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Explosive volcanism on the ultraslow-spreading Gakkel Ridge, Arctic Ocean

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The Gakkel Ridge, stretching ˜1800 km across the Arctic Basin, is the ultraslow spreading end-member (6-14 mm yr-1, full-rate) of the global mid-ocean ridge system. Conductive cooling and suppression of mantle melting appear to have a profound impact on crustal accretion processes at the Gakkel Ridge, but our ability to study this region has been limited by its remote location and ice cover. \We present results from the first-ever photographic survey of "zero-age" seafloor on the Gakkel Ridge at 85°E (˜9 mm yr-1, full-rate). Our imagery reveals that the axial valley, which was the site of a major earthquake swarm and presumed volcanic eruption in 1999, is blanketed with pyroclastic deposits. The pyroclasts, which cover an area of at least 10 km2 and constitute the most extensive unconsolidated deposits ever found in the ocean, appear to discharge from small, cratered, volcanic features found within the axial valley. Pyroclasts obtained using a suction sampler include bubble wall fragments (limu o' Pele) that require at least 13.5 wt% CO2 in a fragmented magma to form at the axial valley depths (˜4000 m). These high levels are interpreted to result from the accumulation of exsolved volatiles in a magmatic 'foam' layer within a deep crustal magma chamber. The pressurized foam may explode energetically when the lid is fractured, and can discharge magmatic jets into the water column to deposit pyroclastic fragments over large areas of the deep seafloor. We find evidence for multiple episodes of both vulcanian explosions and Hawaiian style fountaining, demonstrating that explosive discharge of volatile-rich magmas has been a ubiquitous, recent, process at the 85°E site. These results raise important new questions regarding the accumulation and discharge of magmatic volatiles at ultra-slow spreading ridges.