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The extent of the ice sheet in the area of the Reykjanes Ridge at maximum of the last glaciation: new insights

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It is accepted that during the Last Glacial Maximum (LGM), about 21,000 years ago, the head of the Icelandic ice sheet was extending on a shelf area of the Iceland plateau, beyond the present-day coastline of the island. Attempts at locating the ice sheet edge were made many times, mainly on the basis of the recognition of the end moraines and other marginal glacial landforms on submerged parts of the Iceland plateau. There is, as yet, no full agreement on the exact reconstruction of the extent of the Icelandic ice sheet during the LGM. Both the thermodynamic models of the ice sheet and the glacial landforms discovered around Iceland indicate that the ice sheet has slipped onto (perhaps beyond) the insular shelf; however, determining the exact extent of the ice edge within its individual sectors can be problematic, mainly due to insufficient recognition of underwater glacial depositional or erosional landforms.

We present the results of the scientific expeditions A200608 from 2006 carried by former Marine Research Institute in Reykjavik on board R/V Árni Friðriksson and MSM75 from 2018 carried by GEOMAR on board the R/V Maria S. Merian. The aim of the study was a detailed geological characterization of the axial and near-axial part of the northern Reykjanes Ridge. The Kongsberg EM 300 30 kHz and Kongsberg EM712 75kHz multibeam echosounders were used (on A200608 and MSM75 cruises, respectively) to investigate the topography and surface morphology of the seafloor. In addition, acoustic backscatter was used to determine relative hardness of the substrate.

The bathymetry of the axial (neovolcanic) part of the Reykjanes Ridge, north of 63°N, indicates a rough bottom typical of the mid-oceanic ridge, made up of single hummocky volcanoes, hummocky ridges, shallow faults, volcanic cones and flat-top volcanoes. The last two types are characterized by steep, rough slopes and nearly circular shape. In both axial and off-axis areas, some volcanoes exhibit a dome-like structure with very smooth summits and slopes. Such volcanoes, in off-axis setting, most likely formed in the neovolcanic zone and migrated off-axis as the seafloor spreading progressed.

We suggest that observed domed-like volcanoes are the result of glacial erosion associated with the transgression and recession of the Icelandic ice sheet. High backscatter intensities indicate

presence of a hard substrate (i.e. lava) on smooth summits and low intensities around dome-like volcanoes demonstrating potential direction of deposition of eroded material (or re-deposited by modern bottom currents). The research area has very slow sedimentation rate and strong bottom currents system; hence, there are no other geological processes (other than sedimentation) on the seafloor that could lead to such smoothening of these features and their evolution into dome-like volcanoes, especially in the neovolcanic zone where new seafloor is formed and rough terrain is observed.