



Multi-phase volcanisms along a stretched continental crust: insights from Xisha massif, northwestern of the South China Sea margin

Lijie Wang^{1,2}, Fuyuan Li^{1,2}, Baojin Zhang^{1,2}, Ziyang Xu^{1,2}, and Zhe Wang^{1,2}

¹MNR, Key Laboratory of Marine Mineral Resources, Guangzhou Marine Geological Survey, Guangzhou, 510760, China
(ljwang@scsio.ac.cn)

²Southern Marine Science and Engineering Guangdong Laboratory (Guangzhou), Guangzhou, 511458, China

Volcanism occurs close to the rifting active areas, especially in the passive continental margins. Their occurrence can have considerable impacts on the continental lithosphere breakup process, hydrocarbon accumulation system in a basin, and regional heat flows. The Xisha massif surrounded by two hyper-extended continental crust and three oceanic basins that the area is underlain by stretched continental crust in the northwestern South China Sea margin. Sporadic Cenozoic volcanic samples and structures from wells, seismic data, and multi-beam data in the Xisha massif have been previously recognized. This study focuses on describing the igneous structures and mapping the volcanic distributions. With the use of drilled wells with lithologic and stratigraphic information, 2D multiple channel seismic data, and multi-beam data, the occurrence of three phases Cenozoic volcanism were mapped. The first episodic volcanism during the rifting to spreading stage in the South China Sea occurred together with Mesozoic granitic pluton. The drilling samples in the well CK-2 show that Late Eocene to Early Miocene basaltic pyroclastic rocks beneath the thick Miocene reefal limestone. Only five mound shaped structures from seismic profiles located on the basement highs and entirely overlapped by the following carbonates. The second episodic volcanism occurred during Middle Miocene that features volcanic group, isolated volcanic mounds, lava flows, and hydrothermal vents associated with sills in the northwestern Xisha massif. The volcanic groups are mainly present above a NE-SW trended sag and the long axis trends NW, the same as the Middle Miocene active fault orientation in the Qiongdongnan basin. The volume of the largest volcanic group is ca. 504 km³. From the intruded strata and deformational structures of volcanic mounds, sills, and laccolith, we found the third episodic volcanism occurred during Pliocene on a small scale. The igneous bodies mainly distributed in the southern Xisha massif. Distribution and volume of igneous bodies show that Middle Miocene stage magmatic activity is more intense than the others, where volcanism is dominant. Comparing with tectonic stress field, continental crust structures, and sediment thickness, we found the distribution of volcanos is probably related to NE-SW stretching stress field during Middle Miocene. A high vertical pressure caused by 20-25 km's crust thickness and only ca. 1-3 km thickness sediment layer may build a good vertical gradient for magma transport. We indicate the intense Middle Miocene volcanism in Xisha massif is also related to the high velocity layers in the lower crust and caused the high heat flows. These phenomena probably coincided with more magma intruded in the lower crust when plenty of post spreading magmatism emplacement in

the SCS margin.