Recent seismic swarms in the Tjornes fracture zone, N-Iceland

Kristín Jónsdóttir1, Gunnar B. Guðmundsson1, Luigi Passarelli2, Sigurjón Jónsson2, Yesim Cubuncu1, Thomas Lecocq3, Corentin Caudron4, and Felix Rodriguez Cardozo5

1Icelandic Meteorological Office, EoS, Reykjavik, Iceland (kristinj@vedur.is)
2King Abdullah University of Science and Technology (KAUST), Saudi Arabia
3Royal Observatory of Belgium, Brussels, Belgium
4University Savoie Mont Blanc, Chambéry, France
5Universidad Nacional Autónoma de México (UNAM), Mexico

The Tjörnes fracture zone (TFZ) in N-Iceland is a seismically active zone with on average 4000 earthquakes detected annually since 1993 by the regional seismic network operated by the Icelandic Meteorological Office (IMO). Most of the earthquakes occur offshore and with only one seismic station on the Grímsey island north of Iceland, the seismic network detects earthquakes down to magnitude M-0.5. The fracture zone, essentially a transform between the northern volcanic zone of Iceland and the Mid-Atlantic Ridge north of Iceland, has three major segments; the Grímsey Oblique Rift (GOR) farthest to the North which accounts for 60% of the seismicity of the TFZ, the Húsavík-Flatey Fault (HFF) in the middle, where 38% of the TFZ earthquakes occur and the least active Dalvík Lineament (DL) farthest to the south (only 2% of TFZ seismicity). The IMO’s seismic catalogue clearly draws up the most active segments of the TFZ, where each extends laterally roughly 100 km. The largest earthquakes occur on the HFF where the accumulated seismic moment release is an order of magnitude higher than the GOR and three orders of magnitude higher than the DL.

There are other interesting differences between the segments. There are several known central volcanoes aligned along the GOR and the oblique rifting is likely to cause both tectonic and volcanic seismicity which shows up as a catalogue of many but similarly sized earthquakes, in other words a catalogue with a higher b-value than the neighbouring HFF. Despite these differences, seismic swarms, without a clear mainshock or aftershock sequences, counting thousands of earthquakes with a duration of a few days up to weeks, are recorded every 2-3 years both in GOR and HFF. In late March 2019, one of this seismic swarms took place on GOR, mostly on a single NNE-SSW striking fault near Kópasker. Relative earthquake locations draw the fault up nicely and in addition a few shorter faults with similar strike of 15°deg. The temporal evolution of the swarm shows an upwards migration and how the seismicity starts at the middle of the fault, jumps a little to the north and migrates in two days to the southern end of the fault over 7 km. When that point is reached, the largest earthquake in the swarm takes place, M4.2, however in the very northern end of the fault. The focal mechanism of this largest event shows a left-lateral strike-slip as do the smaller earthquakes. A b-value plot of the 2300 earthquakes that were recorded
during the swarm reveal a value of 1.2, which is typical for volcanic seismicity. The size of active fault is considerable larger than expected from a M4.2 earthquake and the question rises if part of the motion is taken up as aseismic slip.

We will present examples of recent swarms in the TFZ along with new results of a cross-correlation study of the waveforms recorded during the swarm activity.