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Three-dimensional mantle melt generation, migration, and extraction at the Quebrada-Discovery-GoFar fracture zones on the Southern East Pacific Rise.

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The presence of large transform fault offsetting the Mid-Ocean Ridge (MOR) systems influences mantle melting and impacts how melts focus as they migrate through the mantle back to narrow MOR spreading centers. The aim of the present work is to investigate three-dimensional mantle melting processes at the Quebrada/Discovery/Gofar (QDG) fracture zone system located between 3°S and 5°S along the Southern East Pacific Rise. QDG is a fast slipping left-lateral, transform fault system, with a slip rate of 140 mm/yr, characterized by 9 strike-slip transform fault segments and 8 intra-transform spreading centers (ITSCs). Using the observed ridge segmentation, the three-dimensional mantle flow and thermal structure are modeled using a three-dimensional temperature-dependent finite element model, with a viscoplastic approximation for the brittle deformation of the lithosphere. Melt generation, migration and extraction is assumed to occur as a three-step process: 1) melting begins where the mantle reaches its pressure-dependent solidus temperature, 2) the melts ascend vertically through the mantle and are transported along an inclined low permeability barrier toward the ridge axis, 3) melts are extracted in a pre-defined extraction zone. Results indicate that melts are migrating from a large region of the mantle (∼1000 km wide) to the East Pacific Rise ridge axis. Model predictions of crustal thickness variations agree well with previous observations and new gravity data analysis. The observed geochemical variability along the QDG transform faults and their ITSCs indicates that future models need to incorporate multiple, or heterogeneous, sources in order to reproduce the observed range of enriched and depleted elements.