Ice Age Klondike

Fossil treasures from the frozen ground

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Design and layout: Patricia Halladay Graphic Design (Whitehorse, Yukon)

Front cover: Main: Mammoth tusks found in placer mining, circa 1898. Yukon Archives, Emil Forrest fonds, 80/60 #19;
right, above: Skull of ice age wolf from Hester Creek; right, below: foot bones of ice age horse, from the Government of Yukon palaeontology collection in Whitehorse.

Back cover: l-r: Geneticists Eske Willerslev, Ross Barnett, Alan Cooper and Gregor Larson with the tusk of an adult male woolly mammoth.
Photo: Duane Froese

All photos courtesy Government of Yukon unless otherwise noted.

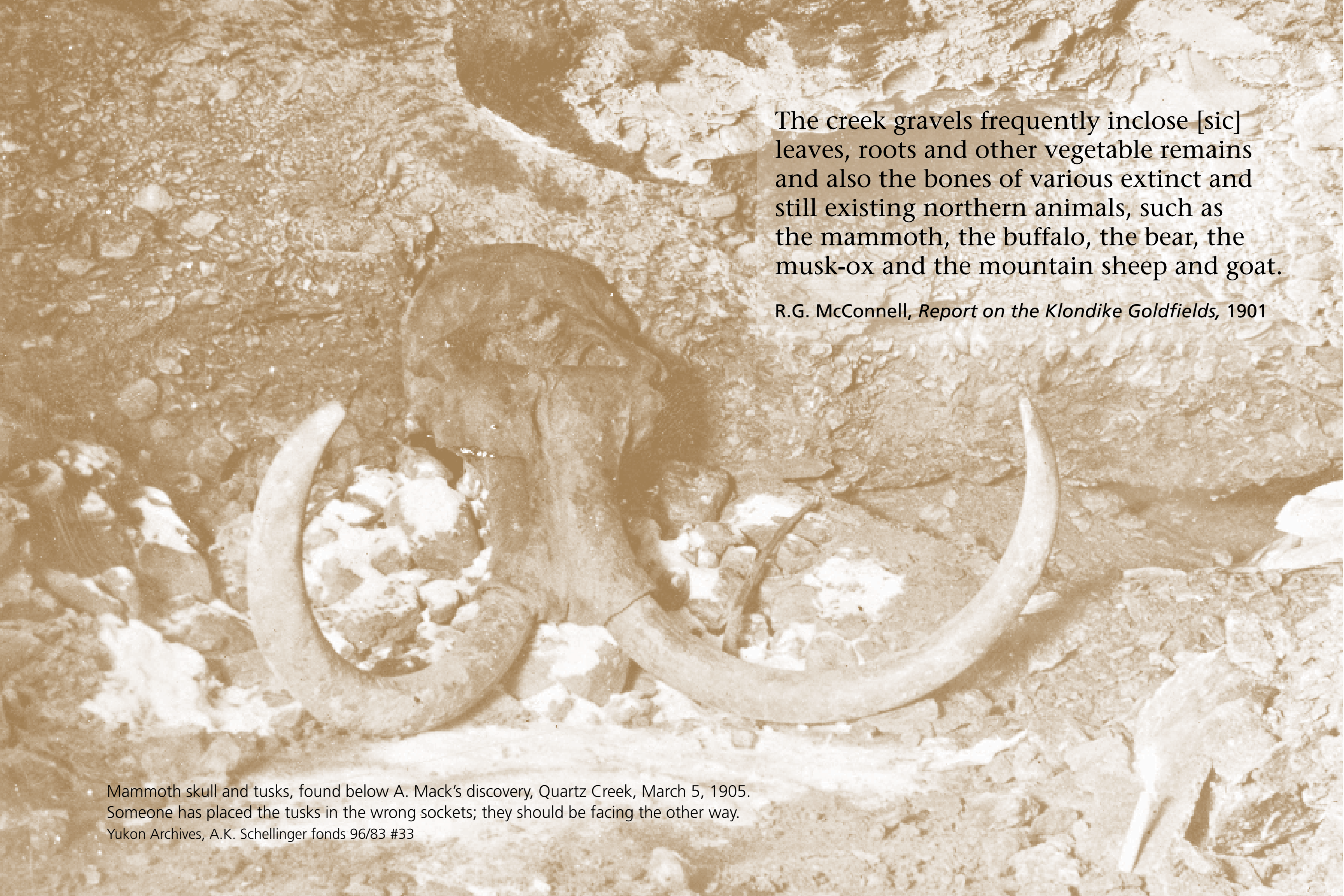
All historic photos courtesy Yukon Archives unless otherwise noted.

Contents

Illustration: George (Rinaldino) Teichmann

The creek gravels frequently inclose [sic] leaves, roots and other vegetable remains and also the bones of various extinct and still existing northern animals, such as the mammoth, the buffalo, the bear, the musk-ox and the mountain sheep and goat.

R.G. McConnell, *Report on the Klondike Goldfields,* 1901



Mammoth skull and tusks, found below A. Mack's discovery, Quartz Creek, March 5, 1905.
Someone has placed the tusks in the wrong sockets; they should be facing the other way.
Yukon Archives, A.K. Schellinger fonds 96/83 #33

Introduction

The Klondike goldfields of west-central Yukon have a fabled history. The region is known worldwide for the famous Klondike Gold Rush of 1896–98, an event captured forever in numerous black and white photographs.

The Klondike has a rich natural history that extends back long before stampeders arrived in search of gold. Remnants of this prehistoric past are revealed every day by the hydraulic hoses and heavy equipment of today's Klondike gold miners. Fossil bones and other ancient treasures from the frozen ground are helping scientists understand the Yukon's ice age history.

Right: Modern-day placer mining equipment.

Below: A New Year's celebration, circa 1898. Yukon Archives, Vancouver Public Library collection #2158

Left: Geologist Duane Froese with woolly mammoth tusks in front of the historic decaying gold dredge on Dominion Creek.

Photo: Brent Alloway

The incredible diversity of ice age mammals is a stark contrast to the relatively limited array of wild beasts in the Yukon today. Illustration by George (Rinaldino) Teichmann

The ice age

The ice age — from 2.6 million to 10,000 years ago — was a time when colossal glaciers covered most of Canada. Much of the Yukon lay beyond these glaciers, and it looked strikingly different from the world the gold rush miners encountered at the end of the 19th century.

During much of the ice age, swaths of wild grasses and small tundra flowers blew in the cold wind instead of the spruce tree forests that now cover the area. You wouldn't have seen moose trudging through the forest; instead, you might have encountered a herd of giant woolly mammoths drinking by a stream.

A vivid picture of the ice age is emerging from the Klondike. This vanished world is not forgotten because of the efforts of placer gold miners who uncover ice age fossils and scientists from around the world who travel to the Yukon to study them.

Left, l–r: Placer miners Lee Olynyk and Sanford Armstrong and geologist Duane Froese release a woolly mammoth tusk from the frozen gravel at Last Chance Creek.

Below: Palaeontologist Jessica Metcalfe samples woolly mammoth bones at the Yukon Palaeontology Program laboratory.

The Klondike goldfields

Next door to Dawson City, the Klondike goldfields are situated in the heart of west-central Yukon. Gently rolling hills with V-shaped valleys are cut by streams that radiate out from rounded domes. The most prominent hill is called King Solomon's Dome. In the days of the gold rush, many people thought it was the primary source of the placer *(pronounced plah-ser)* gold found in the Klondike creeks.

The Klondike lies within northern Canada's vast boreal forest. Permafrost — permanently frozen ground — can be found as far down as 60 metres below the surface. Miners have to thaw this frozen ground in order to reach the gold deposits that are contained within it.

Background: view of hills and distant placer workings

Right: Miners thoroughly check their wash plant for flakes of gold on Lindow Creek.

Map of the goldfields drawn by palaeontologist Charles W. Gilmore during his 1907 expedition to the Yukon .
Smithsonian Miscellaneous Collections Vol. 51, 1908

Although the Klondike goldfields are typically recognized as the area south of the Klondike River, east of the Yukon River and north of the Indian River, we use the term *Klondike* to represent all the placer mining areas of west-central Yukon, including Thistle Creek and the Sixtymile River.

Gold rush palaeontology

Thousands of people flocked to the Klondike creeks following the discovery of gold by Skookum Jim *(Keish)*, Tagish Charlie *(Káa Goox)* and George Carmack in August 1896. As miners dug through the layers of frozen earth and gravel that had accumulated over the years, many of them encountered the bones of giant, fascinating beasts. Some of these creatures were easily comparable with their modern counterparts — elephants, buffalo, bears and the like. However, many of the bones represented animals now extinct that had lived during ancient times.

Left: A Klondike miner using steam pipes to thaw the frozen ground, circa 1898. Yukon Archives, University of Washington photo collection #1307

Tusks and bones found on Hunker Creek, August 30, 1907. MacBride Museum of Yukon History 3898

Right: Three men and two women posing with three mammoth tusks, circa 1900. Yukon Archives, Jacqueline Greenbank collection, 89/19 #24

Many miners proudly displayed their fossil finds. Some of the earliest fossil discoveries by late 19th century miners must have been as awe-inspiring as a sluicebox full of gold nuggets.

Right: Interior of tent-type store, with tusks on display, circa 1900.
Yukon Archives, Vancouver Public Library collection #2173

In those days, people didn't know how old the bones were or why they were found where they were.

Left: Three men posing with fossil bones, probably July 1899.
Yukon Archives, H.C. Barley fonds, #4714

Right: Palaeontologist Grant Zazula sampling frozen sediment along a vast wall of muck at Quartz Creek.
Photo: Duane Froese

What is a palaeontologist?

Palaeontologists study prehistoric fossils to discover how ancient life evolved and coexisted. Some palaeontologists study the fossil record of humans and their ancestors, although it is archaeologists who work with human remains and human-made objects.

In 1904 a team from the Natural History Museum in Paris *(see photo, left)* led the first international fossil expedition to the Klondike. They recorded the bones of many mammal species that are now extinct as well as those still in existence today. These include mammoth, mastodon, muskox, bison, moose, caribou, wapiti, mountain sheep and horse.

Yukon fossil bones also spawned expeditions by the United States Biological Survey, the American Museum of Natural History and the Smithsonian Institution. Scientists in these parties were drawn by stories of incredible fossil specimens, including complete mammoth skulls with intact tusks.

Some of the early finds of McConnell and other Geological Survey of Canada researchers are now housed as part of the national collection in Ottawa.

Above: Partial skull of extinct ice age Yukon horse, *Equus lambei*, from Hunker Creek, collected 1922. Photo: Patricia Halladay; courtesy Smithsonian Institution

Two bison skulls and two half jaws, Fox Gulch, 1907, photographed by L.S. Quackenbush during his expedition to the Yukon.
Courtesy of the Division of Paleontology, American Museum of Natural History, New York

Scientists rush to the Klondike

Canadian geologist R.G. McConnell, at the end of the 19th century, is credited with the making the earliest recorded fossil collections in the Klondike. Word of these fossils spread and attracted palaeontologists from all over Canada and around the world.

Above: The palaeontology gallery at the *Musée nationale d'histoire naturelle* in Paris.

Richard Harington

The years from the early 1960s through the 1970s were the glory days of ice age fossil studies in the Klondike. Legendary palaeontologist C.R. (Dick) Harington conducted his doctoral research in the goldfields between 1966 and 1975. During these years, Dick toured the Klondike, developing relationships with miners and their families and demonstrating his constant enthusiasm for fossil research.

His efforts resulted in the world-class collection of Pleistocene mammal fossils at the Canadian Museum of Nature in Ottawa. Some of the most impressive specimens of ice age mammals ever collected are available for study there. Most scientists acknowledge that Dick made unequalled contributions to our understanding of the ice age mammals in Canada. His legacy in the goldfields serves as a source of inspiration to all the scientists who work there today.

Left: Dick Harington, Curator of Quaternary Zoology, Canadian Museum of Nature. Photo: Richard Harington

Above: Placer miner Paul Favron with a complete Yukon horse skull that he found on Dominion Creek. Photo: Richard Harington.

Left: Dick Harington with a skull fragment from a steppe bison collected in 1971.
Photo: Richard Harington

Above: Palaeontologist Grant Zazula with a partial American mastodon skeleton found on Bonanza Creek and donated to the Yukon fossil collection by Earl Bennett.

Yukon Palaeontology Program

The establishment of the Government of Yukon's Palaeontology Program in 1996 saw a renewed interest in ice age research in the Klondike. This coincided with the establishment of the Yukon *Historic Resources Act* (1996), under which all fossils found on Yukon lands are managed by the Government of Yukon for the enjoyment and education of all Yukoners and visitors from afar.

Geneticist Beth Shapiro wielding a shovel on Quartz Creek.

Since then, fossils collected in the Klondike goldfields have resulted in a small but ever-growing fossil collection in Whitehorse. This collection is studied by researchers from all over the world. Ice age research in the Klondike isn't just about the bones, however. International teams of geologists, geneticists and other scientists visit the Yukon annually. Ice age research is truly a team effort.

Results of scientific work in the Klondike are world renowned, further adding to the significance of the Yukon's heritage. None of this could be accomplished without the support of the many placer miners who laboriously move the muck and reveal the ice age fossils.

Left: Soil scientist Scott Smith examining the layers of frozen ice age soil between Bonanza and Eldorado creeks. Photo: Paul Sanborn

2.6 million years of climate change

Scientists working in the Klondike have revealed evidence of dramatic climate changes in the north. These changes span the last 2.6 million years, a time called the Quaternary Period.

Above: Walls of melting mud are a reminder of how different the climate was during the ice age.

Right: Fossil wood preserved in the frozen mud provides evidence of ancient forests.

Photo: Alberto Reyes

Important information about past climates is revealed in beds of silt, sand and gravel that are exposed in river valleys and placer mining cuts in the Yukon. During the Quaternary there were numerous dramatic shifts back and forth between warm and cold climate. Contrary to what the name suggests, the ice age did not always include icy glaciers and cold temperatures. During brief interludes called interglacials, warm climates — similar to the one we experience today — returned a few times. Cold glacial periods represent about 80 percent of the ice age.

A drastic global cooling around 20,000 years ago may have been the coldest time on earth during the entire Pleistocene Epoch. Ice age mammals such as the woolly mammoth thrived in this frigid climate. The ice age came to an end around 10,000 years ago due to rapid warming, which led to the extinction of many ice age animals. Archaeological evidence indicates that North America's first people hunted these now-extinct beasts at the end of the ice age.

Right: Scimitar cat, now extinct.

Illustration: George (Rinaldino) Teichmann

Continental ice sheets

At cold times during the ice age, gigantic glaciers covered vast areas of Europe, Asia and North America. The Laurentide Ice sheet spread across northern Canada, reaching its maximum extent some 20,000 to 15,000 years ago at the edge of the Richardson and Mackenzie Mountains, near the present-day border of the Yukon and the Northwest Territories.

Above: Glaciers in the St. Elias ice fields are small remnants of the ice sheets that covered much of western Canada during the ice age.

The accumulation of snow and ice over the mountainous areas of British Columbia and southern Yukon formed the Cordilleran Ice Sheet. Several advances of this ice sheet have been mapped in the Yukon. The oldest glacial advances — between 2.6 and 0.75 million years ago — occurred during the period of greatest ice cover in the southern and central Yukon. The more recent advances of the Cordilleran ice were smaller, peaking about 25,000 years ago and covering the areas near Mayo and Pelly Crossing, in the central Yukon.

Each advance of the Cordilleran Ice covered the southern Yukon with ice roughly 1.5 km thick. When the glaciers melted, they left behind a landscape that was blanketed with boulders and gravel.

Above: Braided streams similar to today's White River drained water from the front of continental glaciers.

Left Gigantic boulders called erratics were transported long distances by ice age glaciers.

Both photos: Jeffrey Bond, Yukon Geological Survey

Remnants of the ice age

Although the glacial ice that covered much of the continent never advanced as far as the Klondike, evidence for the beginning of the ice age can be found today in the goldfields. Large braided rivers that drained the Cordilleran Ice Sheet left behind thick deposits of gravel in the goldfields.

Known as Klondike Gravel, this reddish coloured deposit can be seen overlying the White Channel Gravel at Jackson Hill as you drive into Dawson City on the North Klondike Highway.

Geological evidence found in the White Channel Gravel — the oldest gravel in the Klondike — indicates that the first continental glaciers in the Yukon formed about 2.6 million years ago. This first glacial advance marks the beginning of the ice age and a cold Arctic climate in North America. The glacial advance also diverted the Yukon River, which formerly flowed south to the Pacific Ocean, to its present northerly course to the Bering Strait.

Left: Klondike gravel (rusty brown), marking the earliest evidence of glaciation, overlies White Channel gravel in the lower Klondike Valley.

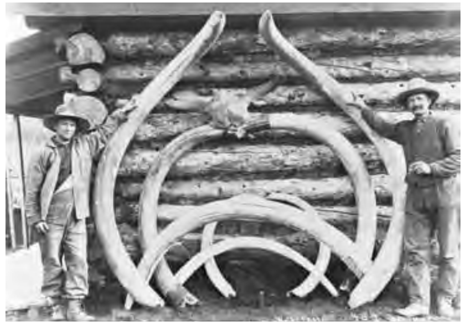
Photo: Duane Froese

Above: Looking northwest across tailing piles and tailing ponds to Jackson Hill in the distance, just south of Dawson City.

Above, left: Fossil leg bone of extinct Western camel.

Beringia

The Klondike region always remained beyond the edge of the colossal ice sheets that covered much of Canada. The continental climate and rainshadow effect of the coastal mountains made the interior of Yukon and Alaska too dry to support glaciers.



Mammoth tusks from Beringian times found on Sulphur Creek, in the Klondike, circa 1898.
Yukon Archives, J.B. Tyrrell fonds, 82/15 #419

The growth of glaciers during the ice age locked up vast amounts of the world's water, causing sea levels to drop by as much as 120 metres. In the Bering Strait this drop in sea level exposed the Bering land bridge, which formed a connection between Asia and North America. The Klondike and other unglaciated areas of the northern Yukon — together with the land bridge and unglaciated portions of Alaska and Siberia — formed the vast ancient land that we call Beringia.

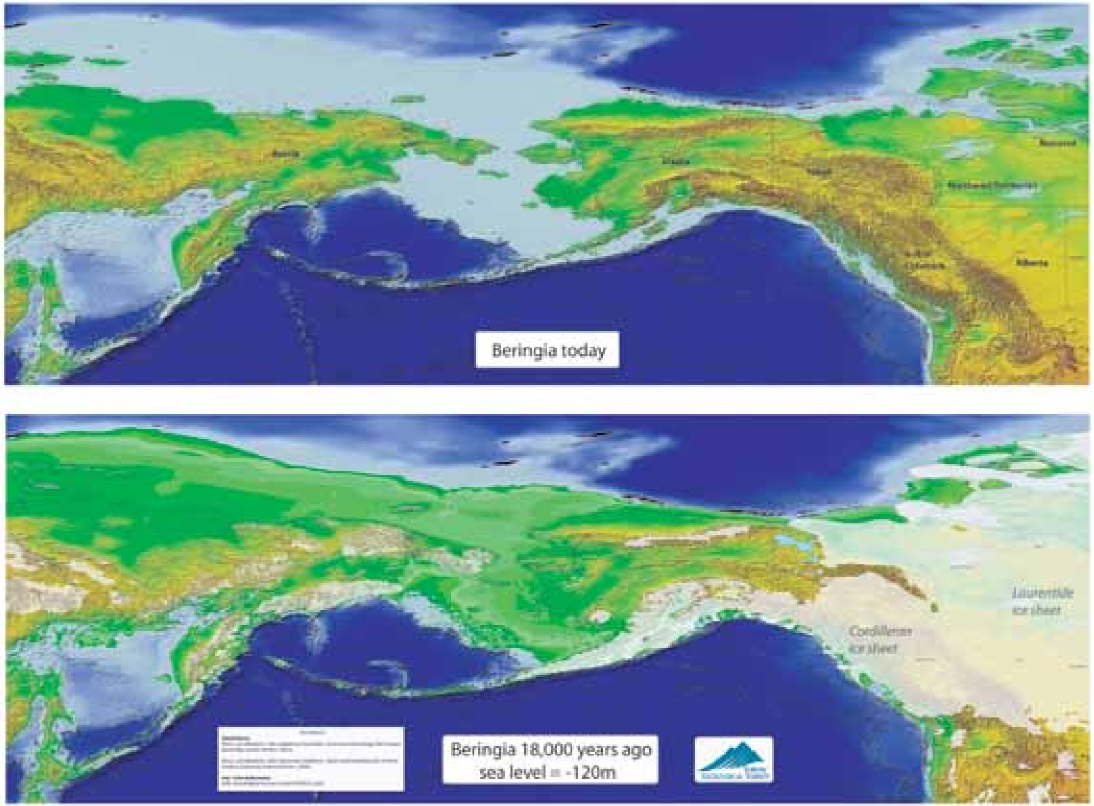
Left: During the ice age, lions and mammoths were found from the United Kingdom to the Yukon.
Illustration: George (Rinaldino) Teichmann

Beringia was a refuge for arctic life during the ice age. For most of this time, Beringia was a landscape uninhabited by humans.

Above: Glaciers and sea-level responded to Quaternary global climate change and greatly influenced the geography of Beringia.

By about 14,000 years ago, however, Canada's first people made their home in the Yukon after migrating across the Bering land bridge from Asia.

Repeated cold periods exposed the land bridge many times during the Pleistocene. During particularly warm interglacial intervals, the glaciers melted. This flooded the Bering Strait and temporarily ended the migration of plants and animals between the two continents. The last time the Bering land bridge was flooded was about 10,000 years ago.



Right: Beringia was not merely a land bridge, but a continent-sized region. Illustration: Jeffrey Bond

Ancient life in the muck

The ice age left behind a lasting legacy that is exposed in placer gold mining areas. Some of the best scientific information comes from the towering walls of frozen black silt commonly referred to as muck. Although placer miners consider muck as overburden — waste material — it is more valuable than gold to scientists who study the ice age.

Above: Water monitors are used by both placer gold miners and palaeontologists to uncover buried treasure.

> **What exactly is muck?**
> **Miners use the term *muck* to describe the frozen organic silt that has accumulated over thousands of years. Miners have to remove the muck to reach the gold-bearing gravel beneath it.**

Placer miners use hydraulic water cannons known as monitors to strip away the frozen muck and expose the gold-bearing gravel beneath. New scientific treasures are exposed in the muck with the blast of water from the monitor.

Anyone who has visited or worked on a Klondike placer mine can testify to the intense odour that emanates from the melted muck in summer. Decomposed organic remains from ancient Beringian plants and animals are the reason for this distinctive smell.

Left: Palaeo-ecologist Rolf Mathewes with a steppe bison jaw and woolly mammoth molar.

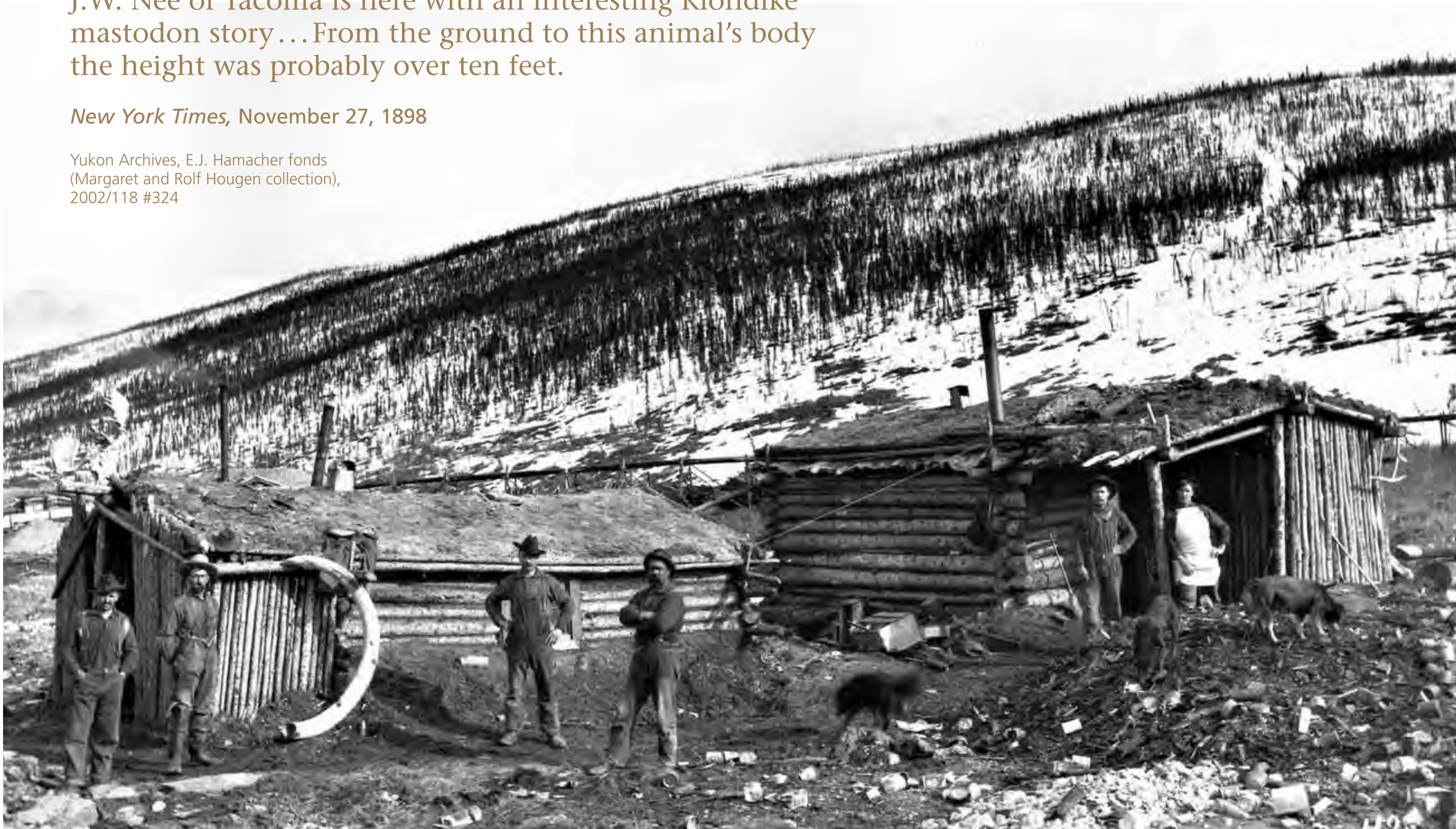
Far left: Palaeo-ecologist Charlie Schweger teaches Grant Zazula how to collect samples of frozen muck.

Photo: Brent Alloway

J.W. Nee of Tacoma is here with an interesting Klondike mastodon story…From the ground to this animal's body the height was probably over ten feet.

New York Times, November 27, 1898

Yukon Archives, E.J. Hamacher fonds
(Margaret and Rolf Hougen collection),
2002/118 #324



Dusty skies

Muck is composed mostly of thick beds of wind-blown silt called loess. There are similar deposits in Alaska and in Siberia, where they are called yedoma. Muck is part of the permafrost — perennially frozen ground — and is found where scrubby black spruce forests with thick mossy ground cover provides insulation that keeps the ground from thawing.

This ancient silt indicates that the climate was dry and windy during the cold periods of the ice age. Soils formed in this ancient silt are similar to those that today support grasslands in the southwest Yukon near Kluane Lake. There, dust from the Slims River blankets the landscape, helping the grassy vegetation grow within boreal forest meadows. The constant dusting of nutrient-rich silt helps maintain a productive grassland or steppe environment.

Left: Woolly mammoths and Yukon horses ate nutritious bunch-grasses like this year-round during the ice age in the Klondike.

Below: The Slims River delta. Windblown silt would have been common in the Klondike during the ice age. Photo: Paul Sanborn

Ice age ice

Massive wedge-shaped bodies of nearly pure ice — called ice wedges — are commonly found at Klondike placer mines. Ice wedges up to eight metres high have been observed in the gold-fields.

They form when cold dry conditions in the winter cause the ground to crack. Snow melt in the spring seeps into these cracks, freezes and gradually forces the ground farther apart. The continued cracking and spreading over several years eventually causes an ice wedge to form. Ice wedges can be

Left: Using a monitor on a huge wall of frozen mud and ice on Dominion Creek.
Photo: Duane Froese

recognized by the distinctive pattern they make on the ground, often seen in Arctic tundra.

Ice wedges can also be very ancient. On lower Gold Run Creek an ice wedge was found to be more than 750,000 years old, making it the oldest buried ice known in the northern hemisphere. Ancient buried snow banks and remnants of former surface ice are also found in the Klondike muck. They are additional reminders of the Klondike's ice age history.

Left: Duane Froese examines a giant wedge of ancient ice along Dominion Creek.

Above: Palaeontologist Grant Zazula describing an ice wedge in the melting muck along Dominion Creek. Photo: Duane Froese

Volcanoes of Beringia

Volcanoes are a critical part of the story of ice age Beringia. Geologist John Westgate has dedicated his career to the study of tephra — volcanic ash — to help determine the age of the surrounding ice age sediment and associated fossils. The tephra, which can be dated precisely, provides a calendar for the ancient events of the Klondike.

Above: Augustine volcano, Alaska, erupting in 1986. Similar volcanic events blanketed Beringia numerous times during the ice age.
Photo: United States Geological Survey

Tephra beds in the Klondike are generally white or cream in colour; they range from thin wisps to beds up to half a metre thick. Some layers of tephra can be traced for several metres along mining cuts.

Intense research over the last decade or so has documented more than 70 volcanic ash deposits in Eastern Beringia. The Klondike region is within the fallout zone of volcanic eruptions in the Alaska's Aleutian Islands and Wrangell Mountains. Each tephra has a distinct geochemical finger-print, which enables geologists to identify it precisely wherever it occurs.

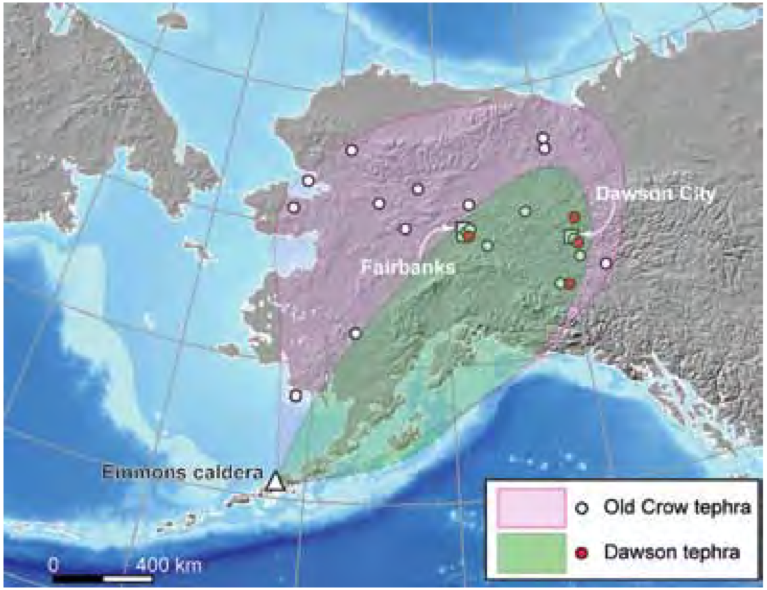
Top: Beds of volcanic ash such as this one at Dominion Creek are found at many Klondike placer gold mines.
Right: Tephrochronologist Britta Jensen collects tephra to be analyzed in the laboratory.
Photo: Alberto Reyes

Dawson tephra

Dawson tephra is one of the most prominent volcanic ash beds from the ice age. It has been found at more than 40 sites in the Klondike in beds up to 60 centimetres thick.

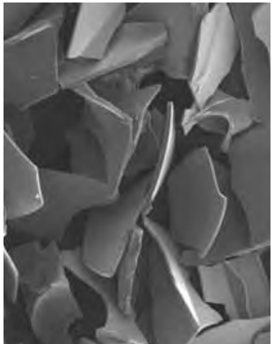
The ash was ejected 30,000 years ago from a volcano in the Aleutian islands more than 1,500 kilometres away *(see map, right)*. The eruption was one of the largest in North America during the ice age.

A thick bed of Dawson tephra at Quartz Creek.
Photo: John Westgate



Left: Map showing the vast distribution of Dawson tephra (30,000 years old) and Old Crow tephra (140,000 years old) in Alaska-Yukon.
Map: Alberto Reyes and Duane Froese

Left, below: Scanning Electron Microscope image of microscopic volcanic glass shards in Dawson tephra.
Photo: John Westgate



The ash bed is an important marker that tells us when the last major cold period in the Yukon began. Other evidence, such as buried surface ice beneath the tephra, suggests that the eruption occurred in winter. The massive eruption likely had an enormous impact on Beringia’s climate, plants and animals and may have contributed to global cooling.

There's bones in them thar hills

Fossils of familiar and extinct mammals are the best known parts of the Klondike's ice age history. Ancient bones have been found at almost every placer gold mine in the Klondike. In fact, the area is one of North America's leading sources of ice age fossils. The reason that so many fossils are found here is because the Yukon was never overrun by glacial ice; it was always a landscape inhabited by animals.

The frozen ground was the ideal medium to preserve fossil bones; they froze quickly after the animal's death. Scientists can find out when the animal died by using a method called radio-carbon dating. This information helps tell us more about which animals lived in the Yukon at various times in the past.

Chemical studies of the bones provide information on the animal's diet — literally revealing who ate what, or whom, during the ice age. These studies give insights into how Beringia's mammals lived and why they went extinct at the end of the ice age.

Left: Placer miner John Flynn with a complete woolly mammoth skull found by Hawk Mining along the Sixtymile River.

Above, left: Fossil jawbone from Beringian lion found at Thistle Creek.

Above: Archaeologist Jana Morehouse excavating a large fossil woolly mammoth tusk from frozen mud along Quartz Creek.

Nature's deep freeze

In most areas of the world only fossil bones survive. But in places with a cold climate, such as the Yukon, permafrost provides a natural deep freeze. It preserves soft tissues like muscle, tendon and hair, as well as bone. In Russia, permafrost has preserved many carcasses of ice age animals, including a complete baby woolly mammoth, which the discoverers named Luba.

Above: Fossil skull of the short-faced bear, now extinct, recovered along Ophir Creek by placer miner Pete Risby and now part of the Yukon Palaeontology Program collection.

One of the most extraordinary mummified specimens found in the Yukon is an ice age steppe horse found at Last Chance Creek, in the goldfields, in 1992 *(see page 25)*. Radiocarbon dating indicates that the horse died around 30,000 years ago. The preserved stomach tells us that the horse ate grasses and small flowering plants just before it died. Teeth marks on the neck suggest that an ancient wolf chewed on the fresh carcass.

Some of the other impressive mummified fossils found in the Klondike goldfields include black-footed ferret carcasses recovered at Sixtymile River and Dominion Creek and Arctic ground squirrel remains from Quartz and Dominion creeks.

Left: Archaeologists Ruth Gotthardt and Greg Hare recovering part of the carcass of an ice-age horse, 1992.

Above: A 40,000-year-old fossil black-footed ferret carcass discovered by the McDougall family's dog Molly at their placer gold mine on the Sixtymile River.

Beringia's Big Three

Most of the fossil bones from the Klondike and elsewhere in Beringia are from what are often called the Beringia "Big Three" — steppe bison, horse and woolly mammoth.

Steppe bison

By far the most common fossils in the Klondike are those of steppe bison. Placer miners are constantly uncovering the horns, skulls and bones of these ancestral beasts.

Illustration: George (Rinaldino) Teichmann

Bison seem to have been the most plentiful large mammal in the Klondike during the later part of the last ice age — between 35,000 and 10,000 years ago. These ancient bison had massive horns in comparison to today's bison, although their bodies were only slightly larger.

Some of the oldest bison remains in North America have been found at Thistle Creek in the Klondike and along the Stewart River. They were recovered in an area covered with a Beringian volcanic ash that is about 140,000 years old. These remains mark the first population of steppe bison that migrated from Asia to North American across the Bering land bridge. The nearly complete carcass of the 37,000-year-old Blue Babe, found near Fairbanks, is the best example of an extinct steppe bison from Beringia.

The massive herds of steppe bison were gone by around 10,000 years ago, replaced by modern bison that migrated from the middle of the North American continent.

Above: Palaeoecologist Charlie Schweger with a fossil steppe bison skull at Quartz Creek.
Photo: Brent Alloway

Below: Large fossil steppe bison skull found at Quartz Creek.

Yukon horse

The fossil bones of Yukon horse are also very common in the Klondike. Horses evolved in North America beginning some 40 million years ago. The first true horses became established in North America between 5 and 2 million years ago, along with the rise of grassland habitats.

Some of the oldest ice age horse fossils in the Yukon were found on lower Gold Run Creek and Thistle Creek, in the same location as volcanic ash that is 740,000 years old. Ice age horses went extinct in North America around 12,000 years ago.

Top: Bones of *Equus* from the Klondike region at the Smithsonian Institution, Washington, D.C. Photo: Patricia Halladay; courtesy Smithsonian Institution

Left: Geneticist Beth Shapiro examines a partial upper jaw bone of a Yukon horse emerging from the frozen mud at Quartz Creek.

The Yukon's ice age horses were the size of a pony, much smaller than the domestic horses that were brought to North America by the Spanish thousands of years later. We think that ice age horses are closely related to today's Prezwalski's horse, found in central Asia.

The fantastic discovery of a nearly complete carcass at Last Chance Creek *(see page 23)* tells us the horses in Beringia had long blonde manes and tails. The beautifully preserved hide is on display at the Yukon Beringia Interpretive Centre in Whitehorse.

Above: A bottom-up view of an ice age Yukon horse skull discovered at Last Chance Creek.

Mammoth or mastodon?

Mammoths are the icon of the ice age. All the mammoth remains recovered so far from the Klondike are those of ice age woolly mammoth. In the Yukon, fewer than 5% of these ancient elephant bones are from their distant cousins, the American mastodon.

Archaeologist Jana Morehouse next to a beautiful woolly mammoth tusk in the muck at Quartz Creek.

You can easily see the differences between Woolly mammoths and their relatives, American mastodon. The Woolly mammoth has long fur and small ears and tail, adaptations to a harsh, cold climate. Woolly mammoth tusks are much larger and more curved than the short straight tusks of the mastodon.

In addition, woolly mammoth teeth are generally flat *(photo right, bottom)*, with a rough chewing surface, as opposed to the highly pointed teeth of mastodons *(photo right, top)*. These differences reflect diet and preferred habitat. Mastodons evolved to eat shrubs and tree branches; mammoths adapted to grazing on grass.

Mammoths and mastodons are both distant relatives of elephants. Recent genetic research tells us that there was a split in the elephant family tree between mammoths and mastodons around 25 million years ago.

Above: The pointed molars of mastodons were adapted to crushing branches and shrubs.

Photo: Patricia Halladay; courtesy Smithsonian Institution

Above: Numerous vertical enamel plates form the chewing surface of a woolly mammoth tooth.

Many of the early reports of fossil discoveries from the Klondike told stories of "mastodon" tusks and bones. To this day, many shops in the Yukon advertise mastodon ivory jewellery. Scientists now know that most of these reported mastodons were in fact the mastodon's distant cousin, the woolly mammoth.

Above: Woolly mammoth.
Illustration: George (Rinaldino) Teichmann

The confusion is not surprising. Since the earliest discoveries of elephant-like bones in North America, people have worked hard to figure out what these animals were. The question fascinated American president Thomas Jefferson, who commissioned palaeontological digs in the Ohio River valley.

In 1806 French anatomist Georges Cuvier proposed the name *mastodon* to describe ancient elephant remains in the Americas which were clearly not mammoths. Many people at the time recognized that there were differences between mastodons, mammoths from Siberia and living elephants in Africa and Asia.

Left: Palaeontologist Grant Zazula holding the shoulder blade of a mastodon donated by Earl Bennett.

In 1807, William Clark of Lewis and Clark fame was one of the first field paleontologists to distinguish bones and teeth of mammoth from mastodon. The work of Jefferson and Clark is considered the birth of palaeontology in North America.

Above: Mammoth remains found at the bottom of a mining shaft, Hunker Creek, January 1901.
Yukon Archives, Walter R. Hamilton fonds 77/51 #54

Gone, but not forgotten

In addition to the Beringian Big Three — steppe bison, horse and woolly mammoth — a number of other mammals roamed the Yukon during the ice age. Probably fewer than 2% of all fossils found from the Klondike represent carnivores — the ferocious meat eaters. These fierce predators and scavengers include the short-faced bear, scimitar cat, Beringian lion and wolverine. Carnivores preyed upon bison, caribou and other herbivores.

Other rare ice age mammals include the Western camel, whose bones have been found along Hunker Creek and the Sixtymile River. Specimens of giant beaver and giant ground sloth have been found in the Old Crow River, but have not yet been recovered from the Klondike. Although caribou are commonplace in the North today, they were not very abundant during the ice age compared with the Big Three.

Right: Archaeologist Christian Thomas gathers fossil bones left behind by miners for the palaeontologists at a placer mine on Hunker Creek.

Above: Comparative sizes of radius bones of (l–r): human, modern grizzly and ice age short faced bear.

Above: Upper jaw bone with large incisor tooth of an ice age lion found on Hunker Creek.

These finds can be very exciting. Because we're mining, we're exposing fossils and artefacts that otherwise would never be found. These things are frozen into the permafrost, so they are very well preserved. Many placer miners take pride in the contributions they've made.

Norm Ross, Ross Mining, *Modern Day Placer Mining in the Yukon* (Government of Yukon 2005)

Palaeontologist Tyler Kuhn displaying a woolly mammoth tusk at Quartz Creek.

Arctic ground squirrel fossils are common in the Klondike muck, which tells scientists that they were much more plentiful during the ice age than they are at present.

Rodents among the giants

We can't forget about the rodents and other small mammals that scurried between the feet of the ice age giants. Palaeontologists have found many tiny rodent teeth in the silt and gravel of the goldfields. Since rodents evolve much more quickly than larger animals, studying them reveals a great deal about the effects of ice age climate change.

Burrows and nests of Arctic ground squirrels show that a vibrant community of rodents lived underground in the Klondike during the ice age. Similar nests have been found all across Beringia — near Fairbanks, Alaska and the Kolyma River in Siberia.

Some of the best information on ice age rodents comes from middens — ancient nests and caches of seeds from arctic ground squirrels found in the melting muck. They stored nests in underground chambers for hibernation. Males cached seeds and fruits in the fall for consumption when they awoke in the spring.

Top: Fossil nest of an Arctic ground squirrel, 30,000 years old, found at Quartz Creek in summer 2005.

Plant remains from middens tell us about the diets and foraging behaviour of ancient Arctic ground squirrels. Skeletons and even whole mummified carcasses indicate that some squirrels either didn't make it through the winter or died as infants.

Right: Some fossil nests contain skeletons of arctic ground squirrels that didn't survive the winter.

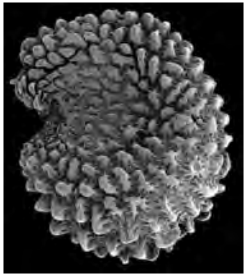
Ice age grasslands

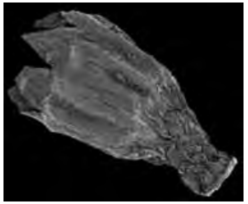
Grasslands such as these in southern Yukon contain many of the same plant species that covered vast areas of Beringia.

Most of what we know about the vegetation in Beringia during the ice age comes from the study of fossil pollen. This pollen is preserved in mud at the bottom of lakes. Pollen studies generally indicate that most of Beringia was covered by grasses, sedges, sage and a variety of small flowering plants.

Many pollen studies have been conducted in Alaska and the northern Yukon. Although few ice age plant studies have been conducted in the Klondike, there has been a recent focus on studies of larger plant remains or plant macrofossils such as seeds, fruits, leaves, twigs and wood found in the muck. A study of more than 100 ice age arctic ground nests found at least 60 different species of grass, sedge and other plants.

Most of these plants are not found in the Klondike today. Many are now restricted to high alpine or arctic tundra or in dry grasslands. This reinforces the view that ice age vegetation was very different than today's forests or arctic tundra. Ice age grassland vegetation is known as tundra steppe or mammoth steppe, with plants from both tundra (cold-adapted) and steppe (dry-adapted) ecosystems.





Right, top: Fossil chickweed *(Cerastium)*; centre: Chenopod pollen grains (seen through a microscope); bottom: fossil sage *(Artemesia)* flower — all recovered from the nests of ice age arctic ground squirrels.

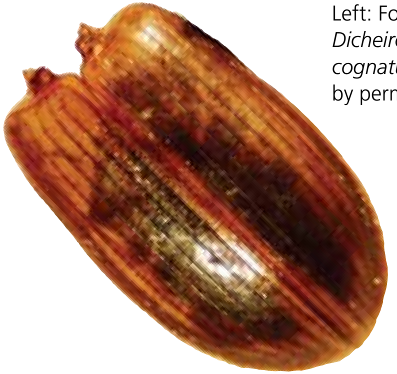
Above: A collection of fossil beetles and terrestrial snails recovered from ice age muck.

Beringian beetles

Ice age beetles and other insects that scientists have recovered from the Klondike muck help fill in the details on ice age environments. Small beetle parts are screened from bags of muck and gravel and identified under a microscope with remarkable precision. Since each beetle species can live only within a narrow range of temperatures, fossils of ice age beetles give us information about past climates.

Recent studies on Klondike beetles indicate that during the ice age, temperatures were about 4°C colder in the winter and 6°C colder in the summer than they are now.

Some beetles have very specific diets. An abundance of fossil sage beetles, which today eat only prairie sage, provides evidence that sagebrush and grasslands covered the Klondike during the ice age.



Left: Fossil beetle, *Dicheirotrichus cognatus,* preserved by permafrost.

Right: Entomologist Svetlana Kuzmina and her team screening muck to isolate fossil beetles along Sulphur Creek.

A woolly mammoth's back yard

In the spring of 2004 a spectacular discovery was made on Gold Bottom Creek. Scientists found an ancient grassy meadow melting out of the muck. The meadow had been buried by Dawson tephra some 30,000 years ago *(see photo below and page 21)*.

Below: Volcanic ash *(white line)* from an eruption 30,000 years ago buried this grassy meadow.

The rooted grass and other plants formed a layer of sod that could be traced for about 40 metres across the mine site. The plants had been preserved to an amazing extent — some of the grass leaves were still green!

Left: Fossil grass below layer of tephra at Gold Bottom Creek.

This was the first time in the Klondike that a fossil plant community was recovered in the same place where it originated. Study of the plants revealed that it was a grassy streamside meadow community, rich in hairgrass, sedges and horsetail. One can easily imagine an ice age mammoth on the meadow as it went down to the ancient Gold Bottom Creek for a drink.

Above: Some of this 30,000-year-old grass has been so well preserved that it's still green.

Last interglacial forests

Remains of ancient forests are also found in the gold field muck. These are the logs, branches and roots of trees that lived in the Klondike during the last interglacial period — around 125,000 years ago. This was the last period of time that the earth's climate was as warm as it is today.

It was also the last time before the advance of the glaciers that dense spruce forests covered the central Yukon. These forests may have extended all the way north to the arctic coast of Alaska and the Yukon.

Studying the fossils of these ancient forests can help us understand present-day climate change and global warming. Studies of wood — and of plant remains and beetles — tell us about ecosystems during past warm periods. In addition, the ice and muck where these fossils are found can reveal clues as to how permafrost may be affected by warming temperatures in the North.

Left: Forests in the Klondike 125,000 years ago would have looked much like this, except for the occasional mastodon or scimitar cat.

Right: Cones and bark from ancient spruce trees.

Left: Palaeontologist Grant Zazula next to a 125,000-year-old tree stump.

Both photos: Alberto Reyes

Ancient genetics

Over the last decade new genetic techniques have revolutionized our knowledge of ice age life in Beringia. The same perma-frost conditions that were responsible for preserving fossil bones are also ideal for the long-term survival of deoxyribonucleic acid (DNA) — the biological building block of life.

Above: Geneticists wear sterile suits to prevent contaminating their fossil bone samples.
Photo: Tara Fulton

Extracting and studying DNA from ice age bones enable scientists to piece together the evolution of extinct animals and determine how ancient creatures may be related to modern ones. Recent genetic studies of Alaskan and Yukon fossil steppe bison reveal that they were replaced by modern bison that migrated from south of the continental glaciers at the end of the ice age.

Left: Loading ancient DNA from an extinct ice age mammal.
Photo: Tara Fulton

DNA evidence also indicates that woolly mammoths evolved in our back yard: the Yukon. People have speculated about whether it is possible to clone extinct beasts like the mammoth. Nobody knows the answer to this question now. But, like so many aspects of science, what seems like science fiction today may become reality in the future.

Above: Permafrost scientist Fabrice Calmels collecting a core of permafrost sediment.

Acknowledgements

We are indebted to the Klondike placer miners for their enthusiastic support and generous assistance. We thank all those who have donated fossils to our collections — this greatly contributed to our scientific understanding of the Klondike's rich past.

We also thank the many scientists and colleagues, past and present, who have helped build the record of the ice age Klondike over the decades.

Studying the ice age is a team effort.

We extend thanks to the staff at the Yukon Beringia Interpretive Centre in Whitehorse, who bring life to ice age stories for Yukoners and tourists. Thanks also to the Friends of the Yukon Archives for the photographs gathered during the production of their "Buried Treasure" exhibition on palaeontology in the Yukon, some of which are used here.

This booklet is available on line at www.tc.gov.yk.ca/966.html. Hard copies are available from the Government of Yukon Palaeontology Program or by e-mailing heritagepublications@gov.yk.ca. More information on those who have contributed can be found online at www.tc.gov.yk.ca/966.

Above: A monitor at work on Quartz Creek.

Right: Placer miner Gerry Ahnert demonstrating time-tested methods of finding gold — and fossils — along No Bottom Gulch.

About the authors:

Grant Zazula is the Yukon Palaeontologist with the Department of Tourism and Culture. He has been conducting research on the ice age Yukon since his first trip north to Old Crow in the summer of 1999.

Duane Froese is an Associate Professor and Canada Research Chair in the Department of Earth and Atmospheric Sciences at the University of Alberta. He has led teams of scientific researchers into the Klondike since 1995.

The Klondike goldfields of west-central Yukon have an ancient natural history that extends back long before the stampeders arrived. Remnants of this prehistoric past are revealed by the hydraulic hoses and heavy equipment of Klondike gold miners. Fossil bones and other ancient treasures from the permafrost are helping scientists understand the Yukon's ice age history.

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The booklet, *Ice Age Klondike: Fossil treasures from the frozen ground*, is available on line at www.tc.gov.yk.ca/966.html. Hard copies are available from the Government of Yukon Archaeology Program at 133A Industrial Road, Whitehorse or can be ordered by e-mailing heritagepublications@gov.yk.ca.

Acknowledgements

We are indebted to the many Klondike Placer Miners and people of Dawson City for their enthusiastic support and generous assistance. We thank all those that have who have taken care to gather and donate fossils to our collections — this greatly contributes to our scientific understanding of the Klondike's rich past.

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