GFDI Colloquium

Modeling mantle flow beneath oceanic plate boundary triple junctions

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We use a three-dimensional numerical model to investigate the general characteristics of mantle flow and thermal structure beneath an oceanic ridge-ridge-ridge triple junction. Triple junctions are the locations where three tectonic plates meet at a single point, and they present a unique opportunity to study three-dimensional mantle dynamics in a tectonic setting considerably different than where only two plates diverge, such as at a mid-ocean ridge. In many prominent oceanic triple junctions, including Rodrigues in the central Indian Ocean, Azores in the northern Atlantic Ocean, and Galapagos in the eastern Pacific Ocean, the slowest-spreading ridge branch intersects the near-collinear faster-spreading branches quasi-orthogonally. A finite element model was used to calculate the steady-state three-dimensional velocity flow field and temperature patterns resulting from advective and conductive heat transfer driven by the diverging lithospheric plates. For the slowest-spreading branch, model results predict a strong component of along-axis velocity directed away from the triple junction. Both upwelling velocity and temperature are calculated to increase along the slowest-spreading ridge toward the triple junction, approaching the upwelling rate and temperature of the fastest-spreading branch. Within 200 km of the triple junction, upwelling velocity is predicted to increase more than threefold along the slowest-spreading ridge. In contrast, the calculated upwelling velocity and temperature for the fastest-spreading branch are not significantly different from the case of a single spreading ridge. For triple junctions where the three ridges spread faster than the Rodrigues Triple Junction system, such as the Galapagos Triple Junction, the contrast in axial upwelling velocity and temperature between the slowest- and fastest-spreading ridges is predicted to be less significant. However, for triple junctions with overall slower spreading velocities, such as the Azores Triple Junction, this contrast is more pronounced.

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GFDI Seminar Room, 018 Keen Bldg.