Mantle source and magma evolution of the dying spreading ridge in the South China Sea

Guo-Liang Zhang[1,2], Matthew G Jackson[3], Wei-Dong Sun[1], Gareth Seward[3]

[1] Key Laboratory of Marine Geology and Environment & Center of Deep Sea Research, Institute of Oceanology, Chinese Academy of Sciences, Qingdao 266071, China

[2] Laboratory for Marine Geology, Qingdao National Laboratory for Marine Science and Technology, Qingdao 266000, China

[3] Department of Earth Sciences, University of California Santa Barbara, Santa Barbara, CA 93106, United States

Corresponding author: Guo-Liang Zhang (zhangguoliang@qdio.ac.cn)

Abstract

The South China Sea developed a seamount chain along the fossil ridge shortly after cessation of spreading. However, it remains enigmatic on the mantle source and magmatic evolution of the dying spreading ridge. IODP Expedition 349 has recovered a shallow volcanic breccia layer with carbonatite clasts and two deeper (upper and lower sections) basalt layers, inter-bedded with hemipelagic sediments, at Site U1431 near the fossil ridge of the South China Sea. Here we show the results of whole-rock major and trace elements and Sr-Nd-Pb-Hf isotopes and high-precision olivine trace element compositions of these basalts. The upper section basalts with unusually high whole-rock MgO contents (up to ~20 wt%) can be attributed to olivine accumulation during off-ridge/intraplate volcanism with lack of a stable magma chamber. The lower and upper basalt sections show distinct geochemical compositions that indicate a compositional change in sub-ridge mantle source. The isotopic compositions of upper section basalts can be explained by mixing between the lower section basalts and the uppermost volcanic clasts with an EM2 type mantle source at Site U1431. A CO_2-rich EM2-type mantle source has likely played a fundamental role in the genesis of the upper section basalts. The MORB type basalts at Site U1431 have bulk-rock low CaO and Hawaii-like high olivine Ni and Fe/Mn and low olivine Ca and Mn that are distinctly different from the normal global MORBs, which we attribute to melting of pyroxenite-rich sub-ridge mantle. We propose that the Hainan plume with a pyroxenitic component has played a fundamental role in the volcanism of the dying spreading ridge of the South China Sea.

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