TSUNAMI HAZARD IN THE ARCTIC REGIONS OF NORTH AMERICA, GREENLAND AND THE NORWEGIAN SEA

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ABSTRACT

There are very few known possible tectonic tsunamis in these Arctic regions. One was a 1 to 2 m event observed by a heavy mineral exploration team checking a beach deposit on the north end of Ubekendlt Island of northwestern Greenland on July 24, 1985. One of the parties searching for the Franklin Expedition overwintered on the Loksland (the land that shakes) Peninsula of Baffin Island in the early 1860s. They recorded local oral history of a large wintertime Inuit hunting party that never returned after a major felt earthquake, suggesting that the loss of the hunting party may have been related to a coastal catastrophe -- a tsunami?

A seismic source zone is known near the shelf break in the Canadian Beaufort Sea, and at least one submarine slump scar has been mapped on the continental slope in the area as early as 1970 using sidescan sonar and remapped in mid-2004 using multichannel seabeam data. A large magnitude (Ms = 7.3) earthquake occurred deep below the continental slope of northern Baffin Bay on November 20, 1933, which could well have triggered underwater slumps in the recent postglacial marine deposits but no known tsunami is known or reported. Other active seismic source zones are known in the coastal region of Baffin Island centred on Buchan Gulf and Home Bay. The Loksland area of Baffin Island and the Lichtenfels area of west Greenland (in 1759) have experienced felt earthquakes, suggesting that tsunamigenic marine slumps could be triggered in the offshore areas. No seabeam data are known in these areas to document the possible scars of possible submarine slumps.

In rapidly deglaciated areas, postglacial faults (pgfs) can occur at the surface of the bedrock over distances of tens of kilometres with throws of several metres to violently release the crustal strain imposed by glacial loading with estimated magnitudes up to Ms 9. A probable pgf is known to have occurred onshore in the Ungava area of Québec at Lac Turquoise on December 25, 1989. The Holy Grail Fault in north-central Manitoba is a 70-km-long prehistoric pgf with throws at the surface of at least 3 to 5 m. The seismic hazard, hence any tsunami hazard, from pgfs tends to be greatest shortly after deglaciation. The Atlantic Geoscience Centre in Dartmouth, Nova Scotia, has mapped apparent pgfs in the offshore Labrador Trough which is a 'marginal channel'. Marginal marine channels are known in most glaciated areas, and are glacially excavated, coast-parallel, linear topographic lows eroded by seaward flowing ice sheets along the contact between the onshore crystalline cratonic rocks and the offshore Tertiary-aged fringing sedimentary rocks. Onshore pgfs are known in northern Sweden and glacial marginal troughs are found around the Norwegian coast.

The recorded amplitudes of certain Beaufort Sea storm surges documented since 1969 fall well above the modelled surge heights, and the events may reflect the arrivals of previously-unrecognised meteorological tsunamis (or rissagas). A remote coastal weather observation station in southeast Greenland suffered a major loss of infrastructure and equipment in WW II that may too have been a rissaga.

A major cause of local tsunamis in parts of the Arctic regions are landslides directly into the sea; we include calving glaciers, or icebergs, as a lesser sub-class in this category. Tsunami-like waves from calving ice have been recorded since Arctic exploration began off Greenland and in Baffin Bay. Landslide tsunamis have been recognised in the area of Disko Island of Western Greenland. One of these in the 1970s would have caused human deaths but for the fact that a former, near-sealevel, mining community was no longer occupied. The prehistoric signature of a minor landslide tsunami appears to have been recorded in the sediments of a small coastal pond in the southern part of Disko Bygt. Norway has suffered several major landslide tsunamis in its fjords on the western coast; some of these events have cost human lives.

The fact that very few tsunamis have been observed in the Arctic may only reflect the very low population densities, the very short written history available, the poorly-studied and recorded oral history of the area's first peoples, the near-total lack of tide gauges, a short 50- to 60-year-long instrumental seismicity record, and a total lack of coastal geological work to look for the onshore sedimentary record of palaeotsunamis' signatures. While there are few tsunamis recorded, the tectonic tsunami hazard is by no means minimal, especially in Baffin Bay and in the Beaufort Sea where marine landslides may be a threat in light of large loads of glacially-transported sediment parked on the continental shelf and upper continental slope.