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Influence of “hot” and “cold” spots on structure of the Southeast Indian ridge (numerical and physical modeling)

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The study is dedicated to changes of bottom topography, segmentation and deep structure along the Southeast Indian ridge (SEIR) under influence of “hot” and “cold” zones of mantle. Mantle temperature anomalies correspond to areas of Amsterdam-St. Paul and Kerguelen hotspots (“hot” zone) and Australian-Antarctic discordance (“cold” zone) in the west and in the east of the studied section of the ridge correspondingly. For the study we analyze published data and apply morphostructural analyses, numerical and analogous experimental modeling.
Analyses of published data show a set of peculiarities testifying for decrease of magmatic activity in the rift zone of SEIR in the eastern direction. They are the following: increase of axial depths, depth amplitudes along the axes of 3rd order segments, gravity anomalies in Bouger reduction, Na8 values of dredged basalts; decrease of 3rd order segments lengths and crustal thickness. Eastwards axial highs are replaced by rift valleys through the area of transit morphology. Highs are overlain by axial magmatic chambers, areas of transit morphology have fragmentary axial magmatic chambers, valleys are absent of them. All these signatures testify for decrease of mantle temperature.
Using published estimates of mantle temperature and crustal thickness and known values of spreading rate we conducted numerical modeling of thermal and rheological state of subaxial lithosphere of the ridge. Modeling showed that thickness of the layer with brittle deformations increases eastwards from 1-2.5 km in the vicinity of Amsterdam-St. Paul hotspot to 3-5 km in the area of Australo-Antarctic discordance. Modeling showed progressive changes of geometry and depth of axial magmatic chambers of subaxial lithosphere with increase of distance from hotspot. Thus, changes of mantle temperature control extent of magmatism, geometry of axial magmatic chambers, thermo-rheological properties of subaxial lithosphere and deep and surficial structure of the axial zone.
Considering all the data on the ridge structure and results of numerical modeling we conducted analogous experimental studies. In the area of modeled hotspot rift axis draws the spreading axis to itself, the area of anomalously heated lithosphere with flattened topography and linear spreading axis forms in the area of modeled hotspot. Area with highly rugged topography and frequently offset nonlinear axis forms in the vicinity of modeled coldspot.