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## Mud volcanoes, diapirs, pingos and relict topographic features on the Canadian Beaufort Shelf

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S. M. BLASCO<sup>1</sup>, K. A. BLASCO<sup>2</sup>, J.M. SHEARER<sup>3</sup>,  
D. POLEY<sup>4</sup>, AND B.R. PELLETIER<sup>5</sup>

1. *Natural Resources Canada, Geological Survey of Canada (Atlantic), Bedford Institute of Oceanography, P.O. Box 1006, Dartmouth, NS, B2Y 4A2 <sblasco@nrcan.gc.ca>* ¶ 2. *Canadian Seabed Research, 341 Myra Road, Porter's Lake, NS, B3E 1G2 <kblasco@csr-marine.com>* ¶ 3. *J.M. Shearer Consulting, 24 Wendover, Ottawa, ON, K1S 4Z7 <jim@peakperformance.on.ca>* ¶ 4. *Suncor Energy Inc, 112 4<sup>th</sup> Avenue SW, Calgary, AB, T2P 2V5 <dpoley@suncor.com>* ¶ 5. *Natural Resources Canada, Geological Survey of Canada, 615 Booth Street, Ottawa, ON, K1A 0E8 <Bernard.Pelletier@nrcan.gc.ca>*

Over three hundred seabed mounds have been mapped on the Canadian Beaufort Shelf using echo sounders, sidescan sonar, subbottom profiler and shallow seismic reflection profile data since 1969. Recent re-examination of 6 of these features using 3-D multibeam sonar has advanced knowledge of the morphology, activity and formation processes. These seabed features are morphologically similar to the 1400 pingos mapped on the adjacent Tuktoyaktuk Peninsula. The seabed features are collectively referred to as pingo-like features (PLFs). PLFs are frequently larger or even elongated in shape in comparison to their terrestrial counterparts. Some PLFs with surrounding moat and lake-basin shaped underlying seismic reflectors may be true pingos. PLFs actively venting gas into the water column may be mud volcanoes. Subbottom profile data showing the stratigraphy and structure associated with the features indicate the presence of mud diapirs, and relict topographic highs which survived the last transgression. Features mapped on the upper slope appear 'conical' in cross-section but when mapped in detail are ridges associated with submarine slumping.

PLFs range in width from 50 to 600 m in cross-section, 10 to 25 m in height and occur in water depths of 30 to 100 m. The height vs. water depth ratio of some PLFs makes them a hazard to navigation for deep draft vessels and they are regarded as geohazards to offshore hydrocarbon development. In addition, mud volcanoes are of special interest as they may be contributing greenhouse gases to the atmosphere, may indicate the presence of hydrocarbons at depth, and may be associated with localized unique ecosystems. The actively

venting Kopanoar mud volcano is associated with disruption of seismic stratigraphy at depth.

The Beaufort Shelf is underlain by thick ice-bearing permafrost which forms impermeable strata. Fluid and gas migrating from depth is trapped under or within the permafrost and escapes to the seabed through taliks and faults. Seepage would be concentrated around such conduits. Crest sediments of Admirals Finger and Kopanoar PLFs contain ice lenses that may relate to the freezing of fresh water seeping from depth when subjected to the -1.5 degree C subseabed temperature regime of the Beaufort Shelf. PLFs form linear patterns along the eastern and western edges of the Mackenzie Trough. Gas and/or fluids from depth may be seeping upwards along the erosional unconformity generated by the Late Wisconsinan glacial ice stream. Along the eastern edge of the trough, morphologic evidence indicates one of these features is continuing to grow while others are relict, inactive and buried in undisturbed Holocene sediments. The undisturbed crests of some PLFs suggest feature growth is faster than re-scouring processes by pressure ridge ice keels.