Off rift and on rift volcanism along the southern most extremity of the Reykjanes Ridge.

Ármann Höskuldsson
Fernando Martinez
Richard Hey
University of Iceland, Science Institute, University of Hawaii, SOEST.

The north Atlantic igneous province

Off rift volcanism in Iceland, Snæfellsnes and Öræfajökull-Snæfell
Reykjanes mission in 2007 reveals the northernmost part of the Reykjanes ridge.

Reykjanes 2007, first central volcano and caldera to be observed on the Reykjanes ridge.

Width of the plate boundary is about 10 km and no volcanism observed outside the boundary.

Down to about 61°N only few vents are observed that do seem to have erupted after the plate left the 10 km wide plate boundary.
The survey in 2014 was to look at the evolution of the plate boundary towards southernmost extremity of Reykjanes ridge.

Close up of the research area, it covers about 96,000 km$^2$ and extends south of the Bight fracture zone to about 56°N.

During the mission magnetics and gravity was collected to keep track of time and crustal variations.

- Magnetic irregularities here indicate the arrival of the Reykjanes Ridge into the area.
- The magnetic variations in the crust are expressed by colors from blue to read. Where the hotter colors indicate normal magnetism and the colder colors reverse magnetization of the crust. The current plate boundary is shown in read.
The active plate boundary

Reykjanes ridge faulting is highly oblique while the rift faulting is orthogonal to rift direction.
Segment south of Bight fracture zone shows typical orthogonal rift/fault relation.

Numerous off rift volcanoes are observed on this segment, extending up to 60 km west of the plate boundary and 45 km east of the boundary.

Oblique faulting of Reykjanes ridge are due to overprinting of the plate boundary propagating southward from Iceland, driven by the Icelandic Hot spot.

The volcanism on the plate boundary is characterized by en-echelon volcanic ridges made of pillow lava and lava flows. Axial calderas and craters are common within the rift valley.
Close up of the axial caldera that measures 3.5x1.8 km. Plate boundary is here about 12 km wide. As new crust drifts off it is extensively broken up and uplifted, destroying almost entirely the volcano formations formed at the boundary. However some craters are observed within the broken part indicating that it is formed in an off rift eruption.

Off axis volcanism to the west of the plate boundary. Here there are three volcanoes lying on top old faults but still do not show any extensive faulting. Age of crust here about 10-12 Ma.

West of the plate boundary in about 9-10 Ma crust, several volcanoes lining up along the Reykjanes ridge fault lines show no to limited tectonic faulting, indicating off rift volcanism.
Reykjanes ridge, propagation and relocation of the plate boundary and decoupling of transform faults.

Currently the Bight transform fault is under influence of the Reykjanes ridge. We observe the that the Ridge over took the transform fault just north of it some 500 Ka ago and has since formed a stable plate boundary across it and thus deactivated the transform fault.

With aid of the magnetics we observe that the Bight transform fault is slowly being deactivated. First the plate boundary south of it is relocated towards the axis of the Reykjanes ridge and then it should be able to cross the boundary.
Oceanic core complexes are numerous in the research area. Reykjanes ridge south

Oceanic core complex at the transform zone north Bight. No volcanism was observed in relation to the OCC.

Geology and tectonics within the survey area indicate that the Reykjanes ridge has been propagating southward for the past 20-25 Ma and is currently reaching the Bight area. Following the propagation, relocation of the plate boundary takes place, however, volcanism can still survive the relocation although its intensity is drastically reduced. Off rift volcanism observed within the research area could be of alkaline variety similar to what is observed in present day Iceland.
V shaped ridges observed in the gravity anomalies at the Reykjanes ridge do indicate that the ridge is propagating towards south. The propagation has been driven by the Icelandic hot spot for the past 25 Ma. Off rift volcanism is a further proof for the plate boundary relocation due to rift propagation.

Takk fyrir