

Where was the Permian Emeishan mantle plume in southwestern China?

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During the past two decades, extensive geological and geophysical studies have been conducted on the Permian Emeishan flood basalt province in southwestern China, which is interpreted as a large igneous province (LIP). Most previous studies proposed that the Emeishan LIP was sourced from a mantle plume, based on the following lines of evidence: (1) 1-km of domal uplift prior to large-scale basalt eruptions; (2) the spatial distribution of low-Ti and high-Ti basalts from the inner zone to the outer zone of the LIP; (3) the presence of picrite in basalt layers and elevated MgO contents, which suggest high temperatures; (4) rapid eruptions of basalt over a short period of less than 1 Myr; and (5) fluctuations in paleo-temperatures and the occurrence of a mass extinction event.

However, recent structural, petrological, sedimentological, and geochemical evidence, together with precise zircon U-Pb dating, does not support previous interpretations of a mantle plume beneath the Emeishan LIP. Recent data show that the apparent 1 km of domal uplift is an artifact of modeling multi-stage deformation. Furthermore, there is no distinct spatial pattern in Ti-enrichment, only with respect to lower (low-Ti) and upper (high-Ti) profile features. Additionally, the initial response of the lithosphere to mantle upwelling would have been a rift system. Rather than picrite lava, there are mafic-ultramafic intrusions and cumulative olivine phenocrysts with corrosion structures, which cannot be used as evidence of a high-temperature primitive magma. Precise U-Pb age data show that the basalts erupted over a period of 10-15 Myr, but large-scale eruptions occurred rapidly within a period of ca. 5 Myr. However, the record of paleobiological evolution shows that the mass extinction event did not coincide with the large-scale eruptions during the 5 m.y. interval.

The available evidence does not support the hypothesis of a mantle plume beneath the Permian Emeishan flood basalt province. As the Emeishan LIP formed during the assembly of the Pangea supercontinent, the large-scale upwelling of volcanic magma may be explained by horizontal flow of the asthenosphere and northward motion of the Yangtze plate.

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