

# Off-ridge volcanism of fast-spreading ridges &#8212; implications from the southern East Pacific Rise and the Oman Ophiolite

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[http://sepc5077.sci.shizuoka.ac.jp/~guest/Staff/Umino\\_j.html](http://sepc5077.sci.shizuoka.ac.jp/~guest/Staff/Umino_j.html)

Multiple studies have shown that lavas at fast-spreading ridges are not erupted exclusively at the axis but also from near ridge seamounts and other off-axis sites. Dredged samples from the near off-axis northern and southern EPR show NMORB compositions distinguished from on-axis NMORB by their unusually depleted and/or highly variable incompatible elements. It is proposed that the source of the off-axis magmas was depleted in incompatible elements by removal of a small-degree partial melt. Depleted geochemistry of off-axis lavas indicates the complexity of the magma plumbing system beneath intermediate- to fast-spreading ridges, and suggests the presence of discrete magma conduits delivering lava to the surface other than passing through the axial magma chamber. Three possible mechanisms are raised:

- 1) Primitive melts directly fed from deep-seated sills in the lower crust without having been trapped by the axial melt lens.
- 2) Off-axis eruption of primitive magmas as suggested by dunite-wherlite cumulates that intruded from the Moho transition zone up to the sheeted dikes in the Oman Ophiolite. Higher mantle adiabat than the solidus of the lower crustal gabbros yields excess melts in the Moho transition zone which generate the dunite-wherlite intrusions.
- 3) Melts that accumulated and passed through depleted mantle which experienced magma extraction during asthenospheric upwelling.

Backscatter imageries obtained along the southern EPR from 3S to 19S using the [TAMU]2 12 kHz sonars depict a number of young volcanic features which extend as far as 20 km (less than 0.2 Myr) from the ridge axis; extensive lava flows filling basins bounded by ridge-parallel fault scarps and volcanic edifices accompanied by sheet flows aligned subparallel to the ridge axes. High backscatter intensity and fresh surface volcanic features shown by the high-resolution side-scan imageries, and a few dredge samples suggest nearly zero ages for these off-axis flows, some of which have apparent fissure vents more than 1 km outside the summit graben. The ridge-parallel alignment of fissure systems and possible vents strongly suggest that these off-axis flows were accreted to the oceanic crust in an extensional stress field of the plate divergent boundary. Large flows have thicknesses ca. 100 m and volumes up to 12-19 cubic km, comparable to or larger than Icelandic flood basalt lava which erupt every ca. 2000 years and the average annual Global volcanic budget of 4-5 cubic km. Four Shinkai dives were carried out on a large flow field at 14deg S found by NIRAI-KANAI Cruise Leg 1 during July-August 2004. SeaBeam 2112 multibeam mappings show that the flow extends in an area of 49 km X 16 km and covers 342 square km with a volume of 19 cubic km.

So-called off-axis seamounts which appear farther away from the ridge axis than the above near off-axis volcanics are apparently associated with, or fed through a rift system that run oblique to the ridge axes. These indicate the far off-axis seamounts erupted in a different tectonic regime outside the extensional stress field near the ridge axis. Dunite-wherlite intrusions in the Oman Ophiolite that run oblique at high angles to the paleoridge axis could be the roots of such far off-axis seamounts. In contrast, the upper extrusives (Lasail Unit) have more depleted HFSE and REE compositions than the on-axis extrusives (Geotimes Unit) and are partly interbedded with the latter, suggesting their on-axis to near off-axis origin. Moreover, depleted dikes correlatable to the upper extrusives are known among the sheeted dikes, indicating that the upper extrusives erupted in an extensional stress field.