

Aklisuktuk (Growing Fast) Pingo, Tuktoyaktuk Peninsula, Northwest Territories, Canada

J. ROSS MACKAY¹

ABSTRACT. Field surveys have been carried out for the 1972 to 1979 period in order to study the growth of Aklisuktuk (Growing Fast) Pingo. The field surveys show that the top of the pingo was slowly subsiding during the seven-year survey period, possibly from a slow downslope glacier-like creep of the ice-rich overburden and ice core. The name "Aklisuktuk" probably dates back at least 200 years. The rapid growth which attracted attention was from accumulation of water in a large sub-pingo water lens.

Key words: Aklisuktuk Pingo, sub-pingo water lens, pingo subsidence

RÉSUMÉ: Des levés sur le champs ont été effectués entre 1972 et 1979 en vue d'étudier le pingo Aklisuktuk ("grandi vite"). Les levés ont indiqué que le sommet du pingo s'est lentement affaissé au cours de la période de levé de sept ans, possiblement à cause du lent avancement genre glacier du terrain de couverture riche en glace et du noyau de glace. Le nom "Aklisuktuk" date probablement d'il y a au moins 200 ans. La croissance rapide qui a attiré l'attention a été causée par l'accumulation d'eau dans une grande poche au-dessous du pingo.

Mots clés: Pingo Aklisuktuk, poche d'eau au-dessous du pingo, affaissement du pingo
Traduit par Maurice Guibord, Le Centre Français, The University of Calgary.

INTRODUCTION

Pingos are ice-cored hills which can grow only in a permafrost environment. There are about 1450 pingos in the Tuktoyaktuk Peninsula area (Fig. 1). Although it is common knowledge among the local inhabitants that pingos grow, no first-hand observation on pingo growth is known to the writer, despite many enquiries made over a 30-year period (cf. Leffingwell, 1919:153). The most frequently cited example of a "growing pingo" is Aklisuktuk (Fig. 2). In local tradition, when Aklisuktuk was small, it could not be seen from East Channel, Mackenzie River

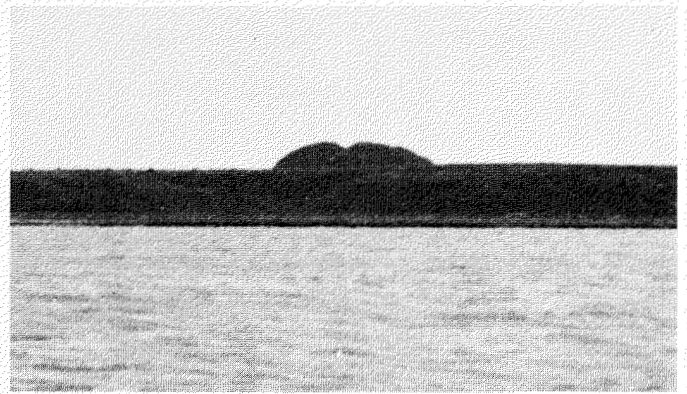


FIG. 2. Photograph of Aklisuktuk from near the left bank (west side) of East Channel, Mackenzie River.

from where the photograph was taken. The name symbolizes the rapid upgrowth of the pingo as viewed from the river. In the absence of written records, the discovery of Aklisuktuk's growth must have been within one person's memory. However, as Aklisuktuk (Fig. 3) was sketched by the explorer Dr. John Richardson in 1848 (Richardson, 1851), the growth tradition must then pre-date 1848. In the early 1930s the botanist A.E. Porsild travelled widely in the Tuktoyaktuk Peninsula area and reported (Porsild, 1938) that the pingo had two local names: Agdlissartok (Aklisuktuk) meaning "the one that is growing" and Pingorssarajuk which means "the poor thing that is getting to be a pingo." However, Porsild could find no one who had personal knowledge of the pingo's growth. Each informant stated that the details had been given by older men, now dead. The pingo was drilled in 1954 (Pihlainen *et al.*, 1956) and pingo ice was encountered at a depth of one metre below the ground surface in the middle of the crater.

In view of the historical importance of Aklisuktuk, field surveys were started in 1972 in an attempt to determine if

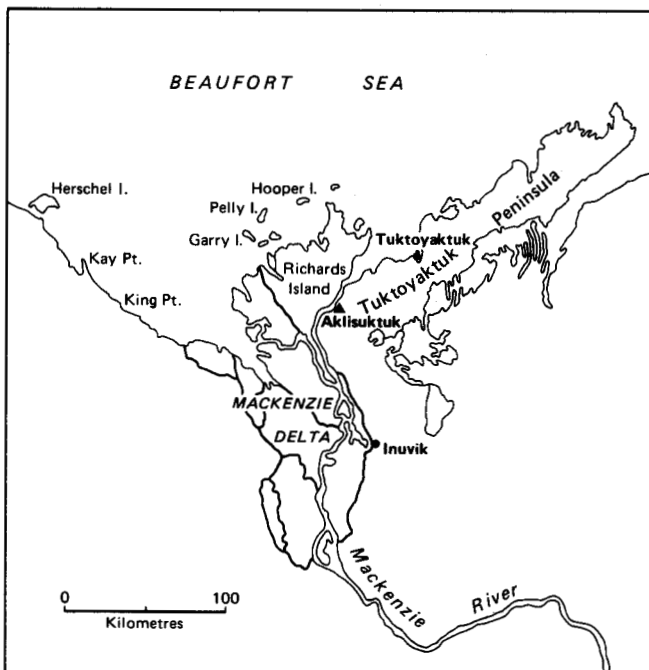


FIG. 1. Location map. Aklisuktuk Pingo lies to the east of East Channel, Mackenzie River.

¹Department of Geography, University of British Columbia, Vancouver, B.C., Canada V6T 1W5

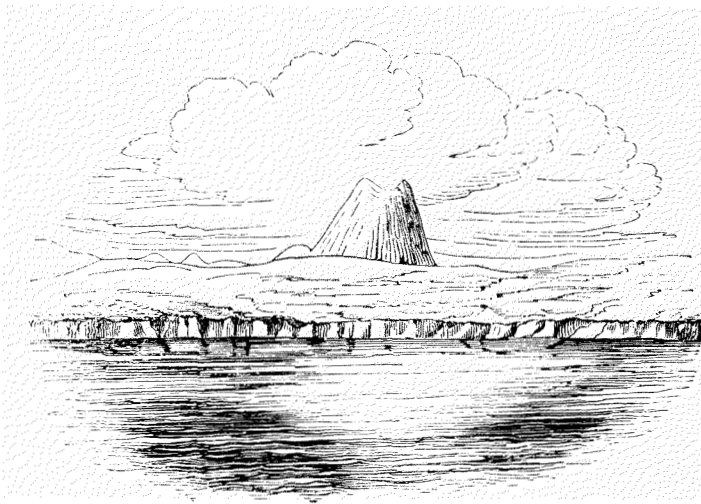


FIG. 3. An 1848 sketch of Aklisuktuk from East Channel, Mackenzie River (Richardson, 1851:234).

the pingo was still growing. The unexpected result of an annual survey conducted between 1972 and 1976 was that Aklisuktuk was slowly subsiding and the results have been briefly reported (Mackay, 1979). In order to extend the four-year period of study, a further survey was carried out in 1979 to provide a seven-year record. The purpose of this paper is to discuss the growth and subsidence of Aklisuktuk as interpreted from the 1972-1979 survey record.

THE HISTORIC RECORD

Field surveys of numerous growing pingos in the Tuktoyaktuk Peninsula area show that the basal diameter of a pingo is attained in early youth, after which time a pingo grows higher but little wider (Mackay, 1979). Therefore, Aklisuktuk probably had about the same 200-m basal diameter in 1848 as it does now. Richardson's 1848 sketch of Aklisuktuk (Fig. 3) shows a steep pingo with slopes of 60-75 degrees. Such steep slopes for a pingo 200 m in basal diameter could hardly be maintained for even one summer without leaving an apron of slumped debris around the pingo periphery, because active layer slumping occurs abundantly with slopes steeper than 45 degrees. As there is no apron of slumped debris around the pingo, it seems doubtful that the 1848 height was much greater than the 31 m of today.

FIELD SURVEYS

The field surveys for Aklisuktuk have involved the insertion of antiheave bench marks into permafrost followed by precise levelling (Wild NA2 level, optical micrometer, invar rods with supporting struts). All surveys were closed at least twice each summer. In 1972, a datum bench mark (BM 82) was emplaced at the former lake shore (Fig. 4) where permafrost probably exceeding 300 m in depth ensured ground stability. Bench marks 83 and 84 were located on the drained lake flat; BM 85 at the base of the

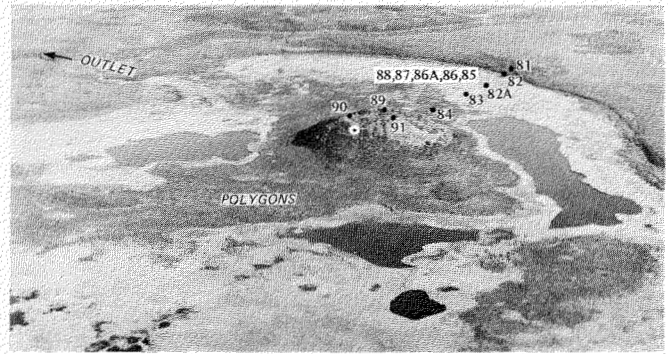


FIG. 4. Oblique photograph of Aklisuktuk showing the bench mark locations, the outlet which drains to East Channel, two small pingos, and residual ponds on the floor of the drained lake.

pingo; BM 86, 87 and 88 on the pingo slope; and BM 89, 90 and 91 on its three peaks. In 1973, a rigid bench mark (BM 86A) was installed midway up the pingo to serve as a fixed theodolite support. In 1974, BM 81 and 82A were added to improve the line of survey.

The measurement of height differences from BM 81 to 85 at the pingo periphery was very precise, as numerous repetitive surveys showed. Levelling up the steep pingo slope was much more difficult. Table 1 shows a comparison of the 1973 - 1976 height changes for Aklisuktuk as calculated from levelling and theodolite measurements, using the theodolite site of BM 86A, part way up the pingo, as datum. As the greatest difference between the two survey methods amounted to only 0.9 mm, the survey results can be used with confidence in interpreting changes in the height of Aklisuktuk.

The height changes for 1972-1979, using BM 84 just beyond the pingo periphery as datum, are plotted in Figure 5. Bench mark 84 near the pingo has been used as datum, because the objective is to show changes in pingo height, not drained lake bottom height. The 1972-1979 results show insignificant height changes for BM 85, 86 and 87 on the pingo periphery and lower slope. However, there was a significant subsidence for BM 88 near the top of the pingo and BM 89, 90 and 91 located on the three pingo peaks. It could be argued that frost heave or lake bottom heave of datum BM 84 would result in an apparent subsidence of otherwise stable bench marks. However, the pattern of Figure 5 occurs if any one of the first six bench marks (BM 81, 82, 82A, 83, 84 and 85) is used as datum.

TABLE 1. Changes (ΔH) in heights of bench marks for the 1973-1976 period using bench mark 86A as datum as determined by levelling and theodolite measurements

Bench Mark	Levelling ΔH in mm	Theodolite ΔH in mm
85	+1.8	+1.6
86	+0.4	+0.5
87	-2.1	-2.2
88	-5.7	-6.6
89	-6.7	-7.6

The inescapable conclusion, therefore, is that the top of Aklisuktuk was slowly subsiding in the 1972-1979 period and it was not growing, as many people still infer from the pingo's name.

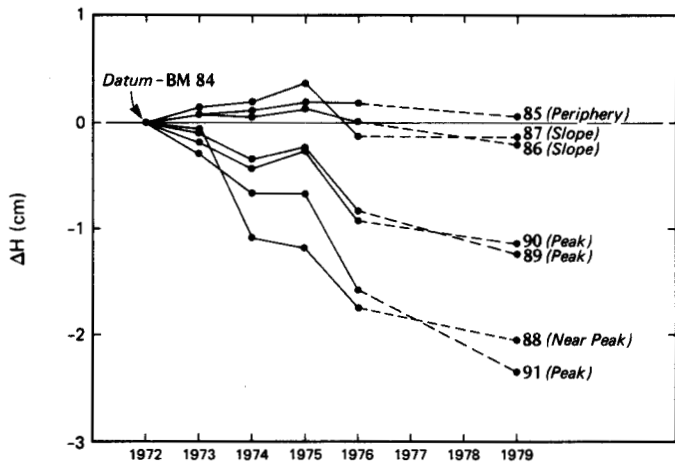


FIG. 5. Changes in height (ΔH) in cm for bench marks 85 to 91 on the pingo for 1972 to 1979. See text.

PINGO GROWTH

A line-of-sight from water level on East Channel to Aklisuktuk shows that the bottom 7 m of the pingo are hidden from view (Fig. 6). Therefore, Aklisuktuk must have grown to a height of about 7 m before its top would have been visible to a traveller on East Channel. The Tuktoyaktuk Peninsula area pingos grow in height by two main processes. First, growth can be from freezing of ice lenses (segregated ice) at the bottom of the pingo ice core. The growth of a pingo solely from ice lensing is slow, with the height of the pingo being proportional (approximately) to the square root of the age of the pingo. Therefore, the rate of growth decreases rapidly with time. Second, growth can result from the accumulation of water in a sub-pingo water lens. In the second method, the growth rate is not dependent upon the freezing rate for ice, but upon the rate of water accumulation. Figure 7 shows the

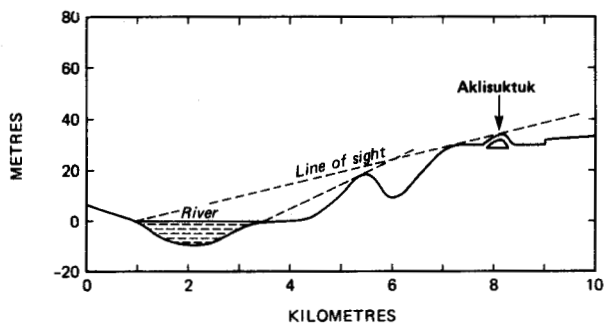


FIG. 6. Diagram showing the line-of-sight from the left and right side of East Channel to Aklisuktuk. The lower 7 m of the pingo are hidden from river view.

growth rate for nine pingos, most if not all of which have subpingo water lenses, in the Tuktoyaktuk Peninsula area.

Let us then consider the magnitude of the growth rate of Aklisuktuk in order for it to attract the attention of a person travelling on East Channel, Mackenzie River. Furthermore, let us assume that the traveller observed the growth over a 50-year period. If the growth rate of Akli-suktuk was as shown in Figure 7, in 50 years the pingo would have grown only 6.5 m. A pingo which in a 50-year period protruded only 6.5 m above the horizon several kilometres away from a traveller would hardly attract

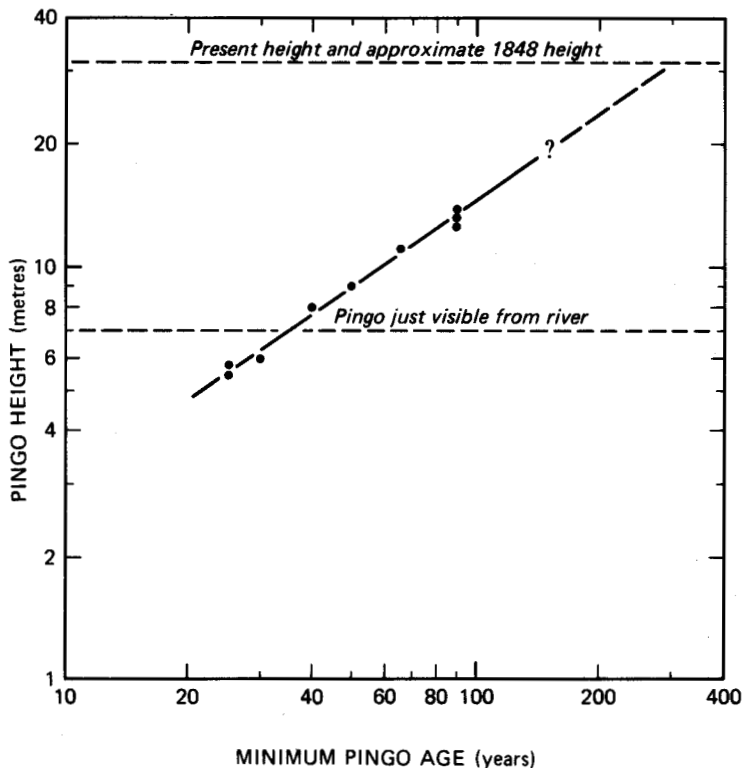


FIG. 7. The plot shows the heights of nine Tuktoyaktuk area growing pingos versus their minimum ages in years. The minimum age is probably very close to the actual age. The 7-m height of Aklisuktuk when just visible from the river (Fig. 6) and the present height of 31 m have been added to the graph.

attention in an area where pingos are commonplace; clearly a much more rapid growth rate would be required. The fastest growth rate of 14 surveyed pingos in the Tuktoyaktuk Peninsula area has averaged 35 cm yr⁻¹ for a four-year period (1974-1978). The very rapid growth rate resulted from water accumulation in a large sub-pingo water lens. If a 35 cm yr⁻¹ growth rate were maintained for Akli-suktuk after it was 7 m high, the pingo would grow 17.5 m in 50 years, a rate probably sufficient to attract attention and to earn the name "growing fast". It seems evident that such a growth rate could not have resulted from the growth of segregated ice but could have occurred if water accumulated in a large sub-pingo water lens.

PINGO SUBSIDENCE

A pingo can subside in several ways. Pingos with pressurized sub-pingo water lenses frequently subside when the dilated overburden ruptures and water escapes to the surface as spring flow (Mackay, 1977). However, no signs of spring flow were observed at Aklisuktuk in the 1972 to 1979 observation period. Moreover, the subsidence seems far too gradual to be attributable to spring flow. A second possibility for subsidence is the slow downward escape of sub-pingo pore water by way of a through-going unfrozen zone (talik) beneath the pingo. In other words, the unfrozen ground would consolidate beneath the pingo as water was squeezed downwards and outwards under the superincumbent load of the pingo. However, this process seems unlikely for Aklisuktuk, because subsidence is confined to the top of the pingo whereas consolidation would likely affect a larger area. A third possibility is that the pingo ice core creeps slowly downhill much like the movement of a rock glacier. There is some evidence, for example, that the lower slopes of Ibyuk Pingo, which is 50 m high, are creeping downhill (Mackay, 1979). When a 1932 photograph of Aklisuktuk taken by Porsild is compared with a 1979 photograph taken from the same spot, there is a suggestion of subsidence of the pingo top and bulging of the sides, but the change is so little that the comparison is inconclusive.

CONCLUSION

The name Aklisuktuk ("growing fast") pre-dates 1848. A conservative estimate based upon the most rapid known pingo growth rate for 14 growing pingos in the Tuktoyaktuk Peninsula area indicates that growth certainly com-

menced before 1800 and probably before 1750. In order for the growth to have been recognized within the memory of one person, and thus to receive a name, water must have accumulated in a large sub-pingo water lens, because growth of a pure ice core would have been far too slow. The name "growing fast" is probably at least 200 years old. Surveys show that the top of Aklisuktuk is slowly subsiding, possibly from a downslope glacier-like creep of the ice-rich overburden and large ice core.

ACKNOWLEDGEMENTS

Field studies have been supported by the Geological Survey of Canada, Polar Continental Shelf Project (Energy, Mines and Resources), and grants from the Natural Sciences and Engineering Research Council of Canada. Logistic help has been provided by the Inuvik Scientific Resource Centre. The writer would like to thank his field assistants for surveys in the 1972 - 1979 period and numerous local inhabitants for discussions on the growth of pingos.

REFERENCES

- LEFFINGWELL, E. de K. 1919. The Canning River region, northern Alaska. Washington: Geological Survey Professional Paper 109. 251 p.
- MACKAY, J.R. 1977. Pulsating pingos, Tuktoyaktuk Peninsula, N.W.T. *Canadian Journal of Earth Sciences* 14(2):209-222.
- . 1979. Pingos of the Tuktoyaktuk Peninsula area, Northwest Territories. *Géographie Physique et Quaternaire* 33(1):3-61.
- PIHLAINEN, J.A., BROWN, R.J.E. and LEGGET, R.F. 1956. Pingo in the Mackenzie Delta, N.W.T. *Bulletin of the Geological Society of America* 67(August): 1119-1122.
- PORSILD, A.E. 1938. Earth mounds in unglaciated arctic northwestern America. *Geographical Review* 28:46-58.
- RICHARDSON, J. 1851. Arctic searching expedition. Vol. 1. London: Longman, Brown, Green and Longmans. 413 p.