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**PALYNOLOGY OF TWO SECTIONS
OF LATE QUATERNARY SEDIMENTS
FROM THE PORCUPINE RIVER,
YUKON TERRITORY**

SIGRID LICHTI-FEDEROVICH

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ABSTRACT

Two exposures of Quaternary sediments along the Porcupine River, northern Yukon Territory, were sampled. The upper part of the pollen and sediment stratigraphic record shows a close correlation with results from the Old Crow Flats area. Two glacio-lacustrine units occur in both sections, and it is likely that the upper is correlative with the Classical Wisconsin and the lower with an older glacial stage.

The sediments underlying the Lower Glacio-lacustrine Unit yield a pollen assemblage distinct from any occurring in younger strata. This assemblage is distinguished by the occurrence of pine and hazel pollen, associated with tree birch, alder and spruce. Subzones with and without hazel are recognized. The assemblage is interpreted as indicating the presence of a forest dominated by spruce and birch with some pine also present. The upper pollen zones are characterized by pollen assemblage types identical to those of the Old Crow area, which were interpreted as representing a transition from arctic tundra through boreal forest to subarctic or arctic tundra.

RÉSUMÉ

Des échantillons ont été prélevés sur deux affleurements de sédiments quaternaires le long de la rivière Porcupine, dans le territoire du Yukon. La partie supérieure de l'échantillon stratigraphique de pollen et de sédiment fait voir une corrélation étroite avec des résultats obtenus dans la région d'Old Crow Flats. Deux unités de formations glaciolacustres se retrouvent dans les deux coupes et tout indique l'existence d'une corrélation entre l'unité supérieure et le Wisconsin classique et entre l'unité inférieure et le stade glaciaire antérieur.

Les sédiments sous-jacents de l'unité glacio-lacustre inférieure ont donné un ensemble de pollen distinct de tous ceux se retrouvant dans des strates plus jeunes. Cet ensemble se caractérise par la présence de pollen de pin et de noisetier, associée au bouleau, à l'aulne et à l'épicéa. Il est possible de distinguer des sous-zones avec ou sans noisetier. Cet ensemble indiquerait la présence d'une forêt dominée par l'épicéa et le bouleau, et quelques pins. Les zones supérieures de pollen se caractérisent par des types d'ensemble de pollen identiques à ceux de la région d'Old Crow, qui indiqueraient un passage de la toundra arctique, par la forêt boréale, à la toundra sub-arctique ou un retour à la toundra arctique.

PALYNOLOGY OF TWO SECTIONS OF LATE QUATERNARY SEDIMENTS FROM THE PORCUPINE RIVER, YUKON TERRITORY

INTRODUCTION

An earlier paper (Lichti-Federovich, 1973) outlined the basic objectives of this general study of the Quaternary pollen stratigraphy of sediments from the Yukon Territory. In that paper, pollen diagrams based on analyses of alluvial sediments along the Old Crow River were interpreted as representing an interstadial vegetation sequence, from an early tundra through a forest or forest-tundra with reversion to tundra communities.

This paper presents the results of pollen analysis and radiocarbon age determinations of two sections of sediment exposed along the Porcupine River. These sites are at 67°28'N, 139°54'W, and 67°31'N, 140°15'W, respectively, 9.3 miles (15 km) and 23.5 miles (38 km) downstream from the settlement of Old Crow. The locations of the sites are shown in Figure 1, together with the positions of the six Old Crow sites described earlier (Lichti-Federovich, 1973).

The regional climate, physical geography, and botany of the area are very similar to those in the Old Crow Flats region, described in the previously cited paper to which the reader is referred for the scant details that are available.

ACKNOWLEDGMENTS

I wish to thank Dr. O.L. Hughes, Geological Survey of Canada, for collecting the samples and Dr. L.V. Hills, Department of Geology, University of Alberta, Calgary, for his assistance with critical identification. Valuable criticism of the manuscript was provided by Dr. W. Blake, Jr. and Dr. J.V. Matthews, Jr., Geological Survey of Canada, Ottawa.

FIELD AND LABORATORY PROCEDURES

Samples for pollen analysis were collected in sealed plastic bags by Dr. O.L. Hughes from freshly exposed river bank sections. Pollen samples were extracted by the standard methods (Faegri and Iversen, 1964), and pollen was concentrated by treatment in 50% hot HF.

Pollen frequencies are shown diagrammatically (Figs. 2, 3) as percentages of the total sum excluding all aquatics and spores of nonvascular plants.

RESULTS

Sediment Stratigraphy and Radiocarbon Age Determinations

The following account is based on the field notes of O.L. Hughes (pers. comm.) and his preliminary reports (Hughes, 1969, 1972) in which he suggested that the Upper and Lower Glaciolacustrine Units (Table I) were "deposited in a rather deep cold turbid lake into which glacial meltwater was being discharged." He proposes that the upper unit is correlative with the Classical Wisconsin and the lower with the pre-Classical Wisconsin or older.

Porcupine River 1

Four radiocarbon age determinations are available for the Porcupine River 1 section, as follows:

GSC-121	10,740±180 years, from a sample at the base of the woody peat layer (Dyck and Fyles, 1964).
GSC-952	32,400±770 years, shells at the 142-foot level (McAllister and Harington, 1969).
GSC-958	>37,000 years, wood at the 142-foot level (McAllister and Harington, 1969).
GSC-199	>41,300 years, organic material at the 112-foot level (Dyck <i>et al.</i> , 1965).

Porcupine River 2

The sediment stratigraphy as shown in Figure 3, consists of 100 feet (30.5 m) of coarse, medium to dark grey sand, 40 feet (12.2 m) of fine sandy silt with organic detritus, 18 feet (5.5 m) of glaciolacustrine dark grey clays and silts, 30 feet (9.1 m) of grey-brown silt, 15 feet (4.5 m) of glaciolacustrine grey-brown silt, with 10 feet (3 m) of unhumified woody peat. That is, the sediment stratigraphy is similar to that of Porcupine River 1, with two glaciolacustrine units separated by fine silts and sands, and an uppermost peat unit.

POLLEN STRATIGRAPHY

Four main pollen assemblage types (I-IV) were identified in the Old Crow sections, and all occur in this material. An additional assemblage type (V) has been recognized, in both Porcupine River sections, from the sediments underlying the Lower Glaciolacustrine Unit.

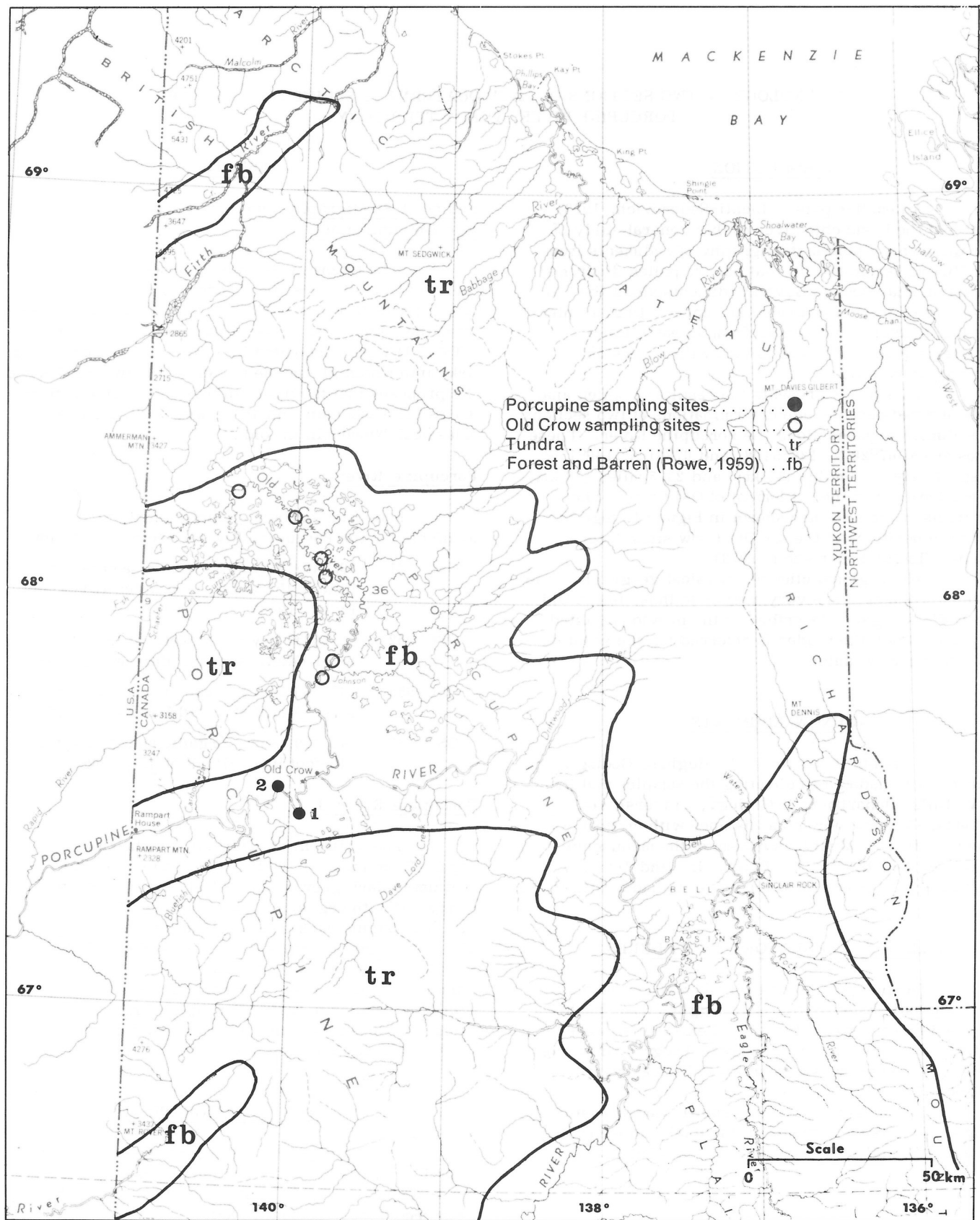


Figure 1. Sampling sites and vegetation zones.

Pollen Zone A extends discontinuously from the base of the section (0') to the 41-foot level consists of pollen assemblage type Va. It is distinguished from all other assemblage types recorded in both the Porcupine and Old Crow River sections by the presence in all samples of *Pinus* and *Corylus*. They occur with frequencies of 10-40% and 3-5% respectively. *Betula* (30-50%) is the dominant pollen type, associated with *Pinus* and *Corylus*, and consistent occurrences in low frequencies (1-5%) of *Alnus*, *Salix*, *Myrica*, Ericaceae, Cyperaceae and Gramineae.

Pollen Zone B is more or less continuous from the 47-foot to the 105-foot level, and with few exceptions consists of spectra belonging to assemblage type Vb. This assemblage type differs from Va in two respects - it lacks, or samples contain only traces of *Corylus* pollen and it is rich in pollen of herbaceous plants and bryophytes. In common with assemblage type Va, *Pinus* occurs in all samples at frequencies of 20-50%, associated with *Picea* (10-20%), *Betula* (30-45%), and relatively low percentages of *Alnus*, *Salix*, Ericaceae, Cyperaceae and Gramineae.

Pollen Zone C extends from the 105 to 148-foot level with gaps between 121 and 130 feet, and 110 and 115 feet, where the samples were barren. The pollen zone consists of spectra, which, although they show some variation between levels in the relative amounts of birch, grass, and sedge-type pollen, nevertheless conform with pollen assemblage type III of the Old Crow study (Lichti-Federovich, 1973). This is the Glumiflorae-herb type, consisting of a preponderance of pollen of grasses and sedges (totalling 50-70%), with small percentages of *Betula* (5-30%), *Picea* (1-15%) and *Salix* (1-5%) pollen, and a varied assemblage of herb types, all occurring in very low frequencies.

Pollen Zone D from 149 to 161 feet, consists of spectra matching assemblage type II- the *Picea-Betula*-Glumiflorae-herb assemblage. It is dominated by spruce (20-60%), associated with birch (5-15%), and low frequencies of sedge, grass, and pollen of herbaceous plants. The herb element is less rich than in some of the spectra of this type from the Old Crow sections, but the overall resemblance is certain.

Pollen Zone E from 162 to 167 feet consists of spectra of the Glumiflorae-herb (type III) assemblage.

Spectra from the postglacial peat sediment are grouped in three zones as follows:

Pollen Zone F from 192 to 194 feet consists of two spectra which match reasonably well the Old Crow *Betula*-herb (assemblage type IV) spectra with their dominance of dwarf birch pollen (60-70%) and low frequencies of sedge, grass, and willow pollen.

Pollen Zone G from 194 to 198 feet consists of three spectra of the assemblage type II group, as described above.

The top sample, at 200 feet, is sufficiently distinct that it might be useful to set it aside as pollen zone H, consisting of a spectrum matching assemblage type I, showing dominance of *Picea*, *Betula*, *Alnus* and Ericaceae.

Only 11 levels in the 200-foot section of sediment yielded pollen adequate for standard analysis.

Pollen Zone A consists of only two samples, at the 45-foot (13.7 m) and 60-foot (18.3 m) levels. The two spectra are similar and closely resemble pollen assemblage type Va which was found in pollen zone A of Porcupine River 1. An additional interesting feature of this zone is the occurrence of two types of *Picea* pollen that are distinguished by size. One type, confined to this pollen zone and to samples in pollen zone B, resembles *Picea banksii* pollen as described by Hills and Ogilvie (1970). Otherwise the spectra have about 20% pine, 30% birch, 20% alder, about 5% hazel, 2% *Myrica* and 5-10% Ericaceae. Non-arboreal pollen is sparse, being represented by very low frequencies of sedge and grass.

Pollen Zone B includes five sample levels, similar in pollen proportions to assemblage type Vb as identified in pollen zone B of Porcupine River 1. The zone is characterized by pine (30-40%), alder (5-10%), and a rich herb assemblage with sedge (10-30%), grass (2-5%), and a varied group of herbs in extremely low frequencies (<2%). The presence of hazel in low frequencies is a slightly irregular feature of the Vb assemblage type, but it is designated Vb because the hazel frequencies are so low.

Pollen Zone C consists of two spectra at the 130- and 138-foot levels which resemble assemblage type III.

Pollen Zone D also includes only two spectra, which resemble assemblage type II.

General Pollen Stratigraphy

Any attempt to draw conclusions from or compare with other sections the Porcupine River 2 results will be tenuous, as only samples from 11 levels yielded adequate pollen counts for analysis. However, it might be useful to compare the Porcupine River results with those from Old Crow. The tentative generalized pattern described from the Old Crow sections was that the sediments below the Upper Glaciolacustrine (Classical Wisconsin) Unit showed a sequence of pollen assemblage types from assemblage Type III or IV through II to I (Lichti-Federovich, 1973). This correlates closely with Porcupine River 2, and there is some rough agreement with Porcupine River 1. The closest correlation is with Old Crow 1; there is also a measure of correlation between the pollen stratigraphy of the uppermost, postglacial peats of Porcupine River 2 and the only Old Crow sections (4 and 5) which yielded postglacial pollen spectra (Lichti-Federovich, 1973). The sequence of assemblage types from older to younger is IV→II→I.

In both Porcupine River sections, the pollen stratigraphy below the Lower Glaciolacustrine Unit from the lowermost sampled levels is Va→Vb→III.

These general stratigraphic correlations are summarized in Figure 4.

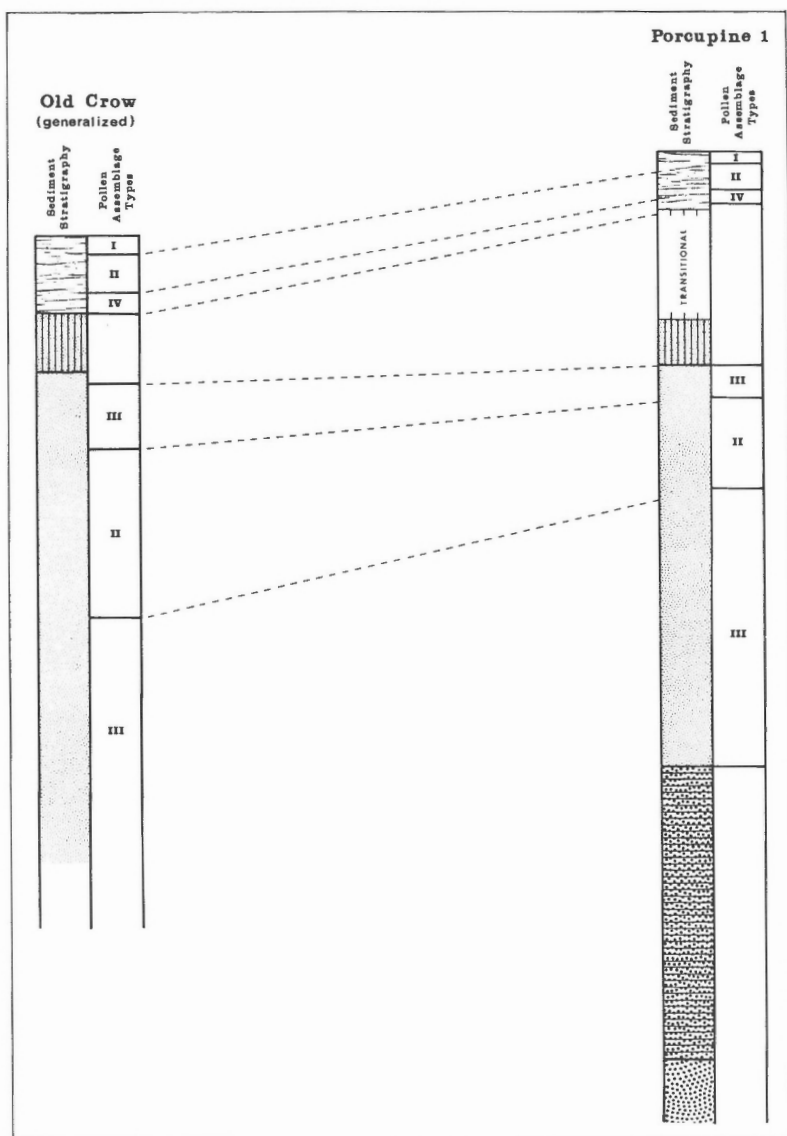


Figure 4. General sediment and pollen stratigraphy of a generalized Old Crow stratigraphy and the Porcupine River 1 section.

INTERPRETATION

The vegetation reconstructions already offered for the pollen assemblage types I-IV apply equally to the Porcupine River material and will not be repeated here, but the new types (Va, Vb) require attention.

Pollen Assemblage Type Va

The high relative frequency of arboreal pollen suggests forest cover, with spruce, birch, and pine, in order of decreasing abundance, as the main trees. Alder was locally common, and hazel occurred sporadically. The relatively high frequencies of ericoid pollen suggest that open heath areas occurred throughout the landscape. However, these suggestions are quite tentative and the reconstruction is weakened

further by the strong possibility that pollen in such a deposit has been partly redeposited and may have undergone differential removal or destruction. With the exception of one spectrum (Lost Chicken Site - Matthews, 1970), the assemblage constituting the Va type has no contemporary or Late Quaternary analog in northwestern North America.

Presence of significant amounts of hazel pollen in Va is important because at present hazel is confined to the southern fringes of the modern boreal forest and reaches its maximum abundance in the aspen parkland and deciduous forest zone.

The pollen evidence for a second spruce type, as indicated in the older Porcupine River 2 sediment, and the discovery of megafossils of cones intermediate in size between those of *Picea glauca* and the extinct *P. banksii* (L.V. Hills, pers. comm., 1972; Hills and Ogilvie, 1970), at the lowermost unit of the Porcupine River 1 section, suggest that this pollen stratigraphic unit (Va) represents an older Quaternary boreal forest vegetation with no exact modern equivalent.

Pollen Assemblage Type Vb

The slightly higher frequencies of pine, associated with higher frequencies of sedge and grass pollen and a relatively rich herb component, suggest an open pine-spruce-birch forest type with herb-dominated treeless communities. Whether this was equivalent to a modern pine savannah as found in warm-temperate climates or to a pine-rich forest-tundra or taiga, is open to question.

Environmental Reconstructions and Conclusions

Any paleoecological inferences from these and the Old Crow data should be regarded as highly tentative and speculative.

It is suggested that a spruce-pine boreal forest occupied the area during a pre-Wisconsin (? Sangamon) interglacial. Climate may have been roughly similar to that in the southern part of the contemporary boreal forest. Immediately before the Early Wisconsin Glaciation (represented by the Lower Glaciolacustrine Unit), this forest zone was replaced by a tundra landscape with abundant grass-sedge-herb communities.

The sequence of vegetational changes that occurred during the episode between the Early and Late Wisconsin Glaciations (Lower and Upper Glaciolacustrine Units) suggests a shift from an initial arctic climatic regime to a subarctic-boreal climate reverting back again to an arctic climate.

The sporadic evidence from the postglacial sediments in these deposits permits even more tentative conclusions. The sequence of pollen assemblage types, from IV through II to I, suggests a zonal succession

Table I

Sediment stratigraphy of the Porcupine River 1 section

Unit	Description	Approx. Thickness	
		(ft)	(m)
Post Glaciolacustrine	Silt, probably eolian	1.5	0.5
	Peat, wood, mostly unhumified	3	1.0
	Silt, grey-brown, with twig and wood lenses, thin peaty layers; probably fluvial	17.5	5.3
	Clay, silty, dark grey (moist), pale grey (dry); sediments slumping and flowing and poorly exposed; glaciolacustrine	10.5	3.2
Deltaic, lacustrine and fluvial sediments	Silt and very fine grained sand, dark grey to grey-brown (moist), yellow-brown (dry); gravel lens 1 foot thick in middle of unit; lacustrine and fluvial	37	11.3
	Silt, grey-brown (moist), yellow-brown (dry), lenses of gravel and of twigs and wood; bedding in upper 3 to 4 feet highly convoluted by cryoturbation	20.5	6.2
Lower Glaciolacustrine	Silt, dark brown-grey (moist), medium brown-grey (dry); massive; markedly jointed with oxidized joint surfaces; glaciolacustrine	41.5	12.6
"Older" deltaic, lacustrine, and fluvial sediments	Silt, sand, fine gravel bedded, grey brown to yellow brown; twig and wood layers abundant in lower 25 feet; upper 4 feet highly convoluted by cryoturbation	40	12.2
	Sand, coarse, and fine gravel, with a few thin silt layers, grey, in part oxidized to dull red-brown; abundant wood detritus	12	3.7
	Cryoturbate layer	5	1.5

from an early birch tundra to a spruce forest stage, which was then replaced by the modern forest-tundra. Such a sequence has been documented thoroughly from sites east of the present study area by Ritchie (in press), and interpreted in terms of a postglacial warming and subsequent cooling.

All of the pollen assemblage types recorded here and from Old Crow lack significant amounts of Tertiary pollen types; thus it is likely that the oldest unit (pollen assemblage type Va) is of mid- or early Quaternary age.

References

- Dyck, W. and Fyles, J. G.
1964: Geological Survey of Canada radiocarbon data III; Radiocarbon 6, p. 167-181.
- Dyck, W., Fyles, J. G. and Blake, W., Jr.
1965: Geological Survey of Canada radiocarbon data IV; Radiocarbon 7, p. 24-26.
- Fægri, K. and J. Iversen
1964: Textbook of pollen analysis; 2nd ed. revised, Hafner, New York, 239 p.

- Hills, L. V. and R. T. Ogilvie
 1970: *Picea banksii* n. sp. Beaufort Formation (Tertiary), northwestern Banks Island, arctic Canada; Can. J. Bot., v. 48, no. 3, p. 457-464.
- Hughes, O. L.
 1969: Pleistocene stratigraphy, Porcupine and Old Crow Rivers, Yukon Territory; in Rept. of Activities, Pt. A, April to October, 1968; Geol. Surv. Can., Paper 69-1, p. 209-212.
 1972: Surficial geology of northern Yukon Territory and northwest district of Mackenzie, Northwest Territories; Geol. Surv. Can., Paper 69-36.
- Lichti-Federovich, S.
 1973: Palynology of six sections of late Quaternary sediments from the Old Crow River, Yukon Territory; Can. J. Bot., v. 51, no. 3, p. 553-564.
- Matthews, J. V., Jr.
 1970: Quaternary environmental history of Interior Alaska: Pollen samples from organic colluvium and peats; Arctic and Alpine Research, v. 2, no. 4, p. 241-251.
- McAllister, D. E. and Harington, C. R.
 1969: Pleistocene grayling, *Thymallus*, from Yukon Canada; Can. J. Earth Sci., v. 6, no. 5, p. 1185-1190.
- Ritchie, J. C.
 Modern pollen assemblages at the Arctic Tree Line Mackenzie Delta area, N.W.T., Canada; Can. J. Bot., v. 52. (in press)
- Rowe, J. S.
 1959: Forest regions of Canada; Can. Dept. North. Affairs Nat. Resour., Forest. Br. Bull. 123, p. 71.