Geodynamical features and geotectonic evolution of Kalimantan and adjacent areas

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Abstract: Kalimantan Island is located in the Southeast Asia continental marginal tectono-magmatic mobile zone in the West Pacific Ocean, where the lithosphere of Earth is one of the most complicated tectonic mobile regions on the Earth since Meso-Cenozoic. Based on the geophysical data of the basement and deep structures, the stress field of mantle flow, the maximum principal stress field and geothermal flux, the crustal nature and geodynamical features of Kalimantan Island and adjacent areas were analyzed. Researches on geotectonic movement and evolution of Kalimantan and adjacent areas show that Southeast Asia continental margin crustobody was formed at about middle-late Triassic. In addition, the geotectonic units of the Kalimantan area were subdivided, and characteristics of their geotectonic evolution were discussed.

Key words: geodynamics; Southeast Asia continental margin crustobody; geotectonics; Kalimantan

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1 INTRODUCTION

Kalimantan Island, which is located in the Southeast (SE) Asia continental margin tectono-magmatic zone of West Pacific Ocean, is one of the most complicated tectonic mobile regions since Meso-Cenozoic. Some researchers discussed the tectogenesis and the formation of tectonic systems of Kalimantan Island in light of plate tectonics theory based on the tectonic movement and magmatism, which have some significance to understand the formation of structure, magmatism, metamorphism and the arc-trench-basin system. But deficiency exists in exploring and reconstructing its movement and evolution history. Hilde et al. suggested that in Mesozoic Kalimantan was located in the central-north part of the nowadays South China Sea, and lay close to Hainan Island or Central South Peninsula. In the end of Mesozoic, it began to drift southward to arrive at the place nowadays. But TANG et al. pointed out that there was little comparability in the strata and structural trend between the Kalimantan and Hainan or Central South Peninsula as there existed Nansha, Zhongsha and Xisha continent blocks. Furthermore, Sarawak fault zone could not be linked with Yuanjiang-Honghe fault zone. The active time of the two faults also was not simultaneous. Gatinsky et al. imposed that the Southeast Asia continent was composed of a number of rigid Precambrian continental blocks separated by highly deformed mobile belts. In fact, crust of Kalimantan and Sunda was a whole block whose basement extended to Thailand bay and South China Sea and may be linked with Cathaysia. It was separated by the expanding of Malay basin from Albian to Oligocene.

CHEN demonstrated that the crustobody of Kalimantan experienced geosynclinal, platform, and Diwa geotectonic periods. Further awareness was inferred in this paper based on the research of geology, geophysics, data and analysis of the constitution, growth and development of crust by using historic-dynamic method.

2 GEODYNAMICS FEATURE REFLECTED BY GEOPHYSICAL DATA

2.1 Basement and deep-seated structures

The crustal thickness of Kalimantan and adjacent areas ranges from 25 km to 30 km, as shown in Fig. 1. The districts of thickness larger than 30 km nearly cover the range of continental basement. The thickness of crust becomes thinner from South China Sea basin eastward to Sulawesi Sea, corresponding to the nature of crust changing from continental to incipient or oceanic crust. Deep-fracture zones lie on the transition zone from continental crust to incipient crust, such as the Lupal River Fault zone in the northwest and the Mulatus Fault zone in the southeast.
In Kalimantan Island there are 3 tectonic-magmatic mobile zones from west to east, in consequence, they are Kuching-Budok, central Kalimantan and south Kalimantan mobile zones. These zones are in consistent with the gravity anomaly, and represent the structural framework of basement.

2.2 Geodynamic features reflected by stress field of mantle current

According to the low-grade and high-grade stress field of mantle current of Kalimantan and adjacent areas, the low-grade stress field diverges towards east and converges in the West Pacific. It indicates the mantle current (deeper than 600 km) flows and drags the crust to move towards east and becomes convergent in the West Pacific. The high-grade stress field indicates that there are 2 extension centers of northeast (NE) strike in this region. One lies in the Sulawesi Sea and the other lies to the west edge of Kalimantan Island. To the north of Sarawak, there is a north-north-east (NNE) strike of extension zone, and to the south-east of the island, there is a convergent center. The complicated distribution style implies that the density of shallow mantle disperses extremely non-uniform. The interlaced extension, compression and shearing result in the formation of all kinds of structures in this area.

2.3 Activity of lithosphere reflected by maximum principal stress axis

It can be inferred from Fig. 2 that the strike of maximum principal stress axis changes from NE to north-east-east (NEE) and east-west (EW) from west to east. The distribution of the stress axis can be interpreted by the joint work that the SE Asia continental margin, SE Asia, South Asia crusto-bodies converging with the Indian Ocean crusto-body, and the extending of various makeup of Asia continental margin, and north-west-west (NWW) movement of Philippines crusto-body. LIU got the viewpoint that at the beginning of the late Cretaceous, the creeping toward NE of deep mantle under north Indian Ocean crusto-body is the critical factor that controls the distribution of the tectonic stress field of SE Asia. But in Eocene (about 40 Ma) the direction of mantle creep in Philippines crusto-body turned from north-north-west (NNW) to NWW. So the direction of principal stress axis correspondingly changed due to the balance of stress.

2.4 Character of heat flow in region of Kalimantan

From the heat flow distribution map (Fig. 3), it can be inferred that the heat flow has great variation. High and low values of heat flow distribute as a number of blocks and have not obvious strikes. The area of high values (the maximum value is 140 mW/m²) is located to the north of Sarawak that may result from the deep-seated magmatic activity. The Sulawesi Sea, the area of low values of heat flow (<40 mW/m²) may be the descend center of upper mantle.