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Seismoacoustic evidence for volcanic activity at eastern Gakkel Ridge in 2001

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The active mid-ocean ridge of the Arctic Ocean, named Gakkel Ridge, is the slowest spreading ridge of the global system of mid-oceanic ridges with full spreading rates declining from 13 to 6 mm/y from west to east. Geological models of seafloor spreading processes predict a decreasing intensity of magmatic processes with the spreading rate. Gakkel Ridge was expected to show amagmatic extension accompanied by tectonic earthquakes when in 1999, a swarm of 250 volcanic earthquakes, recorded by the Global Seismological Network, signalled volcanic activity at the slow eastern end of Gakkel Ridge.

In summer 2001, the Arctic Mid-Ocean Ridge Expedition (AMORE2001), an multidisciplinary expedition of the Alfred Wegener Institute for Polar- and Marine Research in cooperation with national and international partners, set off to examine the Gakkel Ridge. During AMORE2001, a first attempt was made at recording the microearthquake activity of the ridge which allows important insights into the character and dynamics of ongoing processes at the ridge axis.

Due to the permanent ice-cover of the Arctic Ocean, the use of ocean-bottom seismometers bears the risk of instrument and data loss. In this pilot study, we used for the first time ice-floes as platforms for small seismological arrays. The arrays consisted of 4 three-component seismometers arranged on a circle of 1 km in diameter with one seismometer in the centre. Three such arrays were deployed in different rift segments and recorded seismic activity continuously for 5 to 11 days. The array technique allowed to distinguish clearly between icequakes and earthquakes and to localise the earthquake source.

All of the arrays recorded numerous tectonic microearthquakes in the central rift val-

ley and on its flanks. In addition, the seismological array positioned closed to the site of the volcanic eruption at eastern Gakkel Ridge in 1999, recorded two remarkable swarms of acoustic signals, totalling more than 200 events. These signals consist of one to three impulsive phases, representing the direct water wave and multiple reflections at the sea-floor and the sea-surface of the same explosive event. The array was highly sensitive to the propagation direction of these acoustic signals, allowing to determine the backazimuth to within 3 degree. The distance to the source was estimated from the differential travel time between the multiples. The acoustic source is localised at the northern rim of the lava flow of 1999, clearly away from USCG Healy operating in the area. The lack of seismic phases travelling through the crust indicated a source at the sea-floor with effective radiation of energy into the water column. Similar triplicate explosive acoustic signals, recorded by an ocean bottom hydrophone off Hawai'i, are produced at the ocean entry of the Kilauea lava (Caplan-Auerbach & Duennebier, 2001). We therefore postulate that we monitored the sounds of lava emplacement at the seafloor and hence ongoing eruption activity at the prominent volcanic centre of eastern Gakkel Ridge.