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The 2016 Canada–Sweden Polar Expedition: Initial results of seismic reflection and refraction experiments over the Lomonosov Ridge and Marvin Spur

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In August and September 2016, Canada and Sweden collaborated in a scientific expedition to the Arctic Ocean utilizing two polar class icebreakers: the Swedish Oden and the Canadian Coast Guard Ship Louis S. St-Laurent. Each ship was equipped with comparable systems for collecting seismic reflection and refraction data, giving a high degree of operational flexibility and spare equipment capacity in the field. A total of three helicopters supported the deployment and recovery of sonobuoys and on-ice seismometer stations (equipped with two hydrophones and a vertical geophone) along the seismic lines.

A principal scientific objective is to improve understanding of the tectonic evolution of the Arctic Ocean, which will ultimately help to define the Extended Continental Shelf of Canada. A key region to further this objective lies between the Lomonosov and Alpha ridges. The expedition collected a continuous seismic profile running from the Amundsen Basin, across the Lomonosov Ridge and sub-parallel Marvin Spur, through the Makarov Basin and onto the central Alpha Ridge. A second profile of the Lomonosov Ridge was acquired, and a cross-line joining the two was also run along much of the Marvin Spur. The combined length of these reflection and refraction lines is 1037 km. A total of 33 sonobuoys and five on-ice seismometer stations were used successfully to record the airgun shots (source volume between 1150 and 2000 cubic inches), which were fired at a maximum interval of 20 seconds.

The data will provide information on the continent-ocean transition zone at the Eurasian flank of the Lomonosov Ridge between Chron C24 and the more controversially discussed Chron C25. Is C25 a true seafloor spreading anomaly or is the anomaly related to serpentinization processes? A dense receiver spacing of 15 km and reversed observations will provide details on the crustal structure of Marvin Spur and will show how much the spur was affected by magmatism associated with the High Arctic Large Igneous Province. Similarly, the data between the Lomonosov and Alpha ridges will show how these structures are connected. In particular, the results will elucidate the temporal and spatial relationship of the formation of Alpha Ridge and the Makarov Basin.

Crustal scale P-wave velocity models will be developed along the transects. Coincident seismic reflection as well as gravity data will provide additional constraints on the models. Initial results of the forward modeling of observed travel times will be presented.