IODP³

INTERNATIONAL OCEAN DRILLING PROGRAMME

PROPOSAL 1101-L2S-PRE

THAW: Thawing of permafrost and cryosphere-associated gas hydrates by Arctic warming

Abstract

During glacial times, Polar continental margins were either subaerially exposed or were iced covered with annual mean temperatures of around -20°C, resulting in vast regions with on- and offshore permafrost. This permafrost hosts methane as either free gas, dissolved in unfrozen water, and as gas hydrates (GH) - an ice-like substance composed of water and natural gas. Current estimates of methane in GH in Polar regions are speculative, ranging from as low as 27 to over 540 gigatons. This variability results from poor ground truthing and assumptions in parameters defining the inventory (e.g. in-situ pressure/temperature, concentration, porosity).

The stability of GH requires low-temperature and high-pressure conditions; therefore, they occur within and below permafrost as well as beneath large ice sheets. Global warming changes the P-T conditions at the polar margins and thus endangers the stability of GH, which poses the risk of methane being released from GH into the atmosphere, further amplifying climate change. However, the response of permafrost and GH varies according to its local setting. Terrestrial occurrences respond to surface temperature changes while offshore occurrences respond to the history of transgression and warming of bottom water temperatures. Changes to the subsurface temperatures reduce the extent of permafrost and the associated GH stability zone. As permafrost warms, changes in permeability create pathways for gas migration to the surface. GH dissociation may also amplify processes such as ground destabilization and thus pose future risks to infrastructure and human health and widely affects all ecosystems.

This pre-proposal addresses GH and permafrost-related questions in Polar regions under current and future global warming scenarios. The scientific targets are geared towards understanding the distribution of permafrost and GH, the temporal evolution of the cryosphere, and defining the fate of carbon within these systems. The aim is to calibrate numerical models by obtaining high-quality core-samples and ground truth data, and monitoring climate change and related processes. Since Polar regions are warming faster than the rest of the planet leading to drastic and cascading environmental impacts, the scientific objectives of this proposal also bear high social relevance and can only be addressed through targeted scientific drilling and coring.