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Late Cenozoic geology, Ancient Pacific Margin NATMAP Project, report 5: paleoecology and proxy climatic change records, south Klondike placer region, Yukon Territory

Lionel E. Jackson, Jr., Duane G. Froese, Alice M. Telka, John A. Westgate, Shari J. Preece, John E. Storer, and Crystal A. Huscroft

2002

Natural Resources Canada | Ressources naturelles Canada

Canada

Catalogue No. M44-2002/A2E-IN
ISBN 0-662-31436-0

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Late Cenozoic geology, Ancient Pacific Margin NATMAP Project, report 5: paleoecology and proxy climatic change records, south Klondike placer region, Yukon Territory

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Jackson, L.E., Jr., Froese, D.G., Telka, A.M., Westgate, J.A., Preece, S., Storer, J.E., and Huscroft, C.A., 2002: Late Cenozoic geology, Ancient Pacific Margin NATMAP Project, report 5: paleoecology and proxy climatic change records, South Klondike placer region, Yukon Territory; Geological Survey of Canada, Current Research 2002-A2, 16 p.

Abstract: A proxy record of paleoclimates over the past three million years in west-central Yukon Territory is emerging from numerous studies of fossil pollen, plants, and animals. As a part of the Late Cenozoic geology component of the ongoing Ancient Pacific Margin NATMAP Project, organic-rich sediments overlying fluvial gravel have been routinely sampled in the south Klondike placer district to further detail this proxy record. Although several sites yielded rich assemblages of plant and invertebrate and vertebrate remains, only the Eddas Bench site along Thistle Creek yielded a datable record extending to the early Pleistocene. At least one Early Pleistocene glacial to interglacial cycle is recorded within it. A multidisciplinary investigation is underway.

Résumé : De nombreuses études sur les pollens, les plantes et les animaux fossiles commencent à fournir des données indirectes sur les paléoclimats des trois derniers millions d'années dans le centre ouest du Territoire du Yukon. Dans le cadre du volet sur la géologie du Cénozoïque tardif du Projet de l'ancienne marge du Pacifique du CARTNAT, des données indirectes permettant de rendre plus précises les reconstitutions paléoclimatiques ont été obtenues par le prélèvement routinier des sédiments riches en matière organique qui reposent sur les graviers fluviatiles dans la partie sud du district placérien du Klondike. Bien que plusieurs sites aient livré de riches assemblages de restes de plantes, d'invertébrés et de vertébrés, seul celui du banc Eddas, le long du ruisseau Thistle, a produit une suite de données chronologiques qui permette de remonter jusqu'au Pléistocène précoce. On y relève au moins un cycle glaciaire-interglaciaire au Pléistocène précoce. Une recherche multidisciplinaire est en cours.

INTRODUCTION

The west-central Yukon Territory is largely beyond the all-time limits of Late Cenozoic glaciation or has not been ice covered since the late Pliocene or early Pleistocene (Bostock, 1966; Duk-Rodkin, 1999; Froese et al., 2000, 2001; Jackson et al., 2001). In this region, the lack of glaciation, progressive fluvial incision, and colluvial burial have preserved sediments potentially spanning the past three million years making it unique in Canada (Froese et al., 2000, 2001). The exploitation of gold placers has created many excellent exposures permitting the detailed study and sampling of Late Tertiary and Quaternary sedimentary sequences. In the Klondike placer district (Fig. 1), fluvial, glaciofluvial, eolian, and colluvial sediments have yielded records of past soils, plants and their pollen, and vertebrate and invertebrate remains. Absolute dating of this fossil record is underway through radiometric dating and geochemical identification of abundant tephra beds interstratified with fossil-bearing sediments (Westgate et al., 1990; Preece et al., 1999, 2000) the paleomagnetic study of the sediments (Froese et al., 2000, 2001), and the stratigraphic study of permafrost developed within them (Kotler and Burn, 2000). Through these efforts, a proxy record is emerging (e.g. Fraser and Burn, 1997; Schweger et al., 1999; Froese et al., 2000, 2001; Kotler and Burn, 2000) of regional climatic change including glacial and interglacial cycles and their intensity.

The Late Cenozoic geology component of the ongoing Ancient Pacific Margin NATMAP Project has provided an opportunity to continue building this stratigraphy in the Klondike placer district and to expand it to unglaciated areas to the south (south Klondike placer district) in the course of surficial geology mapping in the Stewart River map area (115 N and -O). This paper reports on analyses of preliminary ‘test’ paleoecological sampling primarily from colluviated eolian sediments overlying alluvial and glaciofluvial terrace gravels (Fig. 1, 2). Particular emphasis is placed on an impressive succession of sediments exposed along Thistle Creek, which appear to preserve an exceptional proxy record of paleoenvironmental and climatic change. They also contain a succession of tephra beds permitting the absolute dating and correlation of this sequence with other records in the Yukon Territory and Alaska.

Paleoenvironmental studies have applications beyond the reconstruction of the geological history. In the Stewart River map area, the absolute and relative dating of fluvial, glaciofluvial, and overlying sediments provides an understanding of when and how placer deposits accumulated. This

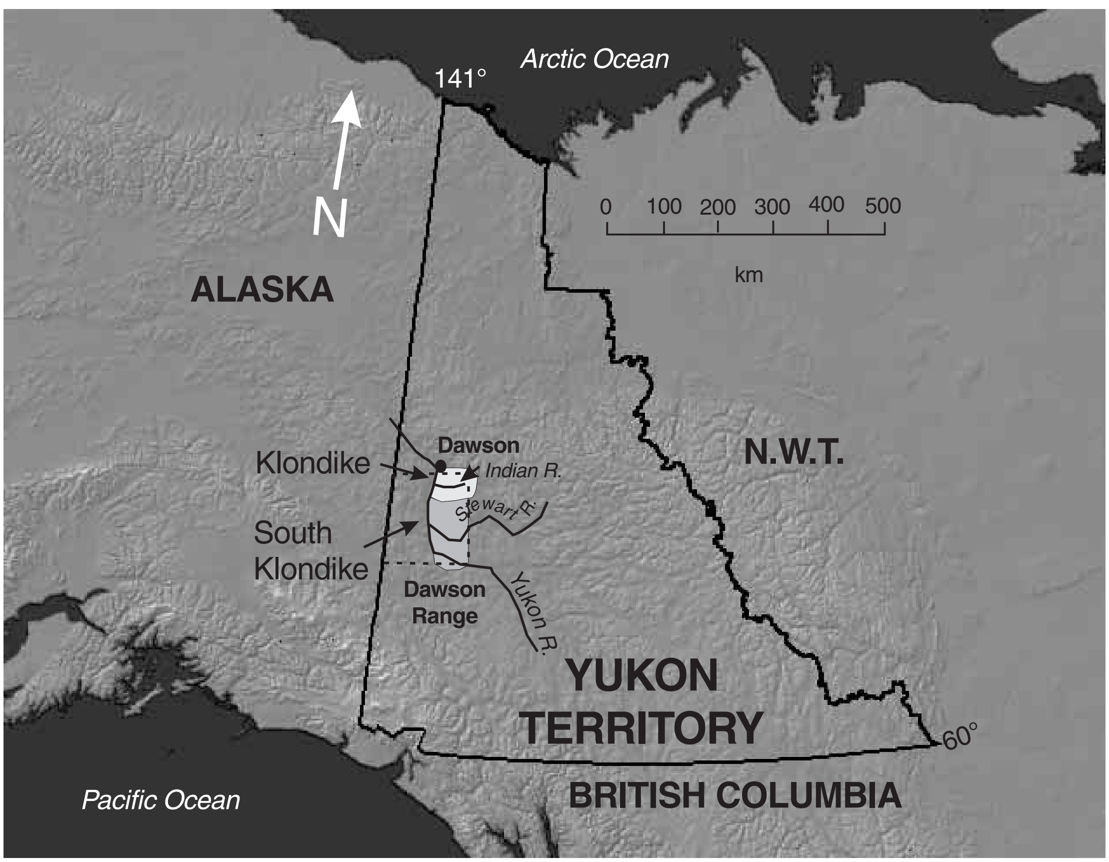

Figure 1. *Digital shaded-relief map showing the location of the Stewart River map area (dashed line) and the Klondike placer district (light shaded area) and the south Klondike placer district (dark shaded area) in west-central Yukon Territory.*

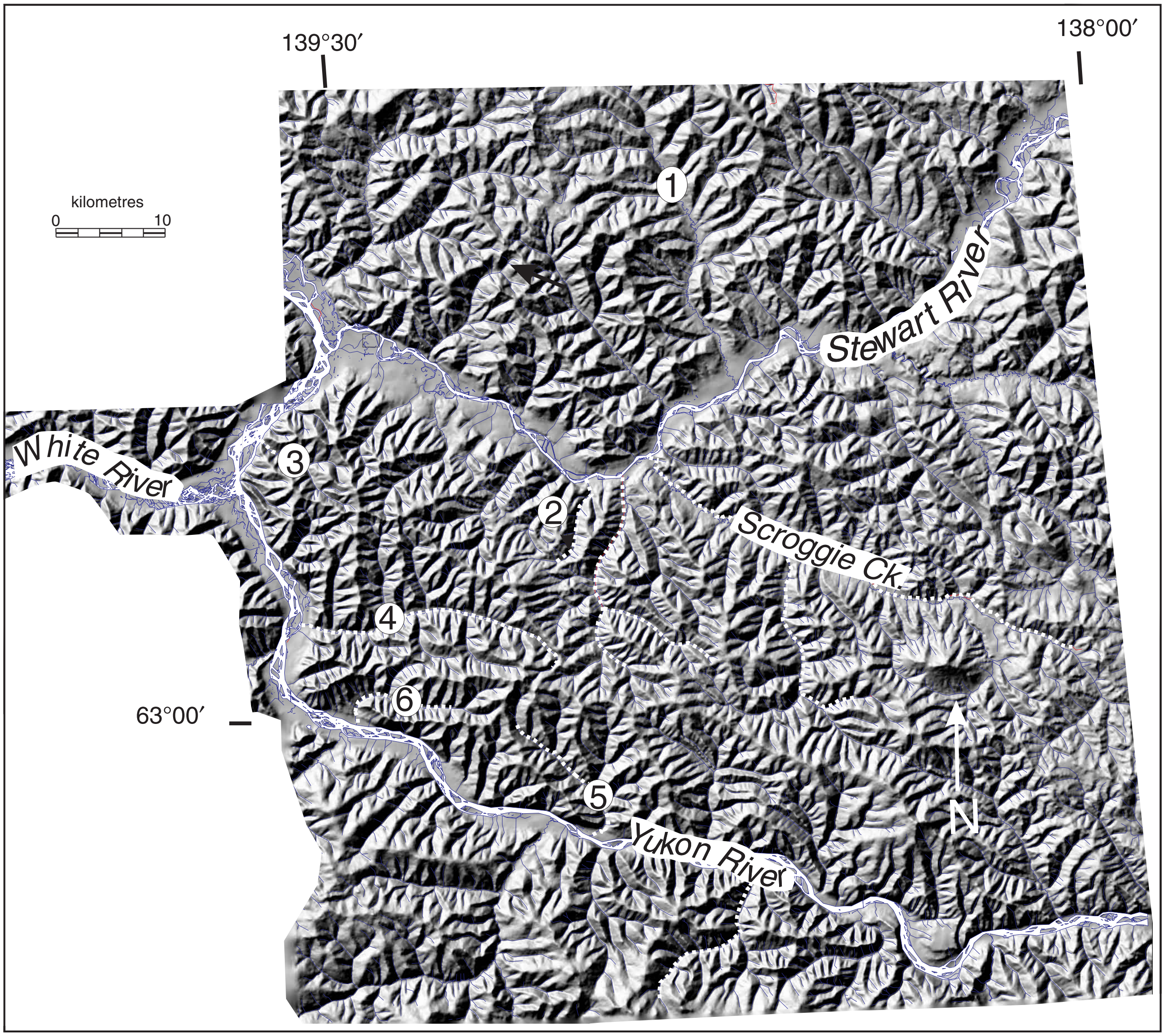

Figure 2. *Location of exposures sampled for paleoecological information in the south Klondike placer district.*

understanding has potential as an exploration tool for targeting placers of specific ages that are known to be of high grade. Reconstructions of paleoenvironments, particularly those associated with interglacial periods, indicate how typical the present climate is with respect to similar climatic periods over the past hundreds of thousands or several million years. Such comparisons have bearing on intelligently dealing with global warming in west-central Yukon Territory; paleoclimatic proxy data help to determine the degree of naturally occurring climatic variability and to understand the impact of climatic warming in this region during the recent geological past. Such information can help decision makers to better plan for and mitigate the effects of climate change as a part of land-use management.

REGIONAL SETTING

The south Klondike placer district lies within the Yukon Plateau, a gently west-sloping, incised upland consisting of concordant ridges locally surmounted by rounded peaks, locally termed ‘domes’. Ridges are separated by deeply incised V-shaped valleys. The plateau is considered to be an uplifted erosional surface produced as a result of extensive subaerial exposure during the early mid- Tertiary (Hughes et al., 1969). The district can be defined as an area of west-central Yukon Territory bounded to the north by the Indian River basin, to the south by the Dawson Range, to the west by the northerly trending Yukon River, and to the east approximately by longitude 138° W. It includes drainage basins undergoing active and extensive placer mining such as Thistle and Black Hills creeks and many other basins that have been mined periodically over the past decade and continue to be mined on a smaller scale.

Within this area, gravel-dominated sediments underlie terraces or flights of terraces along the Yukon and Stewart rivers, as well as major tributary valleys. They also underlie present valley floors. Basalt flows locally overlie terrace gravels or are overlain by terrace gravels of fluvial or glaciofluvial origin. Radiometric dating of these flows indicate that these terraces range from late Tertiary to Middle Pleistocene (Huscroft et al., 2001a, b). Terrace or bench gravels, as they are commonly referred to by placer miners, are commonly partly or totally buried by varied mixtures of colluviated eolian silt and organic sediments referred to as 'muck'. This muck is commonly frozen and can contain large ice bodies. Muck sequences in the Klondike area have been shown to have accumulated over periods ranging from the last few tens of thousands of years to spans of hundreds of thousands of years earlier in the Pleistocene (Froese et al., 2000, 2001; Kotler and Burn, 2000; Westgate et al., 2000).

METHODS

During the 1999, 2000, and 2001 field seasons, exposed sequences of gravel, sand, silt, and organic sediments containing organic remains were measured, described, and

Table 1. Summary of paleoecology investigations.

Figure 2 site no.	Location	UTM (zone 7V) EASTING NORTHING	Polarity (N = normal; ND = no data)	Description	Paleoenvironmental record
1	Black Hills Creek	609505, 7035728	N	Seven metres of interbedded silt, sand, and pebble gravel overlying 2.5 m of cobbly, gold-bearing gravel, cryoturbated in part. Gravel overlies a strath 7 m above Black Hills Creek. Nine samples taken from fine sand and silt beds.	Sediment is largely devoid of identifiable organic material. Two samples indicate vegetation similar to that of today.
2	Brewer Creek	599376 7004568	ND	Organic-rich stratified silt overlying placer gravel: one sample taken	Insect fossil evidence indicates a very dry environment. Insect taxa are diagnostic of dry steppe-tundra habitats dominated by grasses, Chenopodiaceae, and *Artemisia*.
3	Frisco Creek	576609 7009001	ND	Exposure of 2.1 m of frozen organic-rich silt and woody debris overlying 1.2 m of angular placer gravel resting on bedrock: three samples taken at base, middle, and top of exposure.	The combined plant and insect fossil evidence suggests a herb-shrub-type tundra environment. Although few fossil spruce needles occur in this sample, spruce is not growing at the site. Thin stands are probably growing in the region.
4	Thistle Creek (Eddas Bench)	area of 585278 6994889	ND	Fifteen metres of organic and inorganic silt beds, woody debris, and segregated ice: three samples taken near top of exposure (1999) and four near base (2000). *See* Figures 3 and 4 and Appendices 1 to 4	The combined plant and insect fossil evidence indicates environments ranging from closed-canopy spruce forest to tundra. Numerous tephra units present. Sediments may span a significant part of the Pleistocene.
5	Ballarat Creek	604400 6977450	N	Three samples taken from organic-rich horizons within stratified fine sand and silt.	A closed-canopy spruce forest environment was indicated in one sample from the abundance of fossil spruce needles and boreal forest insect remains including bark beetles. Plant and insect assemblages indicative of steppe-tundra and herb-tundra were found in the remaining two samples.
6	Kirkman Creek	area of 586406 6987100	N	Five samples taken from 9 to 10 m of organic-rich silt and sand overlying placer gravel along several adjacent placer excavations along Kirkman Creek.	Environments ranging from riparian, within an overall herb-tundra setting, to herb-tundra to steppe-tundra. Fossil sheep and mammoth remains were also found.

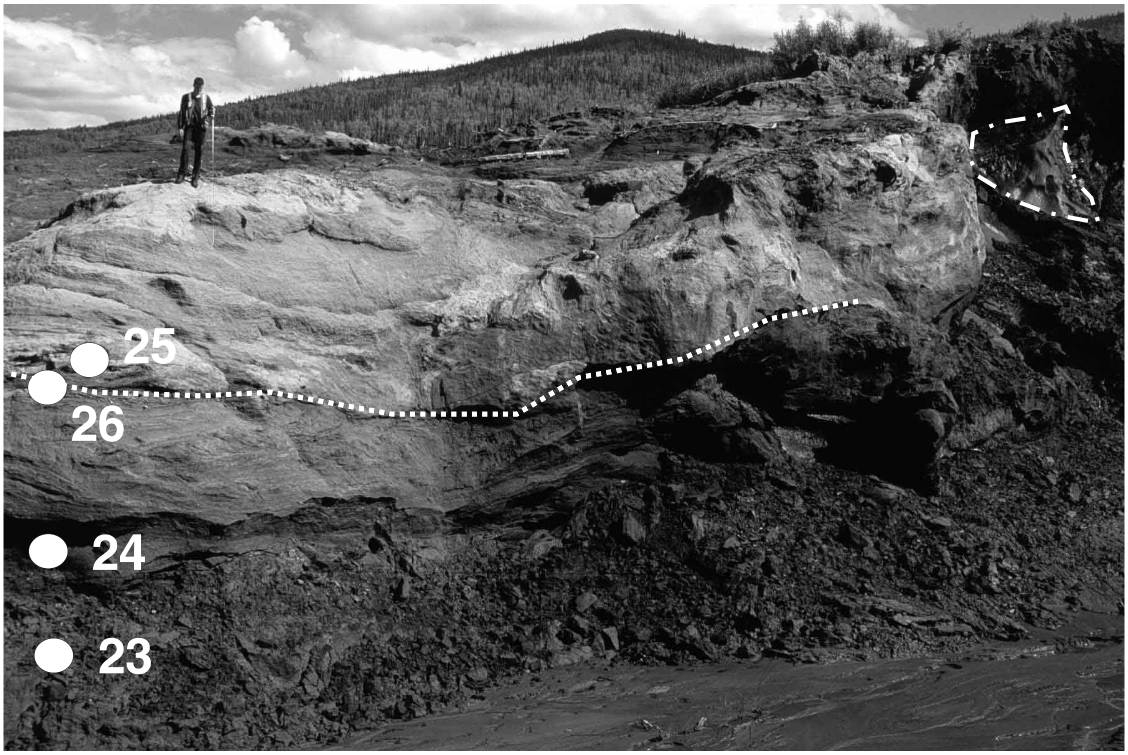

Figure 3. Base of Eddas Bench exposure, July 2000. Locations of paleoecology samples from the lower part of the section plotted in Figure 4 and described in Appendices 1 to 4 are indicated. The dotted line represents the boundary between the top of organic unit 1 and overlying silt (Fig. 4). The dashed line outlines segregated ice. Photograph by P.A. Friele

sampled in the course of surficial geology mapping. Organic-bearing intervals were sampled for macrofossil analysis. Tephra beds, ranging from 20 cm to discontinuous 1 mm laminae, were sampled for identification. Paleomagnetic samples were taken where sufficiently fine sediments were present to indicate whether the sediments were deposited during the present Bunhes Normal interval or prior to the last (Matuyama/Brunhes) magnetic reversal ca. 780 ka BP (Cande and Kent, 1995). The purpose of this initial sampling was to determine whether the sediments might contain significant paleoenvironmental indicators that would warrant more detailed sampling during subsequent field seasons.

Paleoecological samples for analysis were weighed and the volume approximated using the wet displacement technique. Macrofossils within the organic-bearing sediments were extracted by gentle wet sieving using nested sieves (4.0, 0.85, and 0.425 mm). Plant and insect remains including arthropod fragments, molluscs, and rodent teeth and bones were identified using a stereomicroscope, keys, and illustrations and verified using modern collections of vascular plant remains and insects.

RESULTS

Table 1 lists names and locations and some descriptive notes of sites visited and sampled during the 1999 and 2000 field seasons. Although several sites such as Frisco and Kirkman creeks yielded samples with rich assemblages of plant and invertebrate and vertebrate remains, only one site, the Eddas Bench placer workings along Thistle Creek, yielded an apparently long and datable record beyond the late Pleistocene. It is discussed in more detail below.

Eddas Bench site, 1999–2000 field seasons

The Eddas Bench (UTM 585278, 6994889; lat. 63º04′23"N, long. 139º18′46"W) consists of a thick muck sequence with bodies of ground ice overlying a gravel terrace 25 m above Thistle Creek on the south (north-facing) side of Thistle Creek valley (Fig. 3). It is approximately 100 km south of Dawson. A nearly continuous 15 m high exposure has been created by hydraulic monitoring of the muck sequence in order to remove it in preparation for mining the underlying placer gravels. The exposure was drawn to the attention of the

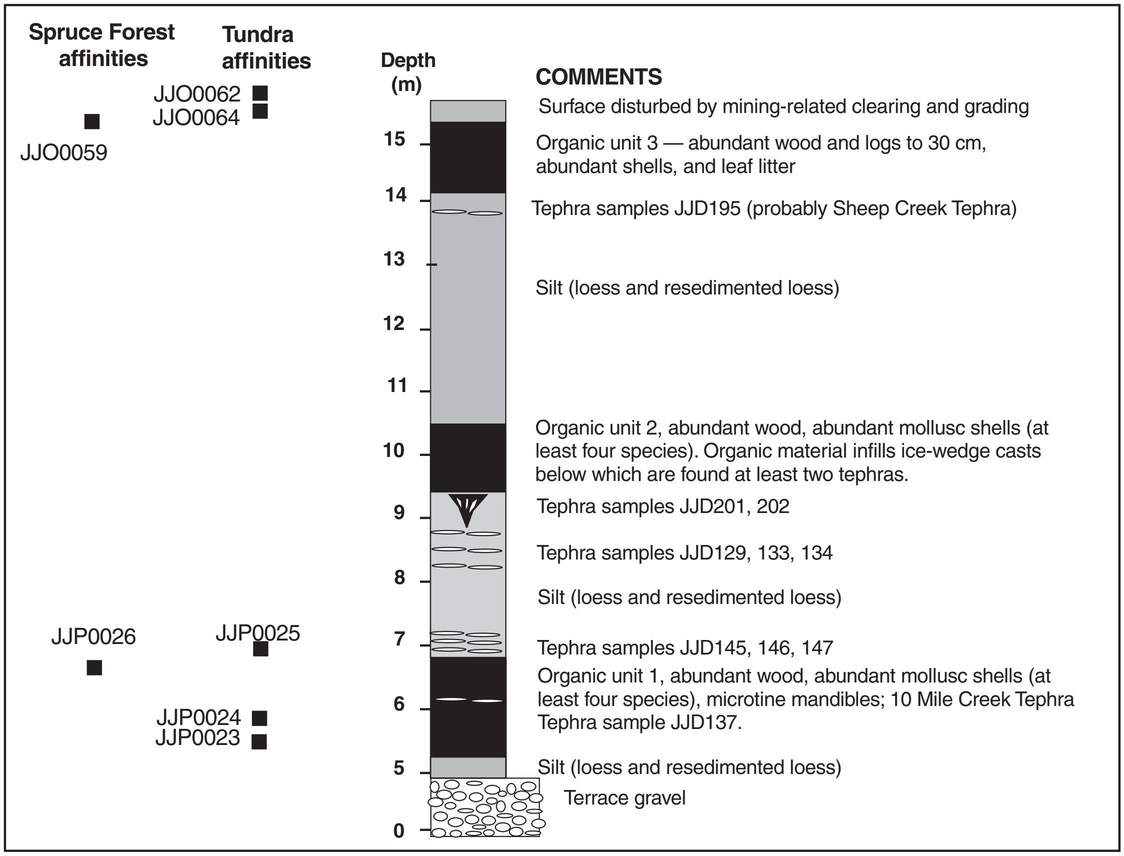

***Figure 4.** Composite generalized stratigraphic section of Eddas Bench with locations of tephra samples and paleoecological samples taken in July 2000 along with generalized environmental affinities.*

GSC (Lionel Jackson and Edward Little) in 1999 by Stuart Schmidt, who was mining in the area at that time. Jackson and Little noted several buried beds rich in logs and other coarse organic detritus and interstatification of these fine sediments with fan gravels. These gravels yielded megafaunal remains including bison and mammoth. They took three samples for paleocological analysis from the upper 3 m of the exposure (Fig. 4). A tephra was noted near the surface, but was not analyzed because it was mistakenly assumed to be the Late Holocene White River tephra. The site was revisited and sampled further during the 2000 field season under the direction of Crystal Huscroft. Although this work was hampered by inclement weather, two tephra beds were sampled, one near the top and one near the base of the exposure. An articulated skeleton of a ground squirrel was found within its burrow and several paleoecological samples were submitted to AMT for macrofossil analysis.

Analysis of the 1999 and 2000 field samples provided some significant results that came together prior to the 2001 field season. The tephra beds were analyzed by SJP and JAW and determined to be the Sheep Creek Tephra (upper) and the Ten Mile Creek Tephra (lower). The Sheep Creek Tephra has an age of 190 ± 10 ka (Berger et al., 1996). The Ten Mile Creek Tephra was previously located along a high-level terrace, within gravel, on a tributary to the Sixtymile River 50 km northwest of Eddas Bench. High terraces in this area have been shown to be >1.5 Ma, providing a preliminary estimate for the age of this tephra. On this basis, the Eddas Bench site is estimated to have a record of climatic events and sedimentation spanning perhaps one million years. The analysis of paleoecological samples taken near the base of the exposure (Fig. 3, 4) found evidence of vegetation and insect assemblages indicative of biomes such as steppe-tundra that grew under climates dramatically different from today's climate, which supports spruce forest. Appendices 1 to 4 include detailed results of macrofossil identification from the lowest four samples. The paleoecology samples (averaging about 1 kg) were also screened for microtine rodent teeth, which were found in some samples, suggesting that a successional record of these prolific vertebrates exists within the Eddas Bench sequence. The upper samples collected in 1999 (samples JJO0059, JJO0062, and JJO0064, Fig. 4) likely are associated with organic unit 3 as shown in Figure 4, but further work is necessary to confirm this.

Eddas Bench, 2001 field season

Results from preceding field seasons were built upon during the 2001 field season with a detailed sedimentological study of the site by DGF. This study included closely spaced paleoecological and paleomagnetic sampling. Figure 4 is a composite section through the site. The sediments at the site consist of loessal silt with multiple discrete distal tephra beds. On the basis of field descriptions and sampling, seven separate tephra beds are estimated to occur in the section. Organic silt interbedded with loessal silt was found to contain abundant macrofossils including at least four species of gastropods, well preserved wood, cones, needles, and microtine rodent fossils, and large mammals remains including horse, mammoth, bison, caribou, and sheep. JES bulk sampled nearly 2000 kg of sediment for microtine rodent material through the section using DGF's measured sections for stratigraphic control.

Eddas Bench investigations, future field seasons

Work on the Eddas Bench exposure during the 2001 field season had considerable immediacy. Like all placer mine exposures, it is ephemeral and will eventually be removed or overgrown. The identification of all the tephra beds found at the site should be completed from September 2001 through May 2002. This, along with a determination of the polarity of the 115 paleomagnetic samples taken at 10 cm intervals through the section, will provide a chronological context for the sediments. The analysis of organic macroremains and the identification of microtine rodent material should be underway during this period. In addition to the investigation of organic macroremains, Dr. Charles Schweger, University of Alberta, will process splits of the paleoecological samples for pollen extraction and identification. Pollen investigation may clarify regional vegetation patterns, complementing the local flora and fauna identified in the macroscopic samples.

In future field seasons, additional work is anticipated at Eddas Bench. This site likely has implications for understanding the history of permafrost in the discontinuous permafrost zone of the Yukon Territory. At least three prominent organic silt units contain retransported wood, and organic material from the adjacent hillslope (Fig. 4). They are the result of periods of warmer climate during which the permafrost table thawed, triggering slurries of hillslope vegetation and soil material that buried organic remains. Dating of these thaw unconformities, likely analogous to the organic sediments capping the Klondike 'mucks' of Fraser and Burn (1997), will provide an indication of the 'warmest' interglacials over the last 1 Ma or more and may clarify whether or not permafrost is a normal environmental factor in the central Yukon Territory during interglacial periods (*see* Burn, 1994). A permafrost specialist will be invited to join the field investigation during the 2002 field season. Adjunct to this is the possibility of using amino-acid racemization from gastropod samples for studying site paleothermometry.

ACKNOWLEDGMENTS

The authors wish to thank the support, encouragement, and help of Stuart Schmidt in completing the work on Eddas Bench. He trucked nearly 2 tonnes of bulk sediment samples 7 km to the Yukon River and barged them over 150 km to Minto. This work would have not been possible without his help. We also wish to thank many other placer miners in the Black Hills, Barker, Thistle, Kirkman, and Frisco creeks area for help, support, and the occasional breakfast and outboard motor oil when we ran out. We are particularly grateful to Joel White, Eric Stretch and the Feller family in this regard. We gratefully acknowledge assistance in the field by Aleksandar Miskovic, Pierre Friele, and Brent Ward.

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APPENDIX 1

Sample no.: JJP0023 Lab no.: 6-19 Collector: Crystal Huscroft Submitters: Crystal Huscroft, Lionel Jackson, Jr. Material: grey, organic-rich, finely bedded silt Sample volume: ~200 mL (weight: ~500 grams) dry	
PLANT MACROFOSSILS:	
Fungal remains:	
fungal sclerotia	+ ~15
Vascular plants:	
Chenopodiaceae ....‘goosefoot family’	
Chenopodium sp.	+ small fragment: 1
Other:	
charcoal	+ fragments: 3
ANIMAL MACROFOSSILS:	
ARTHROPODA	
INSECTA	
COLEOPTERA ....‘beetles’	+ mandible: 1, sternite: 1, trochanter: 1, larval head capsule: 0.5
Carabidae ....‘ground beetles’	+ metasternum: 1
Curculionidae .....‘weevils’	+ pronotal fragments: 5, elytral fragments: 2 (small), head fragment: 1
DIPTERA ....‘flies’	+ pupa: 1
Other:	
puparial fragments	+ ~15
bone	+ fragments: 3
Key: + taxon present, +++ taxon abundant Report based upon examination of organic material larger than 425 microns (0.425 mm) **Note:** The term ‘seed’ is used generically to include all forms of seeds including achenes, nutlets, etc.	

APPENDIX 2

Sample no.: JJP0024
Lab no.: 6-20
Collector: Crystal Huscroft
Submitters: Crystal Huscroft, Lionel Jackson, Jr.
Material: grey, organic-rich, finely bedded silt
Sample volume: ~250 mL (weight: ~600 grams) dry

PLANT MACROFOSSILS:

Fungal remains:	++ fungal ‘spheres’
fungal sclerotia	++
Vascular plants:	
Cyperaceae ....‘sedge family’	
Carex lenticular type	+ seeds: 1 (poorly preserved)
Carex trigonous type	+ seeds: 3
Salicaceae ....‘willow family’	
Salix sp.	+ persistent buds: 4
Chenopodiaceae ....‘goosefoot family’	
Chenopodium sp.	+ seed fragments: 2
Ranunculaceae .....‘crowfoot family’	
Ranunculus sp.	+ seeds: 4 (two are poorly preserved), half seeds: 2
Ericaceae ....‘heath family’	
Arctostaphylos uva-ursi (L.)Spreng.	+ seeds: 2
Asteraceae (Compositae) ..‘composite family’	+ seed: 1
Unidentified plant taxa	+ seed fragment: 1
Other:	
wood	+ fragments (most without bark)
twigs	+ fragments
bark	+ fragments
rust-coloured silt-cemented ped	+ 1
organic material with mineral (grey) on surface	+ 3

Key:
+ taxon present,
+++ taxon abundant
Report based upon examination of organic material larger than 425 microns (0.425 mm)
Note: The term ‘seed’ is used generically to include all forms of seeds including achenes, nutlets, etc.

Sample no.: JJP0024 (cont.)	
ANIMAL MACROFOSSILS:	
ARTHROPODA	
INSECTA	+ scutellum: 1, pronotum: 1
HEMIPTERA ....'bugs'	
Saldidae ....'shore bugs'	+ pronotum: 1, pronotal fragment: 1
COLEOPTERA ....'beetles'	+ head: 1, femur: 1, sternite: 1
Carabidae ....'ground beetles'	+ pronotal fragment: 1, elytral fragments: 2, half elytron: 1, half head: 1
Carabus truncaticollis Eschz.	+ elytral fragments: 2
Pterostichus sp.	+ pronotal fragments: 2, trochanter: 1
Trichocellus mannerheimi R.Sahlb.	+ elytron: 1, half pronotum: 1 (poorly preserved)
Staphylinidae .....'rove beetles'	
Tachinus sp.	+ elytra: 2
Curculionidae .....'weevils'	+ prothorax: 1, elytral fragment: 1, articulated sternites: 2
Lepidophorus lineaticollis Kirby	+ prothorax: 1, prothoracic fragments: 2, elytron: 1, elytral fragments: 2
DIPTERA ....'flies'	+ larval fragments: 3, larval half head capsules: 4
HYMENOPTERA ....'wasps and ants'	+ ovipositor
ARACHNIDA	
Oribatei/Acari ....'mites'	+ half mites: 2 (poorly preserved)
Araneae ....'spiders'	+ cephalothorax: 1
Lycosidae .....'wolf spiders'	+ cephalothorax: 1
Other:	
small-mammal feces	+ pellet: 1, pellet fragments: 2 (two types)
immature	+ mandible: 1

Comments:

From this small assemblage of plant and insect fossils recovered from JJP00-24, the fossil evidence suggests a tundra environment. The presence of abundant fungal remains and the very fine organic composition of the sample are suggestive of an organic soil. The climate was probably colder at the time of deposition than at present. All the plants and insects fossils listed in this report have modern representatives living in the central Yukon Territory today except for two ground beetles that have a northern distribution and are found only above or north of the treeline.

APPENDIX 3

Sample no.: JJP0025
Lab no.: 6-23
Collector: Crystal Huscroft
Submitters: Crystal Huscroft, Lionel Jackson, Jr.
Material: brown bedded silt with abundant wood, sticks, snails, and logs
Sample volume: ~1000 mL (weight: ~2100 grams) dry

PLANT MACROFOSSILS:

Fungal remains:	
fungal sclerotia	+++
Nonvascular plants:	
Bryophytes ....'mosses'	+ charred stem fragment: 1, stem fragments: 2
Sphagnum sp.	+ stem fragment with leaves: 1
Vascular plants:	
Pinaceae ....'pine family'	
Picea sp.	+ charred needle fragments: 99, needle fragments: 2
Cyperaceae ....'sedge family'	
Carex trigonous type	+ seeds: 7, seed fragments: 12, charred seeds: 2
Salicaceae ....'willow family'	
Salix sp.	+++ persistent buds: 101, delicate twig with bark and persistent bud: 3, twig fragments: 6, charred persistent buds: 22, charred twig fragments: 10
Betulaceae ....'birch family'	+ seed: 1
Betula sp.	+ seeds: 2
Betula nana/glandulosa type	+ seeds: 4
Ericaceae ....'heath family'	
Ledum? sp.	+ leaf fragment: 1
Unidentified plant taxa	+ seed: 1
Other:	
modern contaminants	+ filamentous plant fragments: 2
charcoal	++ fragments: 59 *
wood	++ fragments: (with and without bark) partially charred wood fragment: 1
charred twigs	+ fragments: 12, delicate fragment showing annual growth rings
bark	+ fragments
rhizome	+ fragment: 1

Key:
+ taxon present
+++ taxon abundant
Report based upon examination of organic material larger than 425 microns (0.425 mm)
Note: The term 'seed' is used generically to include all forms of seeds including achenes, nutlets, etc.

Comments:
The combined plant and insect fossil evidence suggests that this sample is an autochthonous peaty soil deposit within a tundra environment. All the fossils listed in this report have modern representatives living in the Yukon Territory today.

*Discontinued counting charcoal fragments in 20 to 40 m (0.425–0.85 mm) fraction

Sample no.: JJP0025 (cont.)	
ANIMAL MACROFOSSILS:	
ARTHROPODA	
INSECTA	
COLEOPTERA ....'beetles'	+ half elytron: 1, elytral fragment: 1, sternites: 3, coxae: 5, larval half head capsules: 8, prosternum: 1, articulated pro- and mesosterna: 3, articulated leg: 1
Carabidae ....'ground beetles'	+ half pronotum: 1, half elytron: 1, elytral fragments: 4, prosternum: 1.5, prosternal fragment: 1, articulated meso- and metasternum: 1, articulated sternites: 1, femurs: 5, tibia: 2
Diacheila polita Fald.	+ elytron: 1, half elytron: 1, half pronotum: 1, first sternite: 1
Bembidion sp.	+ head: 1
Pterostichus(Cryobius)pinguedineus Eschz.	+ pronotum: 1
Pterostichus(Cryobius)brevicornis Kby.	+ pronotum: 1, male genitalia: 1
Pterostichus(Cryobius) sp.	+ half pronota: 6, pronotal fragment: 1, elytra: 2, trochanters: 2
Pterostichus sp.	+ half head: 1, half elytron: 1
Staphylinidae .....'rove beetles'	+ head: 1, pronota: 2, half pronotum: 1, elytra: 3, articulated pro- and mesosterna: 3, mesosterna: 2
Olophrum sp.	+ elytra: 4, head: 1
Olophrum rotundicolle (Sahlb.).	+ pronotum: 1
Scydmaenidae ......'ant-like stone beetles'	+ elytra: 7, pronota: 2
Lathridiidae ...'minute brown scavenger beetles'	+ elytra: 2
Curculionidae .....'weevils'	+ head: 1, elytral fragment: 1, prothoracic fragments: 3, articulated leg: 1
Genus?	+ head: 1
DIPTERA ....'flies'	+ larval head capsules: 2, half head capsules: 18, puparial fragments: 35, half pupa: 1, adult thorax: 1
Tipulidae ....'crane flies'	
Tipula sp.	+ half larval head: 1
HYMENOPTERA ....'wasps and ants'	+ thoraces: 2, propodeum: 1
Ichneumonoidea ....'ichneumons and braconids'	+ thoraces: 3
Braconidae	
Cheloninae	+ abdominal fragment: 1
Ichneumonidae	+ thoraces: 3
Formicidae ....'ants'	+ pedicel: 1, mandibles: 2
ARACHNIDA	
Oribatei/Acari ....'mites'	+ 5, half mites: 41
Other:	
small-mammal feces	+ pellets: 1 (whole), charred half pellets: 2
soft-bodied insect	+ immature fragment: 1

Bibliography

Schwert, D.P., Ashworth, A.C., and Clarke, G.
1992: Valley of the *Diacheila*; Quaternary Entomology Dispatch, v. 9, p. 3.

APPENDIX 4

Sample no.: JJP0026
Lab no.: 6-25
Collector: Crystal Huscroft
Submitters: Crystal Huscroft, Lionel Jackson, Jr.
Material: brown bedded silt with abundant wood, sticks, snails, and logs
Sample volume: ~850 mL (weight: ~1800 grams) dry

PLANT MACROFOSSILS:

Fungal remains:	
fungal sclerotia	+ 10
Nonvascular plants:	
Bryophytes ....'mosses'	+ stems with leaves: 8, fruiting body: 1
Sphagnum sp.	+ leaves: 27, stems with leaves: 21
Vascular plants:	
Pinaceae ....'pine family'	+ half cone: 1, cone scales: 5 (two are poorly preserved), charred cone scale fragment: 1, seeds: 2, conifer seed wings: 2
Picea sp.	+ needle fragments: 28, charred needle fragments: 7
Potamogetonaceae ..'pondweed family'	
Potamogeton filiformis Pers.	+ seed: 1
Alismataceae (Alismaceae) .'water plantain family'	
Sagittaria sp.	+ seeds: 3, seed embryos: 6
Poaceae (Gramineae) ....'grass family'	+ seeds: 16
Glyceria sp.	+ florets and seeds: 3, seeds: 7
Cyperaceae ....'sedge family'	
Carex trigonous type	+ seeds: 2
Eleocharis palustris-uniglumis type	+ seed: 1
Scirpus sp.	+ seeds: 21
Juncaceae ....'rush family'	
Juncus sp.	+ capsule (lobe): 1
Salicaceae ....'willow family'	
Salix sp.	+ persistent buds: 3
Betulaceae ....'birch family'	
Betula glandulosa/nana type	+ seed: 1
Betula sp.	+ bract: 1
Polygonaceae ......'buckwheat family'	
Rumex sp.	+ seed calyx fragment: 1
Chenopodiaceae ....'goosefoot family'	
Chenopodium sp.	+ seeds: 5, half seeds: 2, seed fragments: 3
Caryophyllaceae ...'pink family'	+ seeds: 5
Chenopodiaceae/Caryophyllaceae undiff.	+ seeds: 24
Brassicaceae (Cruciferae).....'mustard family'	+ seeds: 35
Rorippa islandica (Oeder) Borbas	+ seed: 1
Rosaceae ....'rose family'	
Potentilla sp.	+ seeds: 2, half seed: 1
Potentilla norvegica L.	+ seed: 1
Rubus sp.	+ seed fragment: 1
Ericaceae ....'heath family'	
Empetrum nigrum L.	+ charred seed: 1
Primulaceae ....'primrose family'	
Androsace septentrionalis type	+ seeds: 3

Key:
+ taxon present
+++ taxon abundant
Report based upon examination of organic material larger than 425 microns (0.425 mm)
Note: The term 'seed' is used generically to include all forms of seeds including achenes, nutlets, etc.

Sample no.: JJP0026 (cont.)	
Lamiaceae (Labiatae) ....‘mint family’	
Lycopus? sp.	+ seed: 1
Plantaginaceae ....‘plantain family’	
Plantago major type	+ seeds: 4
Unidentified plant taxa	+ seeds: 6, seed fragments: 2 (all are poorly preserved)
Other:	
amber	+ fragment: 1 (with detailed surface)
charcoal	+ fragments: 22
charred organic material	+ fragments: 7
net-veined leaf	+ fragments: 12
wood	+ fragments including large pieces (poorly preserved)
twigs	+ fragments
rhizomes	+
unknown brown capsule	+ 1
ANIMAL MACROFOSSILS:	
ARTHROPODA	
INSECTA	+ wings: 2
HEMIPTERA ....‘bugs’	
Corixidae ....‘water boatmen’	+ wing fragment: 1
Saldidae .... shore bugs’	+ pronotum: 1
COLEOPTERA ....‘beetles’	+ head: 1, head fragment: 1, elytron: 1, elytral fragments: 3, femurs: 4, sternites: 3, larval head capsules: 2
Carabidae ....‘ground beetles’	+ head fragment: 1, metasterna: 3, metepisternum: 1, articulated sternites: 2
Bembidion sp.	+ pronota: 3, elytral fragment: 1
Pterostichus(Cryobius) sp.	+ head: 1, pronotum: 1
Amara(Curtonotus) sp.	+ articulated pronotum and prosternum: 1, half pronotum: 1
Amara patruelis type	+ head: 1, elytron: 1
Trichocellus mannerheimi R.Sahlb.	+ elytron: 1
Dytiscidae ....‘predaceous diving beetles’	+ half elytron: 1, immature mandible: 1
Hydraenidae ....‘minute moss beetles’	
Ochthebius sp.	+ elytron: 1
Staphylinidae .....‘rove beetles’	+ articulated pro- and mesosterna: 2, mesosternum: 1
Acidota quadrata (Zett.)	+ pronotum: 1
Quedini	+ pronotum: 1
Tachyporus sp.	+ elytra: 2
Aleocharinae	+ articulated elytra: 1, elytron: 1
Leiodidae ....‘round fungus beetles’	
Agathidium sp.	+ elytron: 1
Helodidae ....‘marsh beetles’	+ pronotum: 1
Byrrhidae ....‘pill beetles’	
Morychus sp.	+ elytron: 1
Curimopsis sp.	+ head: 1
Heteroceridae? ..‘variegated mud-loving beetles’	+ half elytron: 1
Elateridae ....‘click beetles’	+ immature fragment: 1
Curculionidae .....‘weevils’	+ elytra: 2, half elytra: 6, prothoraces: 4, head fragments: 2, articulated sternite: 1, articulated leg: 1, femur: 1, coxae: 2
Connatichela artemisiae Anderson	+ heads: 2, prothorax: 1
Lepidophorus lineaticollis Kirby	++ heads: 9, rostrum fragments: 2, prothoraces: 16, elytra: 4, articulated elytra: 1
Vitavitus thulius Kiss.	+ head: 1, pronotal fragment: 1
Genus?	+ heads: 3

Sample no.: JJP0026 (cont.)	
Scolytidae ....'bark beetles'	+ half elytron: 1
DIPTERA ....'flies'	+ heads: 3, puparial fragments: 8, larval head capsules: 1.5
Tipulidae ....'crane flies'	
Tipula sp.	+ larval heads: 3, half heads: 2
Chironomidae ......'midges'	+ larval head capsules: 2.5
Chironomus sp.	+ larval head capsules: 7
Pentaneurini	+ larval head capsules: 1.5
HYMENOPTERA ....'wasps and ants'	+ adult thoraces: 2, head: 1
CRUSTACEA	
Cladocera ....'water fleas'	
Daphnia sp.	+ ephippia: 41
Ostracoda ....'ostracodes	+ valves: 6
ARACHNIDA	
Oribatei/Acari ....'mites'	+ 3.5
Araneae ....'spiders'	+ cephalothorax: 1, cephalothracic fragment: 1
MOLLUSCA	+ shell fragments: 16
Gastropoda ....'snails, limpets'	+ large snail (~1 inch): 1, small complete snails: horizontal type: 31, vertical type: 13, shell fragments: 17
Pelecypoda ....'clams, mussels'	+ articulated valves: 1, valves: 31, shell fragments: 5
Other:	
microtine teeth	+ fragments: 2
bone	+ small fragments: 22
soft-bodied insect	+ fragment: 1, mandibles: 2
unknown pupae	+ 3
tan egg cases	+ 3.5
cocoon	+ 1

Comments:

Summarizing the fossil data, plant macrofossil evidence in JJP0026 suggests a forested environment dominated by spruce. The presence of bark beetle insect fossils agrees with the plant fossil evidence of a forested environment. The floral and faunal fossil assemblage also indicates the presence of an aquatic environment, a small pond or shallow lake. However, a few of the plant taxa in this sample also refer to plants that grow in dry sandy sites. This is supported by the insect fossil data, which also suggest the prevalence of dry local conditions. Thus the fossil data appear to represent a forest-tundra environment. A pond environment within a very dry region is suggested by the aquatic plant and insect fossils recovered. All the fossils listed in this report have modern representatives living in the Yukon Territory today except for a few insects that have a northern distribution and are found only above or north of the treeline. This suggests that the climate was cool and dry at the time JJP0026 was deposited. It should be noted that JJP0026 does contain one fragment of amber and may contain resedimented organic materal from older deposits.