Geophysical features of permafrost in the Canadian Beaufort Sea

Jong Kuk Hong[1], Young Kuen Jin[1], Seung Goo Kang[1], Michael Riedel[2] ,Scott Dallimore[3]
[1]*Korea Polar Research Institute, Inchon, Korea*
[2]*Geomar Helmholtz Center for Ocean Research Kiel, Germany*
[3]*Geological Survey of Canada-Pacific, BC, Canada*

The shelf of the Canadian Beaufort Sea is underlain by thick terrestrial permafrost which has been inundated by relatively warm seawater as a consequence of post glacial sea level rise. As described by Taylor et al. (2013) the permafrost body beneath the shelf extends far offshore pinching out at the shelf–slope break at approximately 100-m water depth. In 2013, 2014, multidisciplinary expeditions aboard the Korean Icebreaker, *ARAON*, in the Canadian Beaufort Sea were carried out in collaboration between the Korea Polar Research Institute (KOPRI), Geological Survey of Canada (GSC) and Monterey Bay Aquarium Research Institute (MBARI). The multi-channel seismic (MCS) exploration, swath bathymetry, and sub-bottom profiling were conducted to understand the permafrost body in the shelf areas.

Figure 1 shows seafloor topography showing pingo-like features (PLFs) developed in the permafrost. On the Beaufort Sea Shelf, PLFs may be a consequence of gas hydrate decomposition (Paull et al., 2007). On the shelf, the morphology of PLFs show individual conical mounds protruding several tens of meters above the surrounding seafloor with a semi-circular and almost symmetrical moat. Multichannel seismic survey conducted to reveal deeper structures of the permafrost. The MCS data were recorded using a 1500 m long solid-type streamer with 120 channels. Shot and group spacing were 50 m and 12.5 m, respectively. On the shot gather section, refractions travelled along the top of the permafrost show strong amplitudes. On the stacked section shown in figure 2, the boundary between sediment layer and the top of the permafrost show rough surfaces. However the lower boundary of the permafrost is difficult to define on the section. We applied full waveform inversion (FWI) to get seismic velocity information because ice-bonded permafrost has higher P-wave velocity than background sediment has. 2D P-wave velocity model obtained from FWI reveal the upper and lower boundaries of the permafrost. The upper boundaries are well correlated with the boundaries on the stacked section and the lower boundaries are revealed at around 600 ~ 700 meter depth.

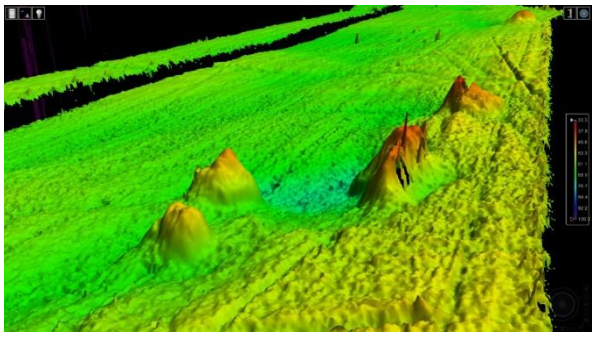

Figure 1. Perspective view of the Pingo-like features

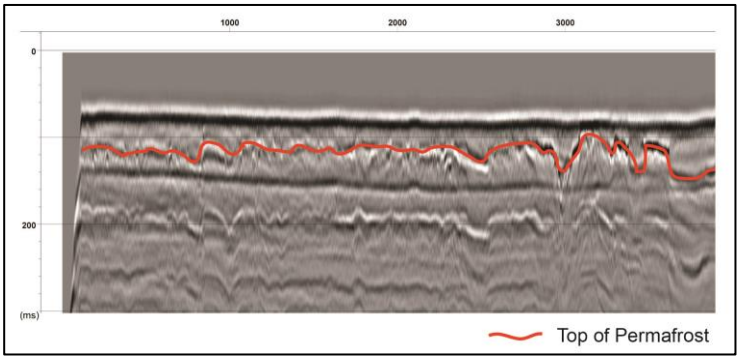

Figure 2. Stacked section showing the top of permafrost

References

Paull, C.K., W. Ussler, S.R. Dallimore, S.M. Blasco, T.D. Lorenson, and H. Melling, Origin of pingo-like features on the Beaufort Sea shelf and their possible relationship to decomposing methane gas hydrates, Geophys. Res. Let., 34, L1603, 2007.
Taylor, A.E., S.R. Dallimore, P.R. Hill, D.R. Issler, S. Blasco, and F. Wright (2013), Numerical model of the geothermal regime on the Beaufort Shelf, arctic Canada since the Last Interglacial, Journal of Geophysical Research: Earth Surface, 118(4), 2013JF002859, 2013.