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Magma-tectonic interactions in an area of active extension; a review of recent observations, models and interpretations from Iceland

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The geological setting of Iceland provides rich opportunities of studying magma-tectonic interactions, as it constitutes Earth's largest part of the mid-oceanic ridge system exposed above sea level. A series of volcanic and seismic zones accommodate the ∼2 cm/year spreading between the North-American and Eurasian plates, and the Icelandic hot-spot conveniently provides the means of exposing this oceanic crust-forming setting above sea-level.

Both extinct and active plumbing system structures can be studied in Iceland, as the deeply eroded tertiary areas provide views into the structures of extinct volcanic systems, and active processes can be inferred on in the many active volcanic systems. A variety of volcanic and tectonic processes cause the Icelandic crust to deform continuously, and the availability of contemporaneous measurements of crustal deformation and seismicity provide a powerful data set, when trying to obtain insight into the processes working at depth, such as magma migration through the uppermost lithosphere, magma induced host rock deformation and volcanic eruption locations and styles.

The inferences geodetic and seismic datasets allow on the active plate spreading processes and subsurface magma movements in Iceland will be reviewed, in particular in relation to the Northern Volcanic Zone (NVZ). There the three phases of a rifting cycle (rifting, post-rifting, inter-rifting) have been observed. The NVZ is an extensional rift segment, bounded to the south by the Icelandic mantle plume, and to the north by the Tjörnes transform zone. The NVZ has typically been divided into five partly overlapping en-echelon fissure swarms, each with a central main volcanic production area. Most recently, additional insight into controlling factors during active rifting has been provided by the Bárðarbunga activity in 2014-2015 that included a major rifting event, the largest effusive eruption in Iceland since 1783, and a gradual caldera collapse.

It is evident from available datasets that improved rifting-cycle models do need to incorporate realistic lithospheric properties, as well as the dynamic transport of magma, in order to reproduce the variety of observations, and provide means of forecasting large future dyking events and eruptions at active rifting segments.