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Formation Mechanism of a Magnetic Quiet Zone in the Northern South China Sea

Liu Hong[1,2], Luan Xiwu[1,2], and Guo Lingli[3]

[1]Qingdao Institute of Marine Geology, ,Qingdao, China
[2]Laboratory for Marine Mineral Resources, Qingdao National Laboratory for Marine Science and Technology, Qingdao, China;
[3]Ocean University of China, Qingdao, China

ABSTRACT

The Magnetic Quiet Zone (MQZ) in the northern South China Sea (SCS) was reported first by Taylor and Hayes (1980). Although massive geological and geophysical investigations were carried out, the origin of the MQZ is still not very clear and there are several different views on the formation mechanism of the MQZ (Taylor and Hayes, 1980; Kido et al., 2001; Xia et al., 2004; Wang et al., 2006). We define the distribution of the MQZ according to the results of fault analysis and interface inversion, reference to the regional geological setting and previous study. There are several different views on the formation mechanism of the MQZ. The stress field in the northern SCS is tensional and there are multi-period extensions during the formation and evolution of the SCS. The thinning of the crust leads to the upwelling of deep mantle materials. The elder Mesozoic strata break apart and bog down, and the deep hot materials are upwelled under the effect of the gravity isostatic compensation and fill the material deficiency. Thus, the Curie isothermal interface is uplifted and the thickness of the magnetic layer is thinning. The spreading of the SCS has intimate relationship with the upwelling of the deep hot materials. The vertical upwelling of the deep hot materials promotes the horizontal spreading of the SCS to a certain extent, and the horizontal spreading of the SCS accelerates the vertical upwelling conversely. The South China continental margin began the extension at later Mesozoic. The MQZ was located in the ancient thinning and extension area of the continental margin, where formed a series of NE-SW-trending huge positive regional faults and several graben or half-graben basins. The basins deposited thick Mesozoic sediments, and the magnetic anomaly caused by the Mesozoic and Cenozoic sediments, which had teeny magnetic susceptibility, was very weak. The crust extension led to the deepening of the magnetic basement, and the magnetic anomalies were attenuated. There were multi-period extensions during the formation and evolution of the SCS. The deep hot mantle materials rose under the gravity equilibrium effect of crust extension. The thermal demagnetization of the magnetic layer was the reason of why the Curie isothermal interface rose and the magnetic layer was thinned. The thermal activities were aggravated in the northern SCS after the spreading center was migrated to southward during the seafloor spreading period. After the seafloor spreading period, upwelled mantle materials formed the high velocity layer under the influence of the strong thermal activities. The hot materials cooled down and were magnetized by modern geomagnetic field. The magnetization direction of the high velocity layer was different with ancient magnetic layer (Kido et al., 2001; Xia et al, 2004). Negative magnetic anomalies were added to the ancient positive magnetic anomalies. The magnetic bodies in the MQZ became fragmental because of the influence of the NW–SE-trending fault at Cenozoic, and the magnetic anomalies caused by neighbouring magnetic bodies at low magnetic latitude could cancel each other out (Lüdmann and Wong, 1999). Thus, the total magnetic anomalies were attenuated due to the different magnetization directions, and it was similar with the MQZ in the central and northern Labrador Sea in the north Atlantic (Roots and Srivastava, 1984).