

Pingos at Nioghalvfjordsfjorden, eastern North Greenland

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Pingos are isolated, conical mounds up to 50 m high with a core of ice covered by silt, sand or gravel. They are formed in regions where the ground is permanently frozen. Two types of pingo are distinguished, a closed-system and an open-system (Washburn 1979; Pissart 1988). The closed-system type is found on flat plains, whereas open-system pingos are found on valley floors. Open-system pingos grow by artesian pressure (Müller 1959; Washburn 1979). Water from higher altitudes migrates within or below the permanently frozen ground and becomes trapped within the permafrost and freezes to form a lens or core of ice. Active pingos have been reported from Svalbard, Russia, Alaska, Canada and Greenland (Washburn 1979), and fossil pingos from Pleistocene periglacial terrains have been reported from Europe and North America (De Gans 1988).

In Greenland, most pingos have been reported from both East and West Greenland. In East Greenland pingos have been described from the area between 71°30' and 74°30'N (Fig. 1). In West Greenland most pingos occur between 70° and 72°N. In addition, a pingo and some pingo-like forms have been described from North Greenland (Bennike 1983). All pingos in Greenland are located in valleys, usually on outwash plains.

During field work in 1997 one fairly impressive pingo and several small pingos or pingo-like forms were observed at c. 79°30'N in eastern North Greenland. These are the northernmost pingos recorded from eastern Greenland, and the aim of this note is to document and describe these forms. The observations add to our knowledge about the distribution of pingos in Greenland, and a map showing the distribution of pingos in Greenland is presented as Fig. 1.

Setting

Nioghalvfjordsfjorden is a large fjord c. 80 km long and 21 km wide, completely covered by a floating glacier

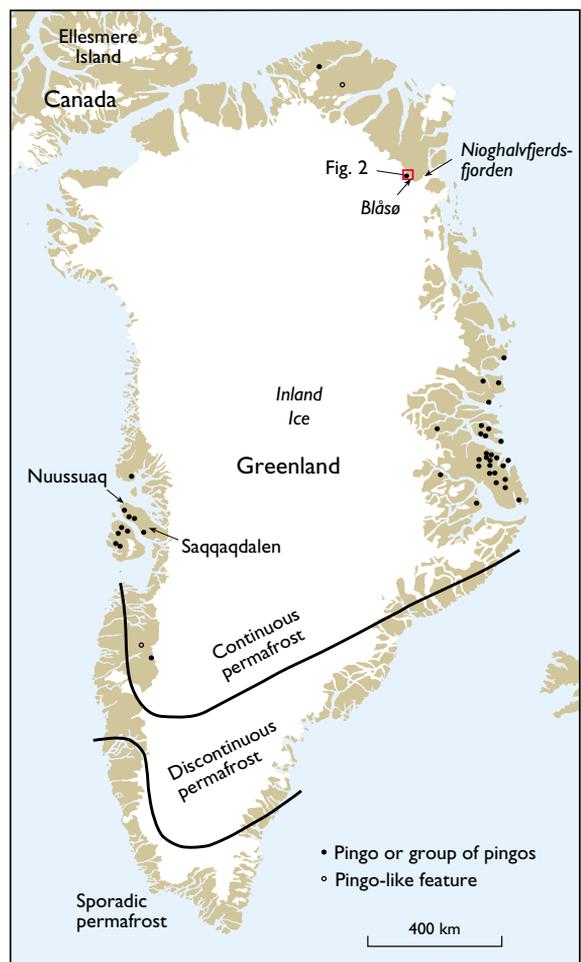


Fig. 1. Map of Greenland showing the geographical distribution of pingos and location of place names mentioned in the text. Compiled from Rosenkrantz *et al.* 1942; Vischer 1943; Flint 1948; Müller 1959; Cruickshank & Colhoun 1965; Lasca 1969; O'Brien 1971; Weidick 1974; Allen *et al.* 1976; Bennike 1983 & unpublished; Funder 1988; Christiansen 1995; Worsley & Gurney 1996; Yoshikawa *et al.* 1996; Scholz & Baumann, 1997. The boundaries between sporadic, discontinuous and continuous permafrost are taken from Weidick (1968).

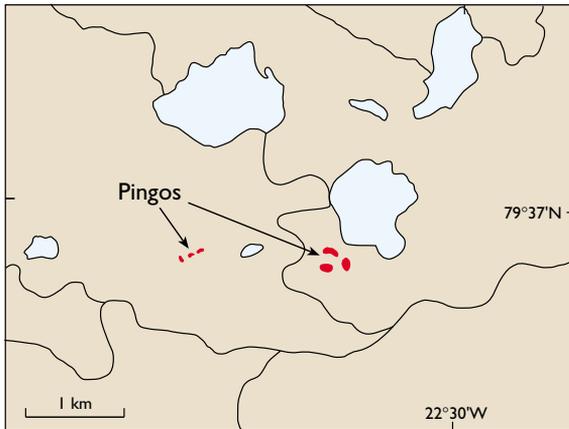


Fig. 2. Sketch map of the outwash plain west of Blåsø near Nioghalvfjærdsfjorden, eastern North Greenland, showing the location of the pingos (shown in red). The elevation of most of the area is below 100 m above sea level. For location see Fig. 1.

tongue. A large lake, Blåsø, is found near the head of the fjord. Nioghalvfjærdsfjorden is very deep and there is undoubtedly no permafrost below it, and this probably also applies to Blåsø. A 3–4 km broad valley is found between the north-western part of Blåsø and the margin of the Greenland ice sheet. The valley is characterised by glaciofluvial outwash plains that consist of thick deposits of sand and gravel. A few large thermokarst lakes are present. The valley bottom is about 50 m above sea level, and the rounded mountains in the area are 400–600 m high.

The high arctic area is semi-arid and desert-like with fell field vegetation. A total of 68 species of vascular plants has been reported from the area (Bay 1992), but most of the plants are confined to small patches with moist soil. The annual precipitation is probably around 150 mm, and the mean temperature for the warmest month 4–5°C. The glaciation limit is *c.* 1000 m above sea level (Weidick 1976); the area was deglaciated about 6000 radiocarbon years BP (O. Bennike and A. Weidick, unpublished data).

Descriptions

Three of the pingos were visited during a short ground stop, whereas the other pingos were only observed at a distance from the ground, or from a helicopter. All pingos are situated on a gravel outwash plain with sand-wedge polygons. For a description of similar sand-

wedge polygons from North Greenland, see Bennike (1987). The altitude of the outwash plain is *c.* 30 m above sea level.

The largest pingo (79°36.69'N, 23°03.09'W; Figs 2, 3) is semi-circular in outline, about 100 × 70 m in size and 8 m in height. The slopes have angles of 25–30°, and the top is flat. This is the only feature in the area that can be classified as a well developed pingo. It is partly collapsed, but appears to be still active, with steep slopes and apparently recently uplifted areas with sand-wedges of aeolian sand. Some wind blown sand and silt is found on the lee side (the south side) of the pingo. Here scattered vascular plants are found. The following species were noted: *Dryas integrifolia*, *Potentilla pulchella*, *Carex nardina*, *Poa abbreviata*, *Papaver rad-icatum*, *Salix arctica*, *Saxifraga oppositifolia*, *Lesquerella arctica* and *Braya purpurascens*.

About 200 m north and north-east of the pingo two smaller hills are found, with slopes around 20°. In size they measure respectively 30 × 10 m and 20 × 50 m; both are about 5 m high. These hills are more irregular in shape. About 1400 m west of the pingo, several small pingos are found. They are only a few metres high, and measure some tens of metres across. These small pingos could be pingos in their early stages of development.

Discussion

In the earlier literature on pingos in Greenland, the genesis of these conical hills gave rise to much speculation (e.g. Rosenkrantz 1940, 1943, 1950; Rosenkrantz *et al.* 1942; Vischer 1943; Flint 1948). The mounds were often called mud volcanoes, and some authors believed that they were formed by rising methane rich gasses. Müller (1959) made the first thorough study of pingos in East Greenland, and recognised that they were formed by water pressure. The West Greenland pingos are now also recognised as formed primarily by ground water pressure, and an ice core is present in one of the pingos in Saqqaq dalen on southern Nuussuaq (Yoshikawa 1991).

The pingos north of Nioghalvfjærdsfjorden described here are referred to open-system type pingos on account of their location in a major valley. Open-system pingos are found in areas of continuous, but thin permafrost. Therefore pingos are by far most commonly found in the southern part of the zone with continuous permafrost (Fig. 1). The rare occurrences in eastern North Greenland reported here, as well as those in central



Fig. 3. Pingos in the outwash plain at Niohalvfjærdsfjorden, eastern North Greenland. **A:** The largest pingo seen from the helicopter, 100 × 70 m across. **B:** The largest pingo seen from the south (person for scale). **C:** The largest pingo seen from the east. **D:** Pingo north of the largest pingo about 50 m across. **E:** Small pingo west of the largest pingo, with distinct 'crater' and 'crater rim' a few metres high which is associated with the well developed sand wedges. **F:** Small rounded hill, a few metres high, probably a pingo in an early stage of development.

North Greenland (Bennike 1983) and on northern Ellesmere Island (Washburn 1979), are presumably associated with local areas where the permafrost is unusually thin for the latitude.

The pingos in eastern Greenland and North Greenland are small compared to many others pingos that can approach 50 m in height. Nevertheless, they are quite impressive geomorphological features.

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