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Structural analysis and tectonic activity of the Húsavík-Flatey Fault in north Iceland, from aerial images and multibeam bathymetry

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The Húsavík-Flatey Fault (HFF) in northern Iceland is a 100-km-long right-lateral transform fault, accommodating an offset of the mid-Atlantic Ridge along with the Grímsey Oblique Rift (GOR), which consists of a set of left-stepping en-echelon basins. The HFF together with the GOR accommodate 18 mm/yr of transform motion between the onshore Northern Volcanic Zone (NVZ) and the Eyjafjarðaráll Basin, which is the magma starved southern continuation of the offshore Kolbeinsey Ridge. Large earthquakes occurred on the HFF in 1755, 1838 and 1872, with estimated magnitudes between 6.5 and 7, and recent geodetic studies have inferred a slip-rate of 6 to 9 mm/yr along the fault. Thus, the HFF poses a significant seismic hazard to northern Iceland, particularly to the town of Húsavík, which is located on the fault. Because the fault orientation is not perpendicular to the main spreading center, significant vertical deformation occurs along the HFF in addition to strike-slip, resulting in an overall trans-tensional fault system. While the HFF is mainly located offshore, the 20-km-long onshore part consists of several sub-parallel sections and pull-apart basins, between Húsavík and the NVZ. The fault structure, the map of the active fault strands, and the geological slip-rate of the HFF remain yet not well constrained.

We use high-resolution imagery to map the HFF and to measure geomorphic offsets along the fault, to better characterize its structure and late-Quaternary tectonic activity. In particular, we compute orthomosaic images and Digital Surface Models (DSM) from high-resolution drone images (centimetric ground resolution) to map fault sections and structures at local scale, and to estimate the late Pleistocene-Holocene deformation of the HFF from offset stream channels, lava flows, and post-glacial morphologies. In addition, we use satellite and aerial images to map the several segments of the HFF at a larger scale, and to study the regional kinematics of the fault. Similarly, we use multibeam bathymetric and subbottom chirp sonar profiling data to map the 80-km-long offshore segment of the HFF and to characterize the post-glacial deformation along the offshore fault segment, between Húsavík and the Eyjafjarðaráll Basin. These onshore and offshore observations along the entire fault system allow us to better describe the HFF and the associated hazard for northern Iceland.