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New insights into divergent margins development: an example from the North Volcanic Zone, Iceland

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In the present work, we have investigated how shallow crustal deformation can occur along spreading plate boundaries, by especially focusing on the development of fractures in the Icelandic Rift, where mid-oceanic ridge formation can be studied directly in the field. We chose, as key site for our study, the Theistareykir Fissure Swarm (ThFS), with particular attention to its central and southern sections. The ThFS is located in the north-eastern part of Iceland and belongs to the North Volcanic Zone. With the goal of better understanding how rifting processes work, we performed a detailed field study of the kinematics and propagation of 33 main Holocene normal faults belonging to the ThFS; moreover, we mapped 568 tension fractures. We studied the fault slip profile, both for single structures and the whole rift, in order to figure out the direction towards which each single fault or the whole rift zone is propagating. Fault slip data have been collected through an extensive field survey, during which we gathered 696 vertical offset measurements.

Analyses of the cumulative fault slip distribution show that there are two opposite directions of fault/rift propagation. This study has led us to observe a certain relationship between fault distribution and the active magmatic area: As a matter of fact, the surveyed structures have been spreading both northward and southward of the Theistareykir volcanic centre. In this scenario, the two opposite propagation directions may be due to the interaction between fault development and dike intrusion caused by a shallow magma chamber.

In regard to this hypothesis, we observed that the southward-directed group of faults, as well as the northward-directed group of faults, developed outward from the Holocene Theistareykir volcanic canter, for which interferometric/GPS data indicate an inflating shallow magma chamber throughout 2006-08. Therefore, our analyses suggest that faults and tension fractures may propagate towards a preferential direction following repeated dyke intrusions from the magma chamber along the plate margin.

This evidence may reflect a scenario whereby natural rift propagation can be hindered by a developing shallow magma system, and the stress field can be influenced by the effects of both regional tectonic forces and local magma ones.