# No plume, no rift magmatism in the West Antarctic Rift

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**ABSTRACT**

The West Antarctic Rift system is one of the largest areas of crustal extension in the world. Current interpretations of its driving mechanisms rely mostly on the occurrence of one or more mantle plumes that was active during the Cenozoic or the Mesozoic. The plume hypotheses are mainly based on the similarity between the basalts from the West Antarctic Rift and those associated with long-lived hotspot tracks. The geochemical signature of the mafic rocks is indeed typical of ocean island basalts (OIB), from a source with a tendency to high m, i.e., high U/Pb (HIMU) mantle. However, these features cannot be exclusively interpreted in terms of a plume sampling very old slab material recycled at great depth for a long time ($10^9$ yr): a metasomatic event at a time on the order of $10^8$ yr (i.e., Cretaceous) is sufficient to have produced the required source features.

Geometric-chronological relationships between magmatism and local tectonic activity further constrain the scenario. In Victoria Land, the occurrence of plutons, dike swarms, and volcanic edifices since the Middle Eocene indicates that magma emplacement is guided by the dextral strike-slip fault systems that dissect the rift shoulder in this area. The faults were active at their Ross Sea termination in Cenozoic time, coeval with magma emplacement, as demonstrated by the ca. 34 Ma age of a pseudotachylyte generated in the right-lateral fault system exposed in northern Victoria Land. Middle Eocene activity is also inferred for the Pacific termination of the faults from apatite fission track thermochronology. In a wider perspective, these faults are in striking continuity with Southern Ocean fracture zones, and mantle tomography depicts a thermal anomaly of linear (not circular) shape overlapping the belt of the same fracture zones, suggesting that the anomaly is related to lithospheric geometry and movements rather than to deep plumes.

The lack of any decisive evidence for plume activity is thus associated with the evidence that large-scale tectonic features drove magma emplacement: the Cenozoic fault systems reactivated Paleozoic tectonic discontinuities, and their activity is dynamically linked to the Southern Ocean fracture zones. As an alternative to both active (plume-driven) rifting and passive rifting, we propose that lithospheric strike-slip deformation could have promoted transtension-related decompression melting of a mantle already decompressed or veined during the Late Cretaceous amagmatic extensional rift phase.