# A Pingo in the Mala River Valley, Baffin Island, Northwest Territories, Canada

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ABSTRACT. A single pingo is located on an alluvial fan within the deeply incised Mala River valley of the Borden Peninsula, Baffin Island. Its formation appears to be related to the abandonment of the river channel due to the influx of alluvium from a tributary stream.

RÉSUMÉ. Un seul pingo est situé dans un cône alluvial dans la vallée très entaillée de la rivière Mala dans la péninsule Borden sur l'île de Baffin. Sa création semble être reliée à l'abandonnement du lit de la rivière en raison de l'afflux d'alluvion provenant d'un ruisseau tributaire.

Traduit pour le journal par Maurice Guibord.

## INTRODUCTION

Two types of pingos, open-system and closed-system, have been described. Open-system pingos develop when hydraulic pressure causes intra- or sub-permafrost groundwater from an area upslope to emerge in a valley at a site of thin permafrost. They are common in the discontinuous permafrost zone of Alaska and Yukon (French, 1976; Washburn, 1979). Closed-system pingos occur where permafrost is aggrading in a water-saturated soil. The water is expelled from the freezing soil if the soil is coarse-grained and eventually freezes into an icy pingo core. Numerous closed-system pingos in the Mackenzie Delta have developed in rapidly drained lake beds (Mackay, 1973, 1979), but in rare cases closed-system pingos may be associated with shifting river channels (Craig, 1959; Pissart and French, 1976; French and Dutkiewicz, 1976).

The distribution of pingos in Canada has been summarized by Brown and Péwé (1973). A map included in their paper indicates that two pingos occur in the Borden Peninsula of Baffin Island, but there is no description of the pingos. In 1983, during a resource analysis study carried out in this area, one of these pingos was observed and examined in the Mala River valley at 72°56′N, 81°21′W, at an elevation of approximately 90 m asl. This brief note comments on the possible origin and age of this feature.

## GEOLOGICAL SETTING

The pingo occurs on an alluvial fan in the Mala River valley about 25 km west of its mouth, on the Borden Peninsula of Baffin Island. The river system is heavily braided, occupying a floodplain about 2 km wide. Small tributary streams have built alluvial fans into the valley. The pingo occurs on such a fan, where a small stream entering the Mala River valley from the south built a fan into the valley, forcing the river to the opposite side of the valley (Fig. 1).

The alluvial fan around the pingo consists of sand, gravel, and cobbles. The maximum depth of the active layer immediately adjacent to the base of the pingo was about 60–65 cm on 31 July 1983. The uplands bordering the valley rise steeply about 750 m above the valley.

## DESCRIPTION OF THE PINGO

The pingo has the characteristic cone shape and is nearly circular in plan view, with a star-shaped pattern of cracks at the summit (Fig. 2). The dimensions of the pingo were estimated from air photos and by pacing in the field, and its approximate height was determined by using a man on its slopes for scale. The pingo is estimated to have a basal diameter of 140 m. The height of the pingo above the surrounding alluvial fan is about 30 m.

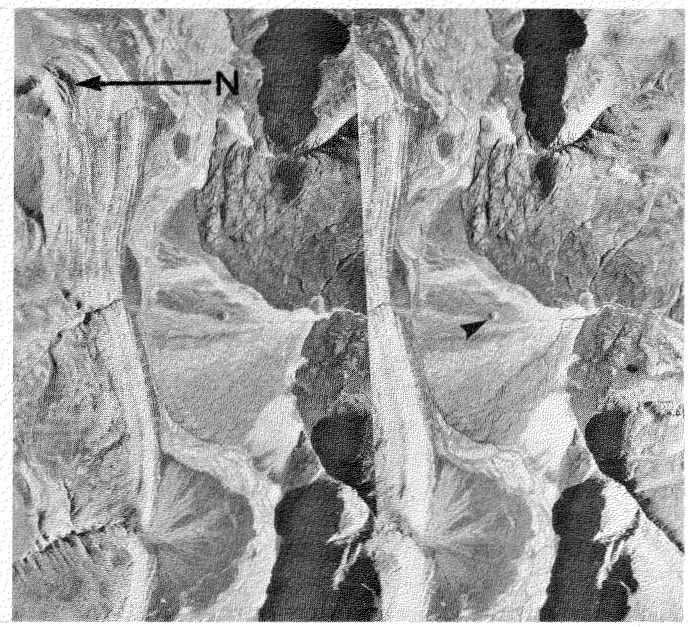


FIG. 1. Stereopair (A16263-53 and -54) showing the pingo and the valley of the Mala River, Borden Peninsula, Baffin Island.

The surface material of the pingo is largely well-rounded gravel and sand (Fig. 3), the same material that composes the surface of the surrounding alluvial fan. Unlike the pingos recently reported by Zoltai (1983) from nearby Bylot Island, vegetation cover is primarily limited to the base of the mound with little on the sides.

## DISCUSSION

The pingo in the Mala River valley is not associated with the landscape components commonly found with pingos in northern Canada. Its geomorphic setting is most closely related to that described by Pissart and French (1976) from Banks

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Island. They hypothesize that pingos develop from the talik beneath a river channel after rapid abandonment of the channel. In the Mala River valley, influx of alluvium from a tributary stream probably blocked the main channel of the river, causing the river to seek new channels around the obstruction. The eventual freezing of the water in the talik could have resulted in the formation of the pingo within the alluvial fan of the tributary stream.

The volume of water-saturated talik necessary to form a closed-system pingo that is 30 m high and has a basal radius of 70 m can be calculated (Mackay, 1963). Assuming that the pingo ice is cone shaped and that the pingo's dimensions above the alluvial fan are caused by ice, the volume of ice in the pingo is about 150 000 $m^3$. If this represents a 10% volume expansion of soil with a 30% porosity assumption for sand and gravel, the required volume of unfrozen material would have been about 5 000 000 $m^3$. Because the width of the present Mala River reaches 140 m only at junctions of several forks, the talik would have been only 140 m wide. If the talik was 10 m deep, as hypothesized for the Thomsen River on Banks Island (Pissart and French, 1976), the length of the talik would have been about 3.5 km. However, since the base of the alluvial fan built into the Mala River is only 2 km wide, this is an unlikely talik configuration. A deeper talik, at least 18 m deep, would have been necessary to form a closed system under a section of the river buried by the alluvial fan. Such deep talik would have been possible under either a warmer climatic regime or conditions of greater discharge than today. In either case, it is concluded that the pingo is not actively growing under the climatic and geomorphic conditions existing at this site today. This conclusion is supported by the morphology of the pingo, which shows little or no evidence of recent growth. One possibility is that the pingo formed during the period of climatic deterioration that followed the post climatic optimum, approximately 5000–2500 years ago.

FIG. 3. The surface of the pingo is composed largely of water-worn rocks, with almost no vegetation.

The possibility of an open-system pingo formation is an alternative. Although the entire region is within the continuous permafrost zone, water under hydrostatic pressure could have reached the river valley, possibly through an old channel of the tributary creek that formed the alluvial fan. However, until conclusive evidence is presented through detailed work, the possibility of origin through either an open or closed system should be entertained.

FIG. 2. Photographs taken of the pingo from the ground (top) and from the air (bottom).

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