Passive margin magmatism caused by enhanced slab pull forces

WEI DAN[1, 2], QIANG WANG[1, 2], WILLIAM M. WHITE[3], XIU-ZHENG ZHANG[1], GONG-JIAN TANG[1, 2]

[1]State Key Laboratory of Isotope Geochemistry, Guangzhou Institute of Geochemistry, Chinese Academy of Sciences, Guangzhou 510640, China

[2] CAS Center for Excellence in Tibetan Plateau Earth Science, Beijing 100101, China

[3]Department of Earth and Atmospheric Sciences, Cornell University, Ithaca, New York 14853, USA

Intraplate volcanism is enigmatic, especially continental magmatism on lower plates in subduction zones, which are generally considered to be tectonically inactive and non-volcanic. An example of continental volcanism on the lower plate in a Triassic subduction zone was documented in the southern Qiangtang, central Tibet. The mafic dike swarms were erupted over 4,000 km^2 and dated by zircon SIMS U-Pb to ~239 Ma, distinctly younger than the 283 Ma dikes to the south and slightly older than closure of the Paleo-Tethys along the Longmu Co-Shuanghu Suture at ~233 Ma. The dikes are composed of tholeiitic basalt and exhibit enrichments of light rare earth elements, have modest negative Nb and Ta anomalies, and unradiogeneic Nd and radiogeneic Sr isotopes, distinct from the contemporary OIB-type basalts. Calculated mantle potential temperatures are normal; this and other evidence rules out production by a mantle plume; rather they were produced by partial melting of metasomatized lithospheric mantle at shallow depths as a consequence of regional tectonic extension. They were coeval with the formation of the Garze-Litang back-arc basin in the upper plate, which was produced by the rollback of Longmu Co-Shuanghu Paleo-Tethys oceanic slab. We propose that enhanced slab-pull forces related to that slab rollback resulted in extension, producing the Triassic mafic dike swarms on the passive continental margin of the lower plate as well as the Garze-Litang back-arc basin in the upper plate. Thus, intraplate magmatism on passive margins can be induced by enhanced slab-pull forces associated with subduction.

The rarity of examples of such magmatism may be partly because such margins are more likely to be subducted during subsequent orogenesis; alternatively, it may be mistaken for subduction-related magmatism. Future studies may reveal more examples of such lower plate magmatism.