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TITLE: Engineering Geology Constraints Associated with Offshore Oil and Gas Development in the Canadian Beaufort Sea

ABSTRACT

A wide range of seafloor and subseabed geological and geotechnical conditions has been investigated to facilitate the safe and efficient drilling of offshore oil and gas exploration wells on the Canadian Beaufort continental shelf. Such studies have also provided a technical base for preliminary production engineering design. The use of bottom founded drilling structures including artificial islands, caisson retained islands, or hybrids like the Single Steel Drilling Caisson (SSDC), in addition to ice strengthened drillships to cope with the ice dominated environment has required an expanded knowledge of seabed conditions from the onset of offshore drilling. Foundation conditions, aggregate sources, subsea permafrost, hydrates, ice gouging, shallow faulting, seismicity, slumping, pingo-like features, gas, overpressure zones, seabed sediment mobility, coastal stability and a regional stratigraphic framework are issues that require consideration in the exploration and development of offshore Arctic oil and gas resources.

A thin veneer of Holocene marine silty clays with low strength properties discontinuously overlies and infills depressions on the seafloor. These sediments are frequently removed to provide a competent foundation so that island berms can resist ice loads. These clays must also be removed, bypassed or preferably avoided in the dredging of underlying sands for island construction. Ice bearing permafrost has been identified to depths of 700m below seabed and appears to exist as a spatially discontinuous multilayered sequence of marginally frozen to well bonded sediments. Velocity inversions caused by the presence of ice disrupt the lateral continuity of shallow seismic reflectors, making it difficult to map the location and extent of shallow hazards such as hydrates, faults and shallow gas. Gouging of the seabed by sea-ice keels to depths in excess of 5m and to water depths of 75m has led to the development of a computerized ice gouge data base for parameter analysis. Repetitive sonar mapping of the seafloor indicates that 90 percent of the seabed between water depths of 14m and 26m has been regouged in less than forty years. The return periods for extreme depth events remain poorly constrained. With the Mackenzie River discharging 85 million cubic metres of sediment per year, and the Beaufort coastline retreating at an average rate of 1m per year, the transport, distribution and ultimate fate of these mobile sediments remains poorly known. An understanding of the surficial geology of the shelf has not only led to the recognition of the above conditions, but has allowed for the prediction of conditions in poorly known areas and may in the future establish constraints on the extent or severity of geological and geotechnical problems facing offshore exploration and development.