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Asymmetric active seismicity along the ultra-slow spreading Gakkel Ridge

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Ultra-slow spreading ridges are frequently characterised by spreading segments that are largely magma starved. Spreading along such segments does not occur by crustal creation/accretion processes such as intrusions, diking and volcanism, but rather by mechanical extension of the lithosphere, exposing the mantle to seafloor where it interacts with seawater to form serpentinite. Such exhumation is thought to occur along detachment faults that form concave down surfaces and produce an extensional geometry that is highly asymmetric. A consequence of all models that have been developed to simulate this type of extension is that stress and strain is focused primarily on the footwall block of the spreading system. This would predict that at any given time, only one side of the system should show active seismicity.

In 2001, the Gakkel Ridge was extensively sampled by dredging during the AMORE cruise. These samples showed that the ridge is divided into distinct segments that today are either magmatically robust (only basalts recovered) or magmatically starved (dominantly serpentinised peridotite and gabbros recovered). We extracted earthquake data along the Gakkel Ridge from the global catalogs to investigate if these distinct segments exhibit any differences in active seismicity. We show that the western volcanic zone shows symmetric active seismicity, with earthquakes occurring on both sides of the ridge axis along a relatively restricted region. In contrast, the sparsely magmatic zone shows active seismicity dominantly along along the southern half of the ridge, with comparatively little seismicity to the north. These results are consistent with the proposed models for the formation of amagmatic spreading centers.