Zhu-Qong movement in the northern margin of SCS, but under a totally different stress regime. Above this unconformity, the Neogene sequence is thin and mainly as fillings of discrete half grabens in the reef-and-shoal area, but thick and continuous on the Liyue Bank, the Palawan shelf and the Zengmu Basin (the Great Sarawak Basin). This indicates that the reef-and-shoal area has stayed mainly in an uplift state since Late Eocene time, different from the shelf area to its south and east.

The recognition of the Late Eocene compressional event in the Nansha block has significant geological implications in terms of the evolution of SCS. Differing from previous models, we suggest that the Nansha block collided with Paleo-Borneo and was uplifted in Late Eocene time, long before the start of the opening of SCS. Before the collision, the Nansha block was a shallow sea bordering the Paleo South China continent, where marginal rifting had been continuing since the Late Cretaceous. Not until Late Oligocene, the extension stress extended southward to the Nansha block and became strong enough to open SCS. Later in the Early Miocene, Borneo rotated counterclockwisely probably about a pole near the center of the Borneo rather than west of Borneo. The narrow Nansha Trough Basin was formed by the elastic downwarp of the Nansha block under the load of the NW-ward overthrusting Sabah nappe, while the Zengmu Basin was formed by the extension west of the pole of rotation.