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Stress changes induced at neighbouring faults by the June 2000 earthquakes, South Iceland Seismic Zone

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The Icelandic rift system belongs to the Mid-Atlantic Ridge and is connected to the offshore Reykjanes and Kolbeinsey ridges by two active transform zones. Plate separation occurs at a rate of nearly 2 cm/yr along the N105°E direction. With respect to the Icelandic Hotspot, westward plate velocities in Iceland are 1.8-2.2 cm/yr for North America and 0-0.4 cm/yr for Eurasia, resulting in a westward displacement of the Icelandic Rift relative to the hotspot. Rift jumps occur when the plate boundary has migrated to a critical point to the west, and a new rift develops above the hotspot apex while the old rift is dying out. The two active transform zones, the Tjörnes Fracture Zone (TFZ) and the South Iceland Seismic Zone (SISZ), resulted from such eastward rift jumps.

Our study focuses on the SISZ which is an onland, E-W trending transform zone where N-S trending right-lateral strike-slip faults accommodate left-lateral transform motion as revealed by historical seismicity. During the most recent seismic crisis, in June 2000, two major earthquakes of magnitude (Mw) 6.4 occurred along N-S right-lateral faults in the central segment of the SISZ.

The high sensitivity SIL (South Iceland Lowlands) seismic network run by the Icelandic Meteorological Office (IMO) provided a complete record of earthquakes down to magnitude Mw = -1. Here, we present an analysis of this earthquakes sequence in term of stress regimes in order to examine the response of two faults that did not experience significant motion during the earthquakes, and hence to determine how far such fault zones provide information about stress changes in space and time when large earthquakes occur at distance of some tens of kilometres. The faults considered are the Skard and Leirubakki faults, along which large earthquakes and significant displacement occurred in the past

Using seismological data recorded from 1991 to 2007, we carried out stress inversion of focal mechanisms of 1,340 earthquakes that affected the Skard and Leirubakki faults, eastern SISZ. Not only did the inversion show typical deviations of stress across the faults, it also revealed anticlockwise and clockwise rotations of stress axes with time. Numerical models of the Leirubakki Fault show that these rotations are consistent with the mechanical effect of a lowered friction coefficient in post-seismic period relative to pre-seismic period. The Skard Fault reveals a more complex behaviour associated with a higher post-seismic friction, resulting from a higher density of pre-existing fracturing and probable stress interaction between faults. Our results suggest that faults where micro-earthquakes occur during neighbouring major seismic events may undergo significant stress changes at the scale of several kilometres and on timescales of several years