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Dike controlled low-temperature hydrothermal activity in far off-axis regions of NW Iceland

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Iceland provides a unique opportunity to make direct observations of the volcano-tectonic settings of active hydrothermal systems both on- and off-axis at slow-spreading ridges. High-temperature systems are associated with active volcanism and rifting of neo-volcanic zones, in a way similar to that known from the seafloor. However, a great majority of geothermal activity in Iceland is represented by low-temperature systems confined to off-axis Quaternary and Tertiary formations (>3.3 M.y). Despite extensive study of these systems, one general model explaining their geological framework has not yet to be presented. However, theoretical calculations indicate that existence and heat output of low-temperature systems is controlled by the temperature and stress conditions in the crust, in particular the local stress field, which controls whether fractures and crack are available for the heat-mining process and how fast these fractures can migrate downward. In seismically active regions of Iceland, geothermal activity focuses along active faults and resulting ruptures where seismicity is the shallowest (<5 km), indicating that repetitive earthquakes likely continuously control geothermal activity and that fluid circulation may be relatively shallow.

Results obtained during fieldwork from autumn 2013 in far off-axis regions of Iceland (Westfjords Peninsula) show a significant correlation between low-temperature hot-springs locations and the presence of basaltic dikes cross-cutting the sub-horizontal lava sequence, with 88% of all hydrothermal manifestations occurring in the direct vicinity of a dike or occupying related secondary fractures. There is very little seismic activity in the Westfjords and this, together with the field research suggests that faults there are no longer active and so cannot support fluids migration; instead, only dikes provide open, permeable and deep circulation pathways. Relatively high-temperature secondary mineralization (e.g. chlorite and epidote) of exposed dikes implies that hydrothermal circulation occurred at the time of intrusion and/or during their initial cooling.