Polarforschung 53 (2): 43—48, 1983

Pingos on Bylot Island, N. W. T., Canada

By S. C. Zoltai*

Summary: A group of nine pingos occurs in the valley of a glacial meltwater river. The pingos rise from a plain of low-center polygons. Some pingos have a typical cone shape, but others are linear, apparently centered on ice wedges. The occurrence of most pingos at the junction of oversize ice wedge polygon ridges suggests that the injection of water and the segregation of ice occurred along pathways provided by the ice wedges.

Zusammenfassung: In einem glaziären Schmelzwassertal auf Bylot Island, N. W. T., Kanada kommt eine Gruppe von 9 Pingos vor. Sie erheben sich über der Talaue, die aus Polygonnetzen mit tiefliegenden Zentren besteht. Einige Pingos weisen die typische Kegelstumpfform auf, andere sind länglich gestreckt und folgen offenbar Eiskeilnetzen. Das Vorkommen der meisten dieser Pingos an den Kreuzungspunkten von übergroßen Eiskeilpolygon-Wallformen läßt vermuten, daß die für ihre Genese wichtige Wasserinjektion und Eissegregation entlang von Leitbahnen erfolgte, die durch die Eiskeile vorgegeben sind.

Pingos are ice-cored, conical hills that grow and persist in permafrost (MACKAY, 1979). They are formed as water, injected under the permafrost, freezes and then lifts the surface to form a conical hill. Subsequent growth results from the development of segregation ice lenses within the pingo (MACKAY, 1973).

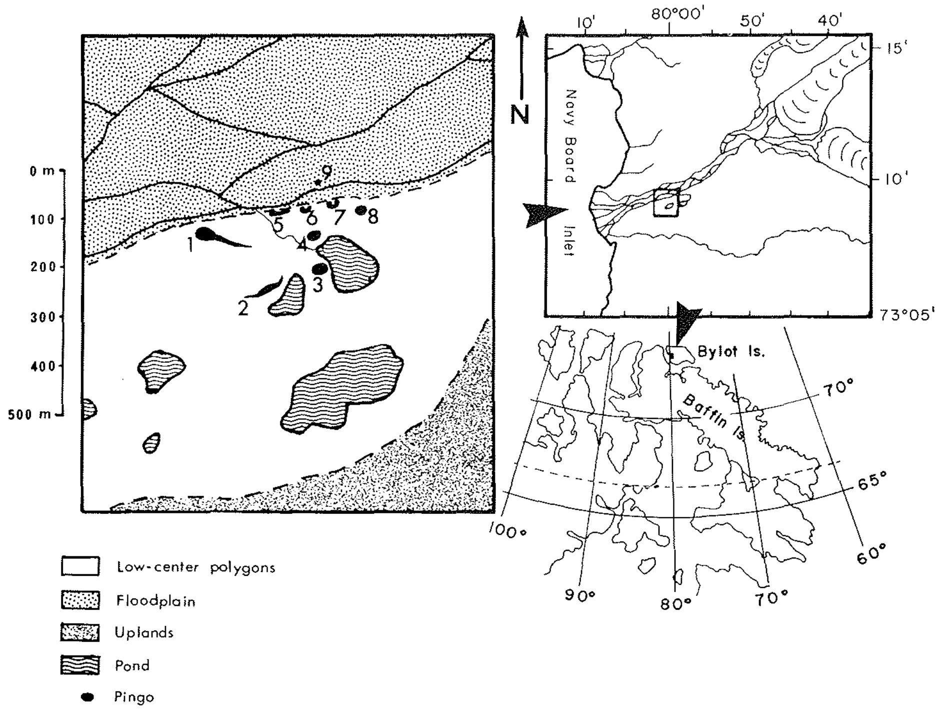

Fig. 1: Location of study area and distribution of pingos.

Abb. 1: Lage des Arbeitsgebietes und Verbreitung der Pingos.

*S. C. Zoltai, Northern Forest Research Centre, 5320-122 Street, Edmonton, Alta. T6H 3S5 (Canada).

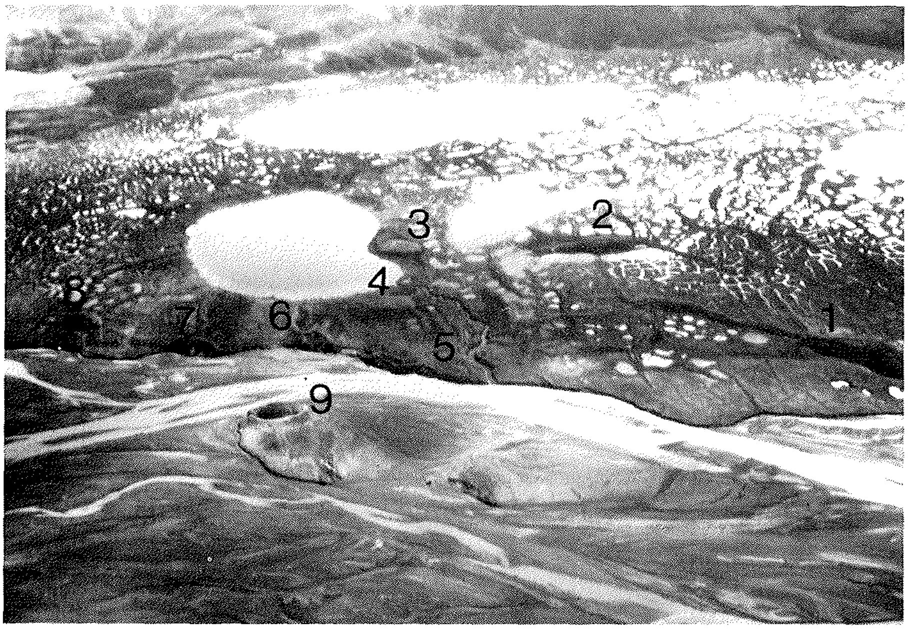

Fig. 2: Aerial view of pingos (numbered) occurring within low-center polygons and on active floodplain.

Abb. 2: Luftansicht der Pingos (numeriert), die auf einer Talaue innerhalb von Polygonnetzen mit tiefliegendem Zentrum auftreten.

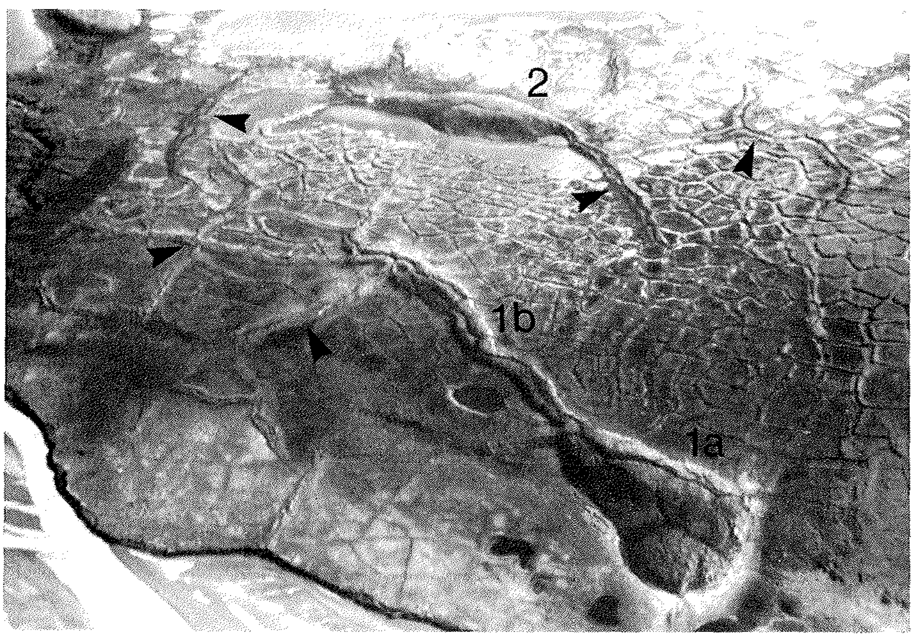

Fig. 3: Aerial view of elongate pingos (1a, 1b and 2) and oversized primary polygon ridges (arrows).

Abb. 3: Luftansicht der länglichen Pingos (1a, 1b und 2) und übergroßen primären polygonalen Wälle (Pfeile).

There are two types of pingos: open-system and closed-system. Open-system pingos develop when hydraulic pressure causes groundwater from nonpermafrost uplands to emerge in the permafrost of a valley. Closed-system pingos occur where permafrost is aggrading in a water-saturated soil. The water is expelled from the freezing soil and eventually freezes into an icy pingo core (MACKAY, 1973).

Open-system pingos are common in the discontinuous permafrost zone of Alaska and the Yukon (BROWN & PÉWÉ, 1973). The numerous closed-system pingos in the western Canadian Arctic have developed in the beds of rapidly drained lakes (MACKAY, 1973). Pingos are rare elsewhere in northern Canada. When they occur, they are associated with shifting river channels (CRAIG, 1959; PISSART & FRENCH, 1976) or lacustrine plains (TARNOCAI & NETTERVILLE, 1976), or they may be related to geological structures (PISSART, 1967). Pingos and pingo-like mounds have been reported on Baffin, Ellesmere, Axel Heiberg, Prince of Wales, and Amund Ringnes islands (BROWN & PÉWÉ, 1973). This note briefly describes a group of pingos found on Bylot Island during the summer of 1982.

ENVIRONMENTAL SETTING

The pingos occur on the inactive floodplain of a river at 73°09'N longitude and 80°01'W latitude on Bylot Island, at an elevation of approximately 15 m above sea level. The sea (Navy Board Inlet) is about 4.25 km to the southwest, and the terminus of a glacier is about 7.5 km to the northeast (Fig. 1). The present river is heavily braided, occupying a floodplain cut approximately 2 m into the floor of the valley. The valley is essentially a level plain of aeolian fine sand over fluvial sediments that probably occur at greater depths. An extensive development of low-center polygons occurs on this plain, interspersed by numerous ponds. The uplands bordering the valley rise about 60 m and consist of till with colluvial slopes.

The valley is poorly drained and is covered by tundra vegetation of sedges (*Carex* spp.), cotton-grass (*Eriophorum scheuchzeri*), and mosses. The soil consists of thin peat (10—20 cm thick) covering stone-free fine sand. Thin peat layers also occur within the sand. Permafrost was encountered at 60 cm under the shallow ponds in low-center polygons and at 45 cm on the elevated ice wedge polygon ridges.

PINGOS

A group of eight pingos occurs on the valley plain near the river, and one pingo occurs on the active floodplain of the river (Figs. 1 and 2). Their dimensions were estimated from air photos and by pacing in the field, and their approximate height was determined with a hand level (Tab. 1). Pingos 5, 6, and 7 are being eroded by the river; at present only about half of their original extent is still intact.

Pingo No.	Length (m)	Width (m)	Height (m)	Surface features
1a (head)	55	30	12	Polygonal troughs
1b (tail)	84	10	11	Central trough
2	80	20	10	Central trough
3	25	20	7	Smooth
4	25	20	6	Polygonal troughs
5	45	10	3	Partially eroded Central trough
6	23	12	4	Partially eroded Polygonal troughs Collapsed center
7	20	12	4	Partially eroded Polygonal troughs Collapsed center
8	22	22	9	Polygonal troughs
9	22	15	6	Smooth

Tab. 1: Approximate dimension of the pingos.

Tab. 1: Ungefähre Größenverhältnisse der Pingos.

Fig. 4: Elongate "tail" of Pingo 1, showing the central frost fissure. A primary polygon ridge is visible in the distance (arrow).

Abb. 4: Länglicher „Schwanz" von Pingo 1 mit einer Frostspalte im Zentrum. Ein primärer polygonaler Wall ist im Hintergrund sichtbar (Pfeil).

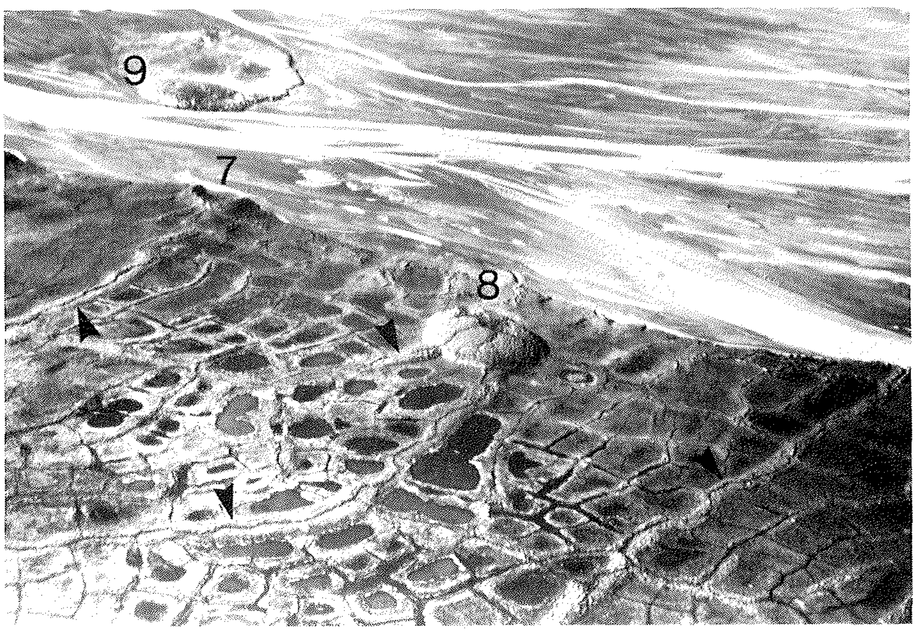

Fig. 5: Pingos 7 and 8 and related primary polygon ridges (arrows).

Abb. 5: Pingos 7 und 8 mit den dazugehörenden primären polygonalen Wällen (Pfeile).

The pingos appear to be of two types: the characteristic cone-shaped pingos (Nos. 3, 4, 6, 7, 8, and 9) and those having a linear shape (Nos. 2 and 5). Pingo 1 has an intermediate form: an oval-shaped conical hill (1a) with a linear ridge (1b), a 'head', and a 'tail' (Fig. 3).

The polygon-patterned lowland on which the pingos occur contains some unusually large polygonal ridges. These ridges, cleft by a central trough, reach a width of 4 m and a height of 1.5 m, rising abruptly from the low centers (Fig. 4). At some trough junctions the ridges are 2 m high. Such oversize polygonal ridges are termed primary polygons. The primary polygons are dissected by smaller, normal-sized polygonal ridges.

The linear pingos (Nos. 1b, 2, and 5) appear to be enlarged portions of primary polygons. Most of the conical pingos (Nos. 1a, 4, 6, 7, and 8) occur at junctions of several such primary polygon ridges (Fig. 5). Pingos 3 and 9, located on a lakeshore and in the active floodplain, respectively, do not show any relationship to primary polygons.

A portion of the internal structure of Pingo 6 was exposed by river erosion (Fig. 6). There was about 1 m of ice and ice with thin bands of fine sand, which was covered by about 1 m of stone-free fine sand. Permafrost was encountered 60 cm below the surface.

DISCUSSION

The pingos on Bylot Island are not associated with the landscape components commonly found with pingos in northern Canada. There are no indications of drained lake beds, although shallow lakes do occur in the vicinity of the pingos. Similarly, there is no indication that the river has shifted its course since the deposition of the sand on the valley floor. Drained lake beds and shifting river channels may have occur-

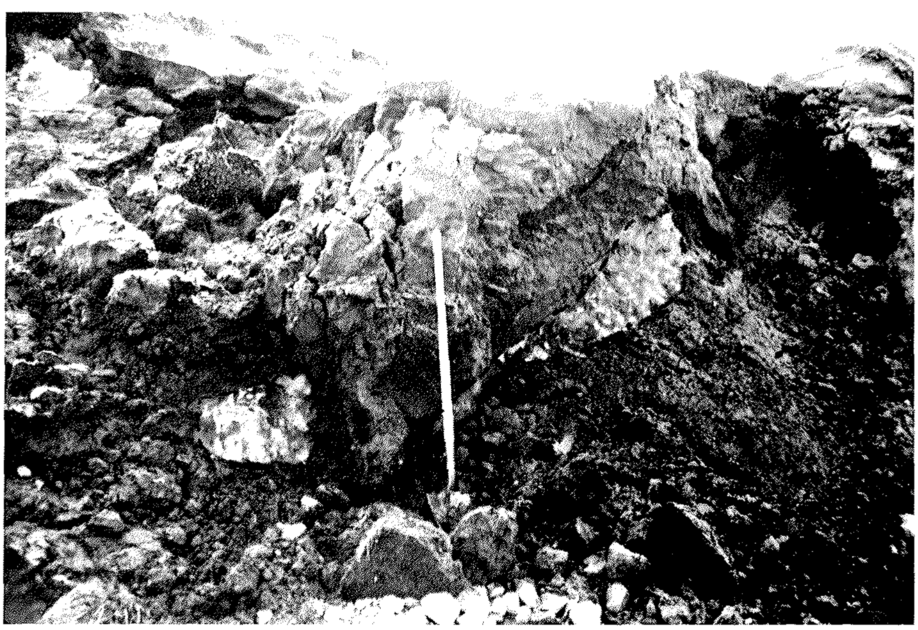

Fig. 6: Ground ice exposed by river erosion in Pingo 6 (outlined).

Abb. 6: Durch Flußerosion in Pingo 6 aufgeschlossenes Bodeneis (umrissen).

Fig. 7: View of pingos and distant glacier.

Abb. 7: Ansicht der Pingos mit Gletscher im Hintergrund.

red in the past, however, and have been masked by the fine sand and peat deposits. They could have provided the talik in which the pingos were formed. Another possibility is that porewater expulsion during an advance of the glacier that is now only 7.5 km away (Fig. 7) may have triggered the pingo formation (MACKAY, 1979). Open hydraulic-system pingos are not likely to occur in this area of continuous permafrost.

The association of the pingos with oversize ice wedge polygon ridges is an interesting and unique feature. The external morphology suggests that the ice wedges may have provided a pathway along which the water was injected into a talik (Pingo 1). The ice wedges then expanded to an extent that pingos formed at their junctions (Pingos 4, 6, 7 and 8) or expanded to form linear pingos (Pingos 2 and 5).

References

Brown, R. J. E. & T. L. Péwé (1973): Distribution of permafrost in North America and its relationship to the environment: A review, 1963—1973. — In: Permafrost: North American contribution to the 2nd international conference, 77—100, Nat. Acad. Sci., Washington, D. C.

Craig, B. G. (1959): Pingo in the Thelon Valley, Northwest Territories; radiocarbon age and historical significance of the contained organic material. — Geol. Soc. Am. Bull. 70: 509—510.

Mackay, J. R. (1973): The growth of pingos, western Arctic Coast, Canada. — Can. J. Earth Sci. 10: 979—1004.

Mackay, J. R. (1979): Pingos of the Tuktoyaktuk Peninsula area, Northwest Territories. — Géogr. Phys. Quat. 33: 3—61.

Pissart, A. (1967): Les pingos de l'île Prince Patrick (76°N-120°W). — Geogr. Bull. 9: 189—217.

Pissart, A. & H. M. French (1976): Pingo investigations, north-central Banks Island, Canadian Arctic. — Can. J. Earth Sci. 13: 937—946.

Tarnocai, C. & J. A. Netterville (1976): Some characteristics of a pingo in the Simpson Peninsula, N. W. T. — Can. J. Earth Sci. 13: 490—492.