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Post-rift magmatism in the hyper-extended failed rift system (Qiongdongnan basin) and its impacts on the tectonic evolution of South China Sea

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The distribution, morphology, and emplacement timing of igneous rocks in the sedimentary basins are critical to understanding the geodynamics and the tectonic evolution of the basin. The Qiongdongnan basin is one of the largest Cenozoic rift basins on the northwest margin of the South China Sea. This basin is a typical hyper-extended failed rift system, as indicated by the extremely thinning crust, rifting ending (ca. 23 Ma) after the break-up in the SW Sub-basin, continuous post-rift NW-trending faults, and the delayed post-rift accelerated subsidence. Both Multiple Channel Seismic and industrial borehole have revealed two main phases of post-rift magmatism in the basin. A number of volcanogenic complexes, vertical intrusion, sill-fed volcanic mounds have been found in the hyper-extended center, the south edge of the basin, and the southern upheaval where the crust thickness is 26 km. Using biostratigraphic data and sedimentary rate from sedimentary sequences overlying and underlying the igneous rocks, the age of magmatism emplacement can be constrained. The first episode occurred at Middle Miocene (ca. 16∼11.6 Ma) and the second episode happened at Early Pliocene (ca. 3.9 Ma). The first episode of post-rift magmatism occurred after most of the NW-trending faults stopped activities in the eastern hyper-extended center, which coincided with the cessation of seafloor spreading of SCS (ca. 16 Ma). The continuous post-rift NW-trending faults and the magmatic activity during Middle Miocene delayed the accelerated subsidence ca. 12 Ma after rifting. The second episode of magmatism was distributed mainly in the southwest of Hainan Island and southern upheaval of the basin. It has little influence on the subsidence of the basin. The continuous magmatism in the basin indicates frequent magmatism on the SCS margin after the sea-floor spreading. Post-rift magma emplacement may be controlled by the depth of hyper-extended crust, pre-existing fault, and weak edge belt between different blocks. The observed high heat flow and the collected mantle sourced CO_2 in the drilled well indicate one or more geodynamic mechanisms, like mantle plume, mantle convection, and decompression melting. These mechanisms may cause post-rift magmatic activity in the basin.