

## Seabed Geoenvironmental Constraints to Hydrocarbon Development in the Canadian Arctic

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Offshore Hydrocarbon exploration and development in the Canadian Arctic is currently focused on 3 regions – the Beaufort Sea, Lancaster Sound-Baffin Bay and high Arctic channels of the Sverdrup Basin. Geoenvironmental constraints include seabed scouring by ice keels, foundation conditions for drilling and production structures, bottom sediment mobility, shallow gas and fault geohazards, subsea permafrost, gas hydrates and ecologically sensitive benthic ecosystems. The relative importance of these constraints varies with the region.

Seabed geoenvironmental constraints were initially investigated during the first phase of exploration in the Beaufort, Lancaster Sound and Sverdrup Basin in the 1970-80s. Renewed interest in the Beaufort Sea since 2001 has resulted in a reassessment of these constraints in terms of meeting the needs of the oil industry, government regulators and Aboriginal agencies.

Marine technologies used to assess these constraints during the first phase of exploration activity included sidescan sonar, sub-bottom profilers, shallow seismic reflection and refraction systems, gravity coring and rotary drilling, remotely operated vehicles and a variety of cumbersome positioning systems including Decca and Syledis. Seabed investigations were conducted from standard and icebreaking survey vessels as well as from the sea-ice surface.

The second phase of exploration is being greatly facilitated by the technological advances of the last 15 years. The most significant advances include the shift from analogue to digital acquisition of high resolution seabed acoustic profile data, multibeam bathymetry systems for 3-dimensional imaging of seabed topography, autonomous underwater vehicles, GPS satellite positioning and GIS mapping capabilities.

These new technologies are now at work in the Beaufort Sea and Lancaster Sound regions investigating constraints to both the exploration and production of Arctic offshore oil and gas. Ice scours generated by sea-ice pressure ridge keels have been observed with depths of 5m below seabed on the Beaufort Shelf and iceberg keels to water depths of 850m in Lancaster Sound. Subsea permafrost appears to be confined to offshore areas such as the Beaufort Shelf that were sub-aerially exposed over 10,000 years ago when sea level was 100m or more below present day. Shallow gas venting and oil seepage have been observed in the Beaufort, Baffin Bay-Lancaster

Sound regions. Gas hydrates have been documented in the Beaufort and Sverdrup Basin regions. Low strength seabed sediments and slope instabilities have been identified as contributing to unstable foundation conditions. Seabed classification mapping with multibeam sonar coupled with bottom sampling and video imagery provides the methodology for identifying sensitive benthic ecosystems.