EGU22-12218
https://doi.org/10.5194/egusphere-egu22-12218
EGU General Assembly 2022

Current geodynamics and evolution of Tjörnes transform zone, North Iceland

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Tjörnes transform zone (TFZ) is complicated fracture zone in North Iceland connecting Kolbeinsey ridge and Northern rift zone of Iceland. It includes several different structures such as segmented oblique rift, amagmatic rifts and oblique slip fault zones. They developed consequently since ca. 9 Ma. The aim of this work is to determine current geodynamic activity and ratio of tectonic and magmatic activity of each structure and adjacent structures of Mid-Atlantic ridge (MAR) basing on normal faults morphometric parameters and to reconstruct evolution of TFZ by physical modelling. Morphometric analysis is based on multibeam bathymetry data of Marine and Freshwater Research Institute in Iceland and ArcticDEM digital elevation model. There were collected data on more than 900 normal faults on five parameters: heave, thrust, length, distance between faults and maximum profile curvature. They reflect recent rate of horizontal and vertical deformations and morphological age of the normal fault. Heave and distance ratio shows the relative intensity of tectonic and magmatic activity. The results show that structures have different level of recent tectonic activity and therefore, are on different stages of their evolution. In addition, they have various tectono-magmatic ratio that proceeds from their development stage, width of faulting zone and mantle structure. Physical modeling is based extending setting with mineral oil that have numerical resemblance with oceanic crust in density, shear modulus and thickness. Two-layered model have elastic bottom layer, brittle top one and local heating source corresponding to Icelandic plume impulses. Initial configuration reflects two spreading segments of MAR that develop transform zone in conditions of crust thinning in direction out of Icelandic plume center. In result of their interaction is generation of overlapping spreading centers. One of them became extinct and another one develops into transtensive transform zone, which corresponds to Husavik-Flatey oblique slip fracture zone (HFFZ) and adjacent amagmatic rift. Activation of local heating source rejuvenates extinct branch of the overlap and generates subparallel to extension direction rifting fractures reconstructing Grímsey oblique rift with high magmatic activity. HFFZ activity abruptly declines. In conclusion, consequent development, activation and decline of structures correctly correlate with results of morphometric analysis and reflect the development stages of each structure. The specific current structure of TFZ is determined by initial development of overlapping spreading centers and their control by Icelandic plume magmatic impulses.