Gold in the Klondike

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Abstract: The Klondike Valley lies deep in the Yukon Territory of northern Canada. In 1896, gold was found on one of its tributary creeks, and this prompted the world's greatest gold rush. The stampede of gold seekers endured awful hardship in hauling their supplies over the snowbound Chilkoot Pass before sailing down the Yukon River in fragile hand-made boats, but they arrived in Dawson after all the claims had already been staked by prospectors who were already on the Yukon River. The rich gold ores were formed by low temperature hydrothermal mineralisation of alluvial gravels and the upper zone of bedrock schist; some was reworked and further enriched as true placer deposits. Mining was originally by hand-dug shafts and adits in the frozen gravels; this was later replaced by hydraulic washing and large scale dredging.

Just 100 years ago, the largest, craziest and richest gold rush that the world has ever known descended on the Klondike — which lay in an almost unbelievably remote location in sub-arctic Canada. Between 1896 and 1904 thousands of fortune seekers endured the most awful conditions in the unforgiving wilderness, to dig for gold in placer deposits of staggering richness. The story of the Klondike is one of wild adventure, stunning extravagance and dreadful hardship — laced into a geological background which is no less remarkable. The Klondike was unique — unprecedented and never to be repeated.

Environments in the Yukon

The Klondike is a relatively small river within the Yukon Territory of northwestern Canada. It is a tributary of the Yukon River, entering its right bank about 100km before it crosses into Alaska, on its way out to the Bering Sea. This mighty river drains most of the interior of Alaska and the Yukon, its basin trapped between the coastal mountains along the Pacific rim and lesser ranges on the Arctic side (Fig. 1).

The Yukon basin is today a periglacial environment — and most of it has been so throughout the Quaternary. In each cold phase of the Pleistocene, a Cordilleran ice sheet developed in the basin's southern sector, by the coalescence of glaciers and ice caps on the coastal mountain ranges. Farther to the east, the huge Laurentian ice sheet advanced in the same cycles, but at its maximum only covered the upper reaches of the Yukon River (Fig. 1). Most of the Yukon basin was not glaciated, due to the lack of snowfall in its land-locked rain shadow. The periglacial zones are distinguished by the high plateaus and minimal relief of altiplanation; river valleys are minor, and hollows are filled and aggraded by solifluction. This cold environment is characterised by very low erosion rates — critical to the preservation of the Klondike gold deposits.

Continuous permafrost occurs where the mean annual air temperature is lower than about –8°C; this covers the Arctic coast zone and also the higher mountain areas of the interior. In most of the Yukon basin, there is discontinuous permafrost, and in the

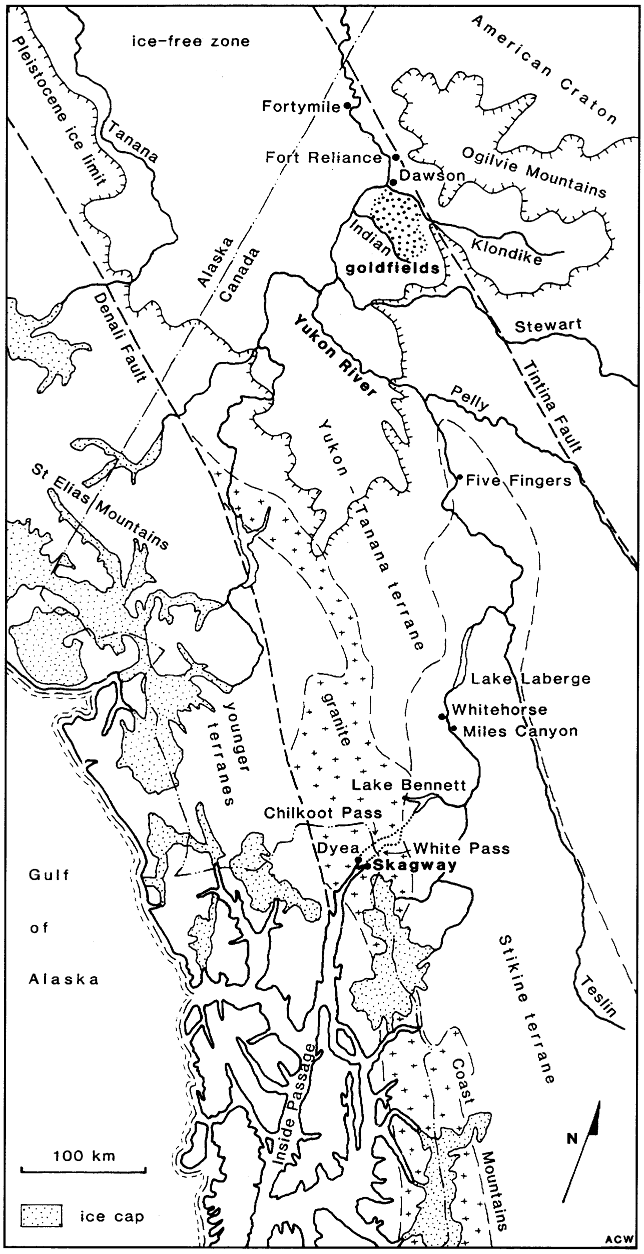

Fig. 1. The upper Yukon Valley and the gold rush routes in from Skagway and Dyea on the Pacific coast. The coast batholith and the faults bounding the Yukon-Tanana terrane are shown. The Pleistocene periglacial zone had Laurentian ice to the east and Cordilleran ice to the south.

Klondike it is about 20m deep. Above the permafrost, the active layer has its winter ground ice thawed by the summer sun; it becomes an undrained, unstable quagmire just a few metres deep during each short Arctic summer. In the Klondike's marginal permafrost zone, frozen ground only survives under an insulating blanket of undisturbed vegetation; clearance or destruction of the trees and their organic soils leads to ground thawing — and was often intentional to facilitate mining operations.

Until the great gold rush, very few people penetrated beyond the coastal mountains into the sub-arctic wilderness of Alaska and the Yukon. It is a seriously hostile country, with vast expanses of wetland, forest and mountain defended by a climate that is rarely comfortable. The coastal mountains provide an almost continuous line of peaks, with many rising to over 4000m between glaciers and icefields; only a few passes provide routes to the interior.

Beyond the mountains, the vast lowland of the Yukon River basin is largely covered by forests of spruce and birch; farther north these thin out to the taiga — a ragged cover of low shrubs and isolated trees. Higher on the hills, or even farther north, the tundra is a treeless landscape of mosses and dwarf vegetation.

The climate is severe by any account. Exposed to the Pacific Ocean, the coastal mountains can receive 30m of snowfall in a single winter. The interior lies in the rain shadow, and has a comparatively thin snow cover in winter, and little summer rain. Winter lasts from October to May, and temperatures can stay below –40°C for weeks at a time. With the summer thaw come voracious mosquitoes, which thrive until August. September offers a brief respite, with its explosion of autumn colour before the snows return.

Into this alien environment of horrendous cold, deep snow, bog, mosquitoes and frozen ground, came thousands of fortune seekers. Nobody in their senses would set off unprepared and on foot into the Arctic wilderness, but gold is the ultimate lure.

The Klondike gold rush

Hardened prospectors and trappers were the first into the Yukon valley, and a trading post known as Fort Reliance was established on the river bank in 1874. Seven years later, gold was found on the Stewart River, but the first significant discovery was on the Fortymile River in 1887. Though this river was largely in Alaska, it joined the Yukon just inside Canada, where a mining camp grew and took the name because it was 40 miles from Fort Reliance.

By 1895 there were hundreds of prospectors and miners on most of the creeks draining into the Yukon River. Robert Henderson was the first man to pan a little gold in Rabbit Creek (now known as Bonanza Creek), which is a tributary of the Klondike just above its confluence with the Yukon. On his advice, George Carmack and two Indian friends camped on Rabbit Creek 15km up from the big river. On August 16th 1896, they found gold richer than their dreams in the creek gravel. They staked their claims, and went to Fortymile to record them.

Within days, hordes of other miners from up and down the river followed the stories; by the end of 1896 most of the Klondike creeks had been staked as claims. The next year, 1897, the river terraces high above the creek beds had also been prospected, had again been found to be rich in gold, and had subsequently been staked. Claims cost just $15 to register, and more than 30 claims on Bonanza and Eldorado Creeks each yielded a million dollars in gold.

The Stampede. On July 17th 1897, a ship docked in Seattle carrying 68 miners and $700,000 in gold, and the world's most frantic gold rush began. More than a rush, it was a headlong stampede, and its ill-prepared participants were known as stampeders. Every ship on the west coast sailed north, packed with optimists and opportunists, each with his own mountain of supplies. Few had any idea of what lay ahead. A few wealthy adventurers took the long ship route around the Alaska Peninsula and up the Yukon River from the Bering Sea (Berton, 1990). But for most the sea journey ended at the head of one of the two most northerly fiords in Alaska's Inside Passage. Unloading the boats onto the tidal flats was just the first desperate task, but by the end of autumn 1897, there were 30,000 stampeders in the sprawling fiord-head camps at Skagway and Dyea, just 2km apart (Fig. 1).

Directly out of Skagway, the White Pass took a pack-horse trail through the mountains. Although it was the easiest route north, 3000 horses died on its trail during the first winter. By July 1899 there was a railway over the White Pass, and Skagway thrived as the port town, while Dyea died. But that was too late for the stampeders of 1897, of whom few could afford the tolls on the original horse trail.

So most of the stampeders set off north from Dyea, on the old Chilkat Indian trail which climbed over the Chilkoot Pass (Fig. 1). Throughout the winter of '97-98, some 25,000 of them hauled their supplies through deep snow over the Chilkoot trail, and over the 990m high pass. Dyea is in Alaska, and the Canadian border was marked by an outpost of the North West Mounted Police on the crest of the pass. As there were no supplies in the Yukon wilderness, stampeders were only allowed to enter Canada if they had a year's supplies with them. Essential items included 160kg flour, 70kg bacon, 1 box candles, 2 heavy blankets, 2 wood saws, 10lbs pitch; the list was long, but gave no room for comfort.

Each man therefore had to haul about 700kg of food and essential materials — mostly on their backs, as no horse could make the steep, rough trail. So the kit was ferried load by load, cache to cache,

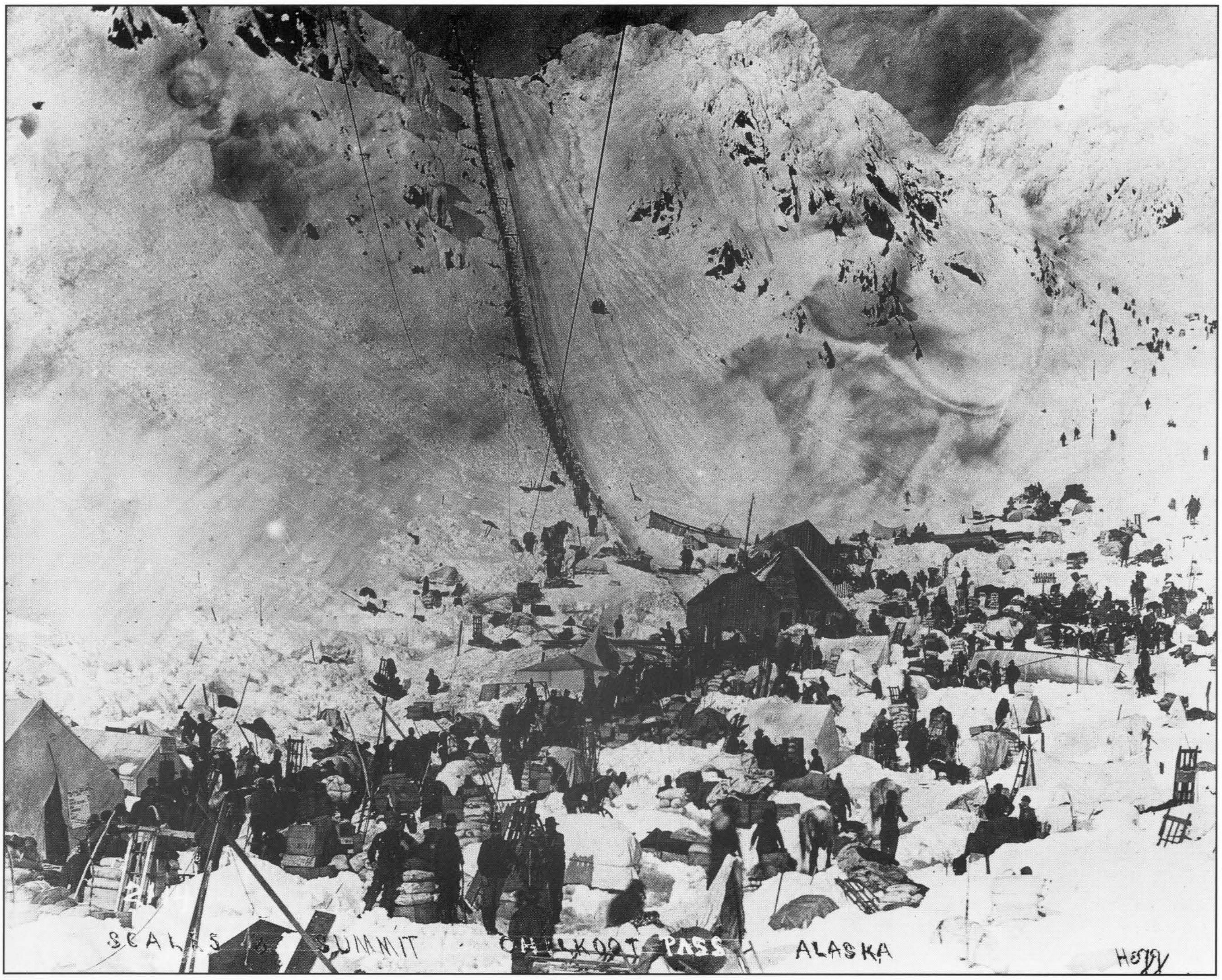

Fig. 2. Stampeders' supplies stockpiled on the Chilkoot Pass, while an unbroken line of men haul them up the snow slope of the Golden Stairs in the centre background. These stampeders were late in the Rush, as the first of the aerial tramways was being built at the time (photo by E. A. Hegg, courtesy of Dawson City Museum).

and it took up to 3000km of trudging to and fro with a backpack to cover the 53km to Lake Bennett. The suffering and endurance of that winter on the Chilkoot were legendary (Berton, 1983, 1990; Morgan and Hegg, 1967). The final ascent to the pass was a 40° ascent on a snow covered scree slope (Fig. 2). An endless line of men carried their heavy packs up the steps stamped in the snow, and known as the Golden Stairs; only in 1898 were aerial tramways built to improve the route for the traders who came after the stampede.

Once over the Chilkoot Pass, the stampeders descended to the banks of Lake Bennett, where a huge tent city grew steadily through that winter. There they cut down most of the surrounding forest — and used their saws, oakum and pitch to make boats which could survive a trip down the Yukon River. On May 29th 1898, the ice broke up on the lake, and within a few days 7124 boats were counted by the Mounted Police as they set off down the outlet river. The current carried them downstream, to start an unpowered journey of 900km to the Klondike. Much of the Yukon River provided easy and steady floating, but there were some rude interruptions. Miles Canyon had wild water between walls of columnar basalt, and the Whitehorse Rapids were equally wild (but now lie submerged behind the dam at the town of the same name); Five Fingers Rapids, over a band of hard conglomerate, were not so troublesome.

In June 1898 the armada of stampeders floated into Dawson, the miners' town at the mouth of the Klondike River. Only then did the ultimate tragedy hit them — by the time that they arrived, every claim in the goldfields valleys had already been staked. The 30,000 new arrivals could only work for wages from the prospectors who had got there before them. Many departed, broke and broken. One stampeder wrote home:- "Martha. All the ground is taken. Everyone is a king but me. I'm off to Nome on the last boat out. Affectionately, Henry". Those who did make it rich were mostly not gold-diggers — they were the thoughtful ones who had come equipped for trade in the Dawson boom-town (Berton, 1983).

Dawson and the Klondike camps. The miners' camp on the mudflats at the mouth of the Klondike River had expanded steadily since 1896; its collection of tents and a scatter of log buildings was named Dawson, after a Canadian government geologist (Fig. 3). With the arrival of the stampeders, Dawson became Canada's largest town west of Winnipeg. An initial chaos of ragged tents in a sea of mud slowly evolved in the wake of the mining boom. A fleet of sternwheelers, brought endless supplies up the river from Alaska — along with a few thousand more gold seekers. Timber buildings and raised sidewalks lined the muddy streets — which have never been tarred to this day.

The gold diggings started in the Klondike valley right at the back of town. They stretched up each and every creek that drained into the Klondike from the south. Every claim had its own collection of log cabins, tents and makeshift shacks, and traders established posts wherever they could. Grand Forks became a key town with hotels, shops, saloons and a floating population of over 5000 above the junction of the two richest creeks, Bonanza and Eldorado (Fig. 4). From 1906 to 1914, it was linked to Dawson by a railway through the heart of the goldfields.

The wildest days of the gold rush ended in August 1899, when word came up the river of new gold discoveries on the beaches of Nome, on Alaska's Bering Sea coast. There was a new rush for the boats as most of the stampeders and itinerants without a claim of their own headed out of town. A slightly less crowded Dawson continued to thrive with the highs and lows of the mining industry. In 1953 the Yukon government moved from Dawson to Whitehouse, but there are still miners on the Klondike today.

Geology of the goldfields

The Yukon terranes. The geology of the north-western tip of North America is essentially the product of convergent plate boundary activity and terrane accumulation, complicated by massive oblique shearing. The Western Cordillera, including the Rockies, the Coast Mountains and the Alaska Range, was formed largely in Mesozoic times as an orogenic belt above the eastwards subducting, eastern Pacific plates. This orogenic belt was accreted to the western edge of the very old continental craton known in part as the Laurentian Shield. In the early Tertiary, the divergent boundary of the Pacific Rise was overridden by the advancing North American plate. Thereafter, the subducting Pacific plate was moving west of northwards — and most of the plate boundary along the Pacific coast of North America became a massive transform fault

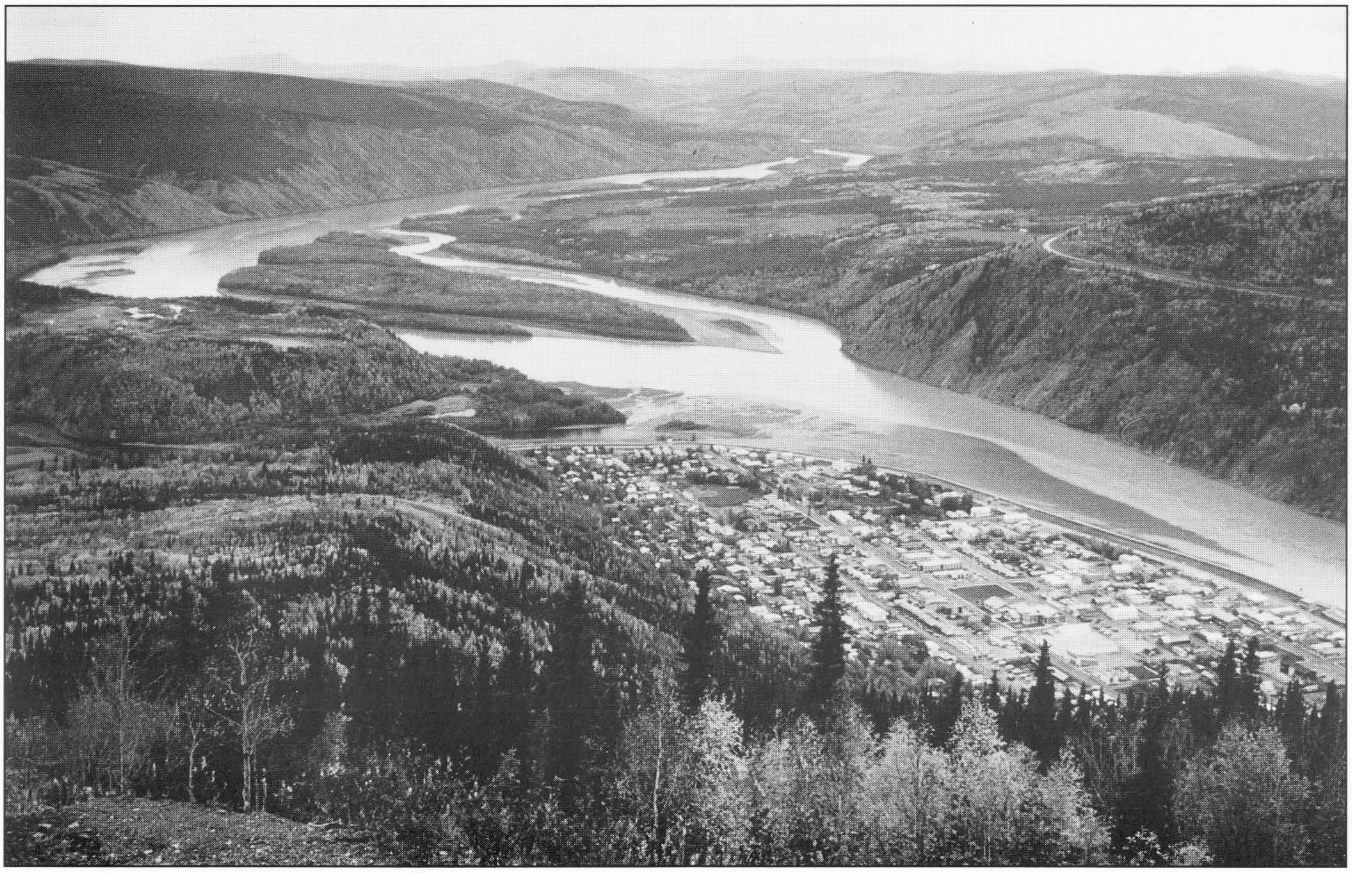

Fig. 3. The present town of Dawson, on its mudflat beside the Yukon River. The Klondike River enters between the high terraces at the far end of the town, and produces the dark wedge of clear water against the pale, muddy water of the Yukon River. The goldfields lie upstream on the Klondike, just off to the left. The view is to the southwest, looking up the Yukon River where it is entrenched between the periglacial plateaus (photo by the author).

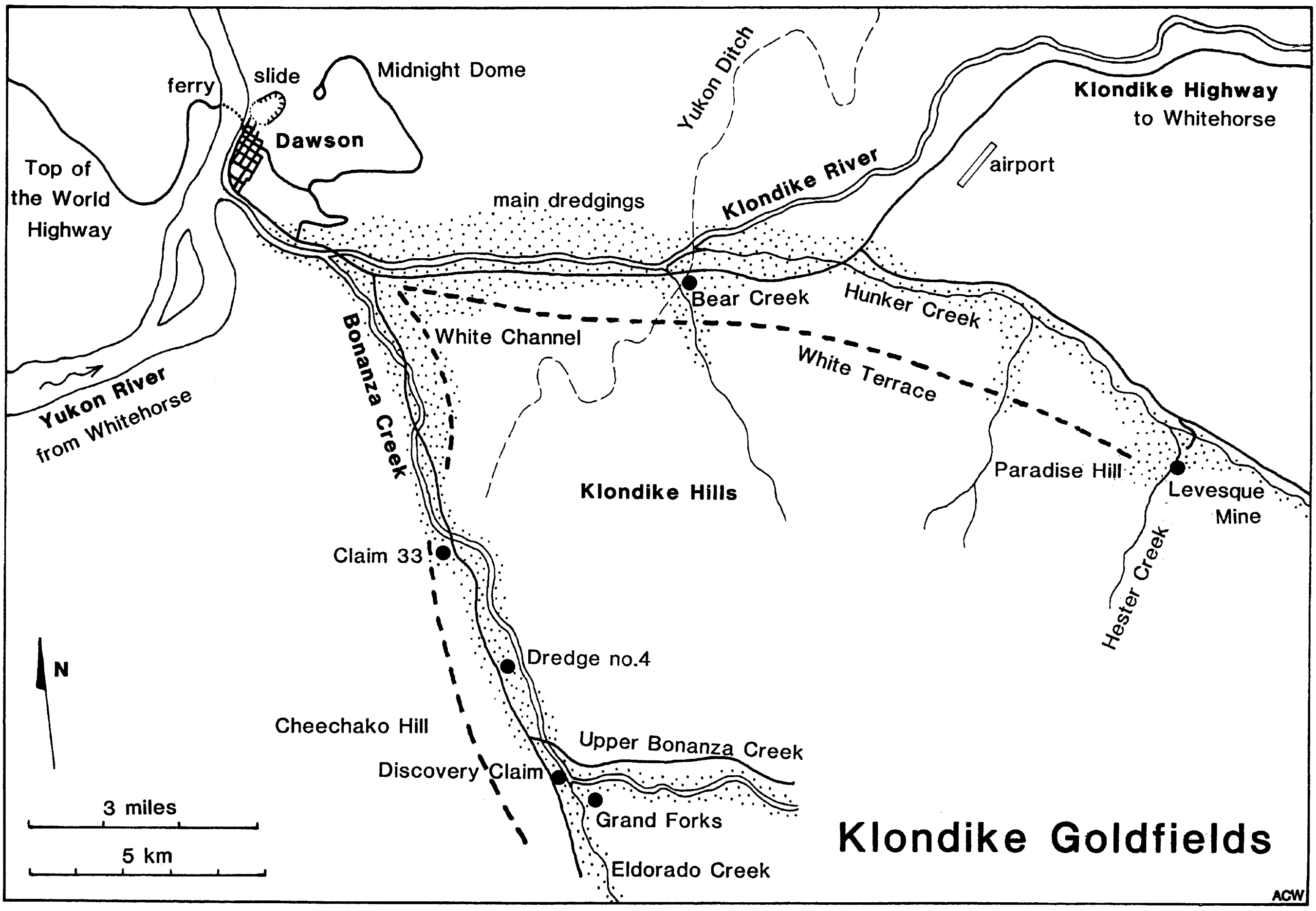

Fig. 4. Outline map of the heart of the Klondike goldfields on the Bonanza and Hunker Creeks. The stippled areas are those most thoroughly worked by dredging and hydraulicking operations. The heavy broken line traces the richest zones of the White Channel within its high terrace, and was also heavily mined across Cheechako Hill.

system dominated by shear movement. However, plate convergence continued along Alaska's southern coastline.

The long period of northward movement of the Pacific plate had the effect of a massive conveyor belt that carried various terranes from distant sites northwards, to be accreted onto the south coast of Alaska where the plate boundary turned sharply to the west (Waltham, 1995). Much of the terrane material was derived from huge greywacke sequences that accumulated along the western margin of the North American craton. Individual terranes have been recognised by detailed mapping along with an overview of the metamorphic facies (Dusel-Bacon *et al.*, 1898-94).

Early Jurassic times saw the arrival of the Yukon-Tanada terrane; this was a chunk of Precambrian-Paleozoic schists, drawn out into a long strip by the shearing of the oblique collision. The boundaries of the terrane are major faults (Fig. 1). On the south side, the Denali Fault has a shear displacement, whose continued activity threatens to create a lateral offset of the Alaska oil pipeline which crosses it just north of the Alaska Range (Waltham, 1995). On the north side, the pattern of oblique slip has created an element of tension across the Tintina Fault throughout its Tertiary history, when a narrow graben developed along it. This is recognisable as the Tintina Trench; it is now partly filled with Tertiary sediments, but is recognisable where it is occupied by segments of the Yukon, Klondike, Stewart and Pelly Rivers (Fig. 1). Subsequent terrane arrivals trapped and compressed intervening greywacke belts, and the impact of the collisions with the American continental slab was great enough to generate partial melting of the crust, thereby creating the huge coastal batholith of granite, now exposed around Skagway.

Origins of the Gold. Within the Yukon-Tanada terrane, the Lower Paleozoic Klondike Schist is the ultimate source of the Klondike gold. But as in all the world's great gold rushes, the miners' targets on the Klondike were the enriched placer deposits. The richest gold was found as flakes and grains in loose alluvial sediments. As worked both in the first rush and today, most grains are less than a millimetre across, some is the finest of dust, and some is in nuggets formed where smaller grains are annealed together in the riverbed. All the gold occurs as the native metal, though it is alloyed with a little silver and traces of copper.

The placer deposits occur along most of the creeks in an area of over 1000 square kilometres. The richer gravels, just a few metres thick, are mostly covered by up to 12m of barren gravel, loessic silt and organic peat (locally known as muck). Late Tertiary gravels, 2-50m thick, occur as terraces on the higher valley sides, at levels up to 100m above the creeks; these also contain gold, with the richest in the White Channel, named after its clean, white, quartz sand (Fig. 5).

It had long been assumed that all the gold, in both the White Channel and in the modern gravels, was typical alluvial placer material, derived by mechanical erosion of gold-bearing quartz veins within the bedrock and then concentrated by selective deposition. But this is not entirely the case, as much of the gold is found in enriched zones within the schist just below rockhead.

The marine clays which now form the Klondike Schist originally contained low levels of gold. This was mobilised during Cretaceous metamorphism, at temperatures around 300°C, and was concentrated into numerous, widely dispersed quartz veins (Rushton *et al.*, 1993). Few of these are large enough or rich enough to warrant underground mining on even the smallest scale.

Overlying the schist, the oldest drift sediments, occupying the highest topographical positions, are the braided channel sediments of the White Channel terrace. These are of Plio-Pleistocene age; they are also mineralised (Morrison and Hein, 1987). Their lower parts show clear signs of low-temperature hydrothermal alteration; most notably there is kaolinisation with new growths of clay minerals. Similar alteration also occurs in the top few metres of the immediately underlying bedrock — the quartz chlorite sericite schists. This second phase of gold mobilisation concentrated the metal to economic levels just above and below rockhead (Fig. 5); its medium of transport was largely rainwater draining through the drift and weathered bedrock, but it is distinct from conventional secondary mineral enrichment that occurs purely by weathering processes. Gold/silver ratios vary from creek to creek, indicating local variability in the sources of the metals and their emplacement systems.

Erosion and reworking of both the mineralised sediment and the shallow bedrock, by the contemporary early Pleistocene rivers, produced further gold concentrations in the White Channel; these were traditional placer deposits, which provided the richest pay streaks in the terrace gravels. All the White Channel alluvium was left above the valley floors by a phase of incision and rejuvenation that probably occurred when local base level declined in response to downward movements on the rifts along the Tintina Trench. Fortunately, Pleistocene ice did not reach the Klondike; if it had, it would have dispersed the gold into glacial till spread over huge areas. Instead, fluvial erosion of some of the mineralised schist and terrace sediments produced successive generations of placer deposits in the modern creek gravels, in various intermediate terraces, and in the modern creeks (Fig. 5).

Within the placer gravels of both the modern valley floors and the terraces, the pay streaks with the very richest gold lie immediately above the rockhead and follow ancient channels cut into the bedrock. This is typical of placer deposits, and the exact positions of the channel floors cannot be predicted from surface observation. To the frustration of the weary miners, the rich paystreaks were only found by sinking shafts through the entire thickness of the muck and gravel, and then digging adits immediately above rockhead until gold-rich ground was discovered.

This interpretation of the ore enrichment mechanism explains the lack of any mother lode in the Klondike. Most of the world's richer placer deposits were created by fluvial deposition after erosion of hydrothermal minerals in one or more veins — the mother lodes; these were generally found merely by tracing the placer ores to their upstream limits. The veins commonly provided a second phase of mining, albeit not as rich or as easily worked as the placer ores. But hard-rock mining in the Klondike has only ever revealed a few isolated and rather meagre vein deposits.

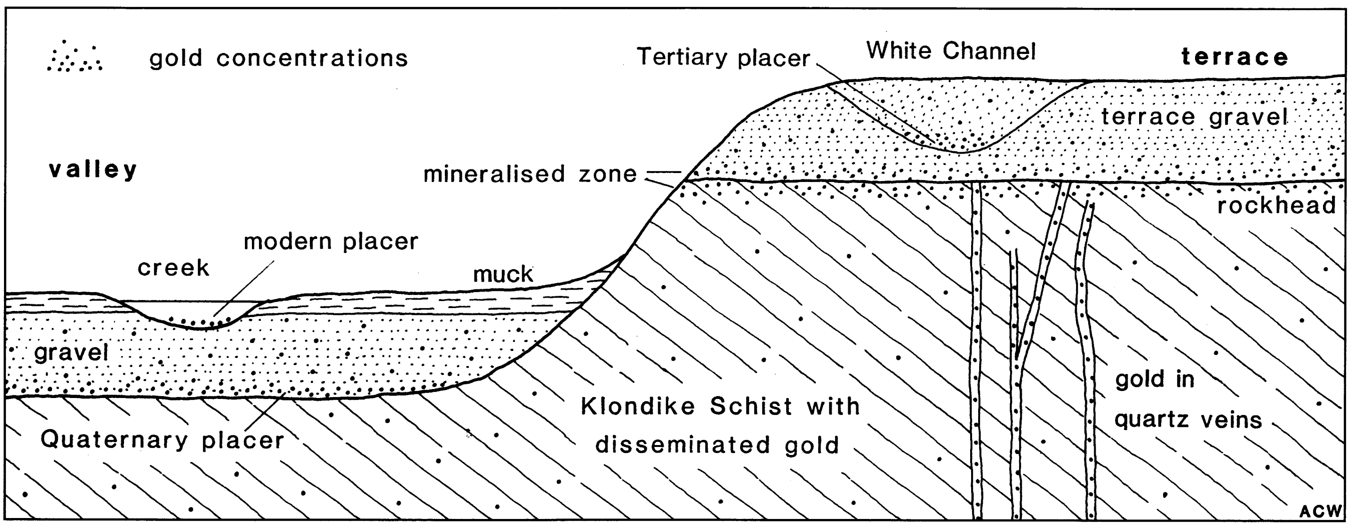

Fig. 5. Diagrammatic profile to show the various features of gold mineralisation in the Klondike schists and gravels.

Fig. 6. Early summer on the creeks, with a group of miners shovelling the sediment from a winter's underground digging into their long timber sluice. The photographer's inscription refers to the 21st claim downstream of the first claim on Hunker Creek (photo from the Turnbull Collection held by Dawson City Museum).

Mining the Gold

Panning for gold entails washing water across a shallow bowl fast enough to remove the light sediment and leave behind the heavy gold. With this quick and simple technique, the prospector worked his way up the creeks, panning the streambed gravels, until he produced a rich pan. Then he staked his claim, to 500 feet (150m) along the creek and 1000 feet (300m) up each side, and had to start digging into the deeper gravels, largely frozen solid in the permafrost, as the richest gold was always down at the rockhead. Panning has always been the tool of the prospector, but methods of mining have evolved through the years, largely in response to the nature of the gold ores which were the best available at any particular time.

Hand mining. This was the technique of the frantic Gold Rush years, but was employed on the Klondike only until 1904. A shaft was sunk straight down until bedrock was reached, and then horizontal adits were driven to find and then follow the pay streaks. Permafrost ice cemented the drift sediments to the extent that these tunnels could not be dug without powered machinery. At first the ground ice was melted by fire-setting, but this was horribly inefficient. More effective was steam from boilers at the mine entrance, but its production needed huge quantities of wood — and contributed to the complete removal of the forest in the entire Klondike region. The permafrost did keep the mine galleries stable, but the entrance shafts through the thawed active layer became unsafe during the summer, when they were best avoided. So the miners worked underground through the winter, and the gravel that they dug out was stockpiled on the surface, where it froze solid. Then in summer, the stockpiles were sluiced in running water — which was not available during the winter.

Separation of gold and waste. Sluicing was and still is the main method of separating the gold from the barren quartz and rock gravel. The original sluices used in the Gold Rush were inclined wooden channels about 400m wide and deep, with wooden riffle bars across their floors; water cascaded through them, and the channels were as long as the miners could afford to make them (Fig. 6). Gravel and dirt from the stockpile was shovelled into the sluices, where the lighter quartz and rock was washed down the channel by its cascading water. The gold was trapped behind the riffles, as it was too heavy to be washed over by the water flow; the finest gold dust was trapped on coconut matting beneath the riffle bars. A modern sluice works on similar principles, but it is a shorter and wider steel table which is vibrated by an electric motor, and it catches the finer gold on a carpet of nylon. In both the old and the new, the sediment from behind the riffles is subsequently panned to separate the gold from the other heavy minerals that are also trapped by their weight.

Most of the first miners used rocker boxes to recover the gold. Each box was about 500mm wide and 800mm long, with riffles on its base. Loaded with water and a few shovel loads of dirt, it was rocked back and forth by hand until the gold was trapped on its floor. A rocker box was a cross between a pan and a sluice; it was popular with miners of limited resources because it required less water and timber, but it was hard work to run.

As all the gold is of dust, sand and small nugget size, the separation process is improved by removing the very coarse material before sluicing. This is particularly valuable in working the leaner ores after the first rush had picked out the riches. Sieves, or screens, normally remove all the gravel coarser than about 10mm. Plane vibrating screens, a few metres across, are used on smaller mines. Larger operations feed the dirt, rock and gravel into rotating cylindrical screens known as trommels; these are 2-3m in diameter and generally 10-15m long. Both the plane screens and the trommels have hole sizes, gradients and feed rates which are selected to be most efficient for the grain size distribution of the particular deposit being worked.

Hydraulicking. Powerful water jets, blasted out of monitor pumps, are very effective at washing gravel and dirt from an exposed slope (Fig. 7). The washed debris is then scooped up and dumped into sluices just as in hand mining. The technique was introduced on the Klondike in 1902, long remained the favoured method on the terraces, and is still used on the largest mines that are worked today. It is quicker than digging, but requires a good water supply. A major step forward in the early mining was the construction of the Yukon Ditch, a sequence of canals, flumes, iron pipe syphons and vast timber aqueducts, totalling 115km in length, that brought water into the Klondike valley from unused rivers to the north.

Fig. 7. Monitor pumps in the hydraulicking operation at the Levesque Mine above Hunker Creek. The water jets are cutting into a thick cover of organic muck overlying gold-bearing gravels. Dark Klondike Schist forms the lower half of the bluff to the left of the pumps; its altered and mineralised zone is also being washed out by the water jets. The loose debris is scooped up by a front-end loader and dumped into a sluice off to the left (photo by the author).

Cat mining was started on the Klondike in 1973. It uses a caterpillar bulldozer to clear away the muck and barren gravel, before piling up the gold-bearing gravel ready for sluicing. Crude and simple, it is still used on small exploratory operations and where there is not enough water for hydraulicking.

The Levesque Mine is mainly a hydraulicking operation currently worked by two men on a tributary to Hunker Creek. Overburden of 5-20m of muck and gravel is washed away, frequently revealing very large bones and tusks from Pleistocene mammoths (Fig. 8). The lower gravels have good gold values, but, unlike in true placer ores, the richest gold occurs over bedrock ridges where it is associated with hydrothermal graphite mineralisation in the schist. Monitor pumps, blasting out 5000 litres of water per minute, rapidly cut through the unfrozen sediments and into the upper zone of altered and mineralised schist (Fig. 7). The ground is already thawed because earlier miners dumped their tailings and killed the insulating blanket of moss. In winter, the organic muck re-freezes to depths of 2m deep underneath a snow cover. Left alone a bare exposed face freezes inwards to 5m from the surface, and this would delay the spring start-up until it had thawed. To prevent this, the monitor is used to undercut and slump the face before winter, to leave a low profile on which an insulating cover of snow can accumulate; this effectively prevents the ground freezing to more than a minimal depth.

The gold dredges. Dredging was the great gold producer in the years 1905-66, when up to 35 dredges operated on the creeks (Neufeld and Habiluk, 1994). A typical floating dredge weighed up to 3000 tons, and sat in a lagoon of its own making. At its front, a chain of 75 buckets, each holding half a cubic metre, scooped up 8000 cubic metres of gravel per day (Fig. 9). It could reach to a depth of 17m, and scraped up the top 3-4m of altered schist — which had the high gold values. All the broken rock and alluvium was fed into a huge

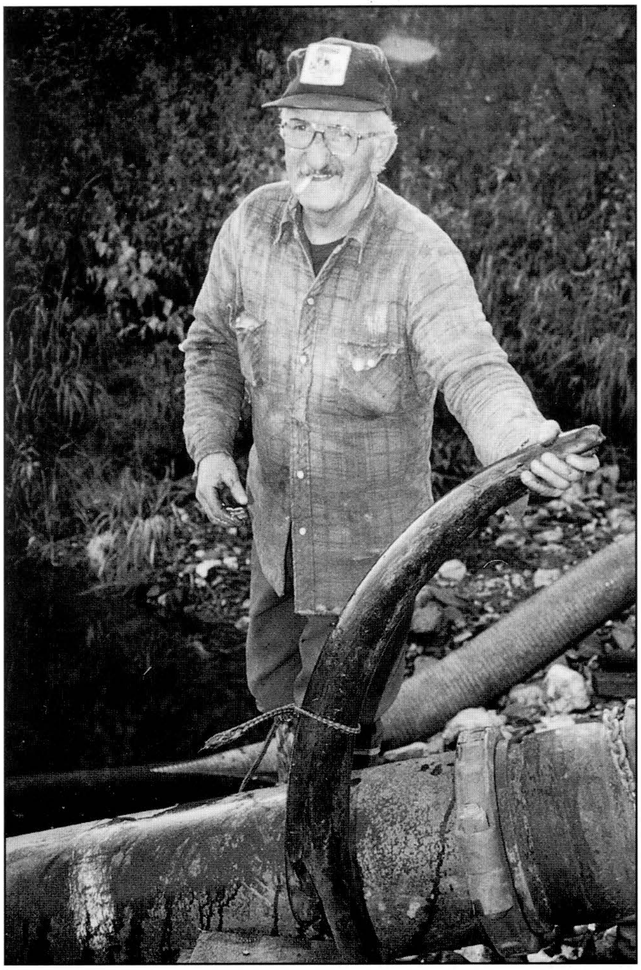

Fig. 8. Emil Levesque holds one of the Pleistocene mammoth tusks which he washed out of the gravel in 1996 at his hydraulicking mine. The string around it allows him to pull the tusk out of the pond where he keeps it underwater to stop the ivory breaking up as it dries out (photo by the author).

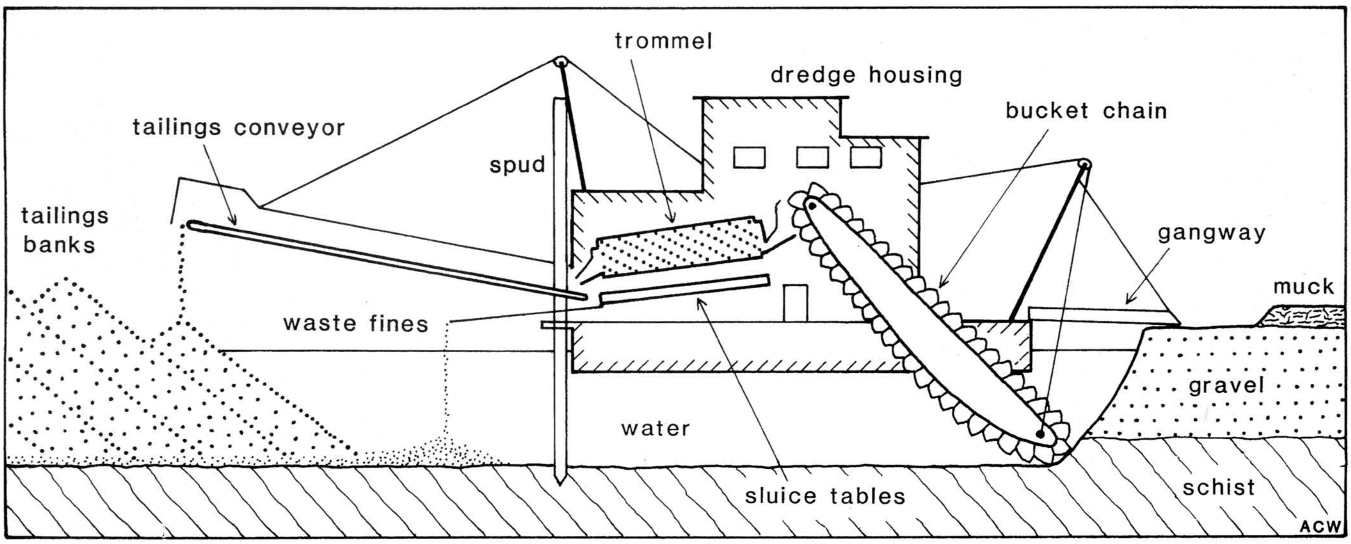

Fig. 9. Sketch drawing of the main features of a Klondike gold dredge.

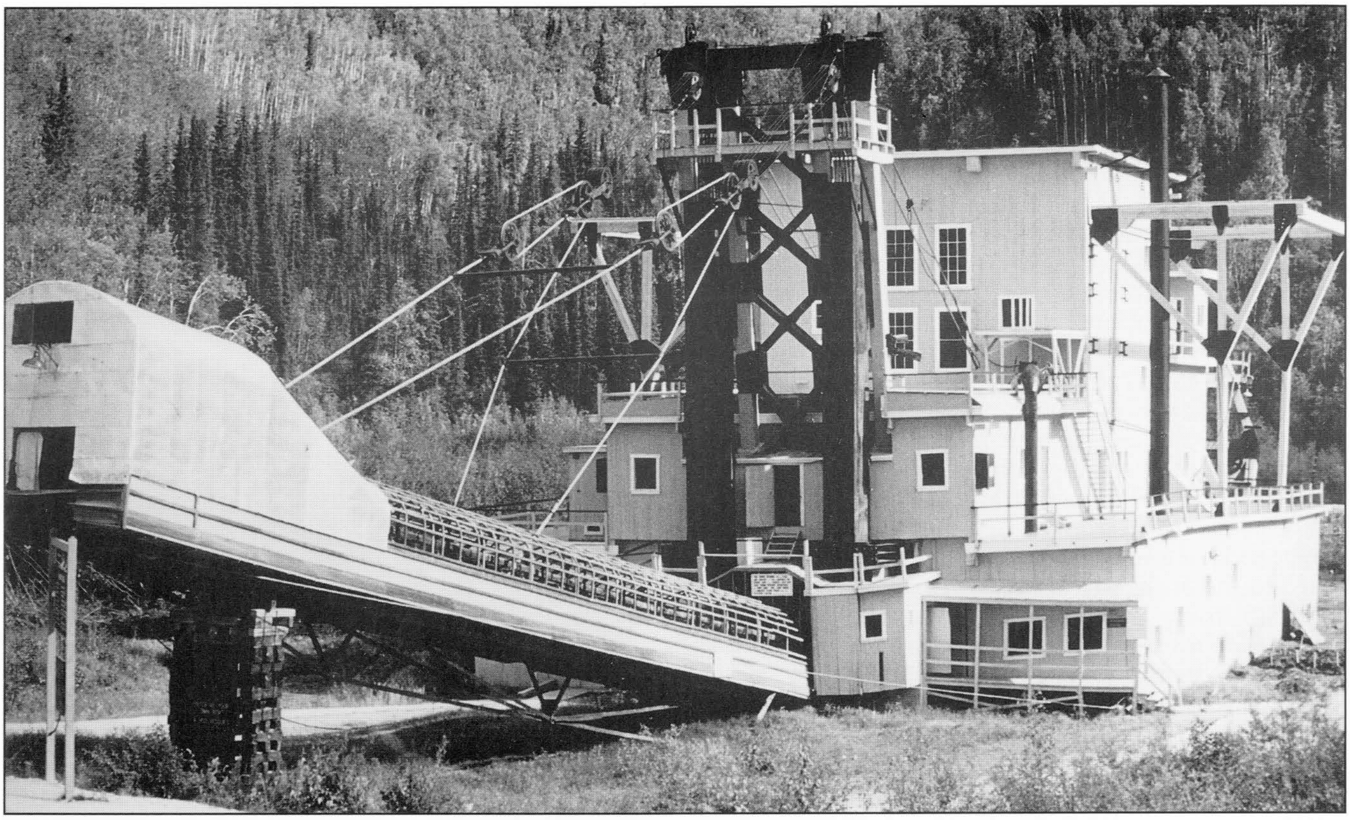

Fig. 10. Dredge Number 4, preserved on Bonanza Creek where it ceased mining in 1959. The long arm houses the tailings conveyor belt, and the bucket chain is out of sight at the far end. The photograph was taken in 1990, before the dredge was completely dug out of the gravel and turned around (photo by the author).

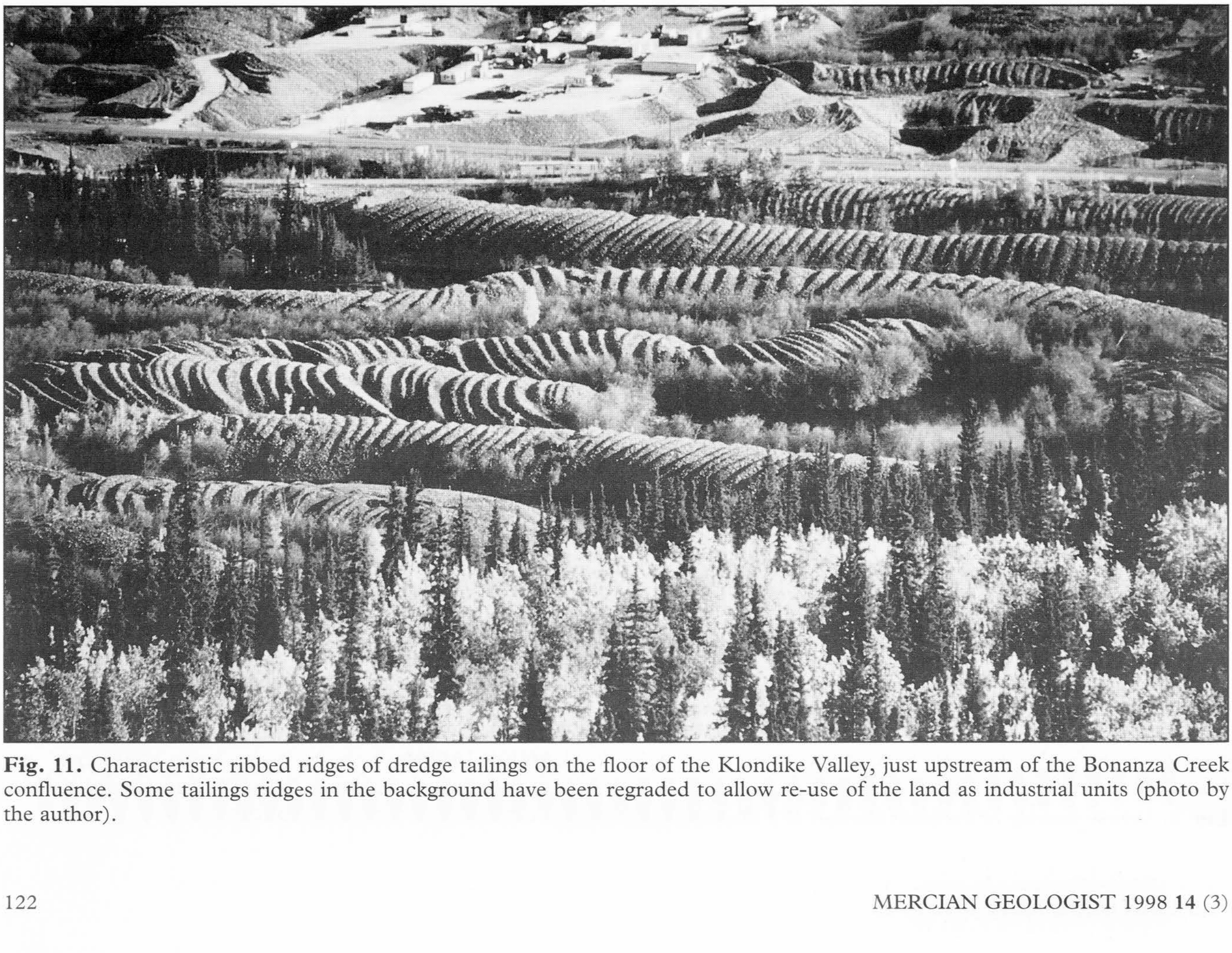

Fig. 11. Characteristic ribbed ridges of dredge tailings on the floor of the Klondike Valley, just upstream of the Bonanza Creek confluence. Some tailings ridges in the background have been regraded to allow re-use of the land as industrial units (photo by the author).

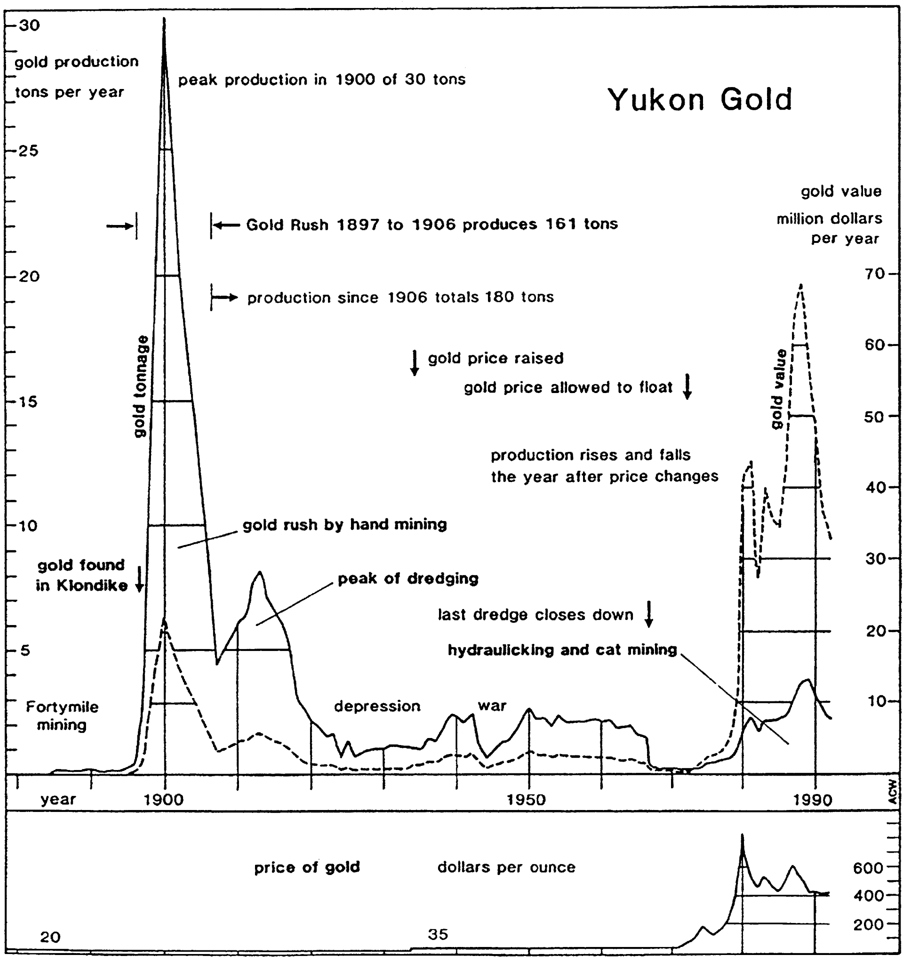

Fig. 12. Gold production statistics from 1885 to 1993. Though the data applies to the entire Yukon Territory, nearly all the mining has been on the Klondike and the changes almost entirely reflect the operations on the Klondike creeks.

revolving trommel inside the dredge housing, and the coarse debris went straight through onto the tailings disposal conveyor belt (Fig. 10). The fines dropped out of the perforated trommel onto the vibrating sluice tables, which trapped the gold with impressive efficiency. One dredge could gather up to 800 ounces (11kg) of gold in a day; but dredging had to stop when the sluices froze each winter.

Before the dredge could advance, the ground was prepared by washing off the vegetation and organic muck using the powerful monitor pumps. Then the permafrost was thawed by pumping cold water into holes bored into the alluvium; it was slower than steam, but was far more economical. The dredge advanced through the cleaned and thawed alluvium by winching itself forward on cables attached to temporary ground anchors. Once in a new position, its central steel spud was sunk into its lagoon bed. The whole dredge could then rotate around the spud, so that its bucket chain could scrape up the gravel from a wide arc. This rotating motion also swung the tailings conveyor belt at the back of the dredge, so that the barren debris formed its distinctive crescentic banks. Finer tailings from the sluices were dropped directly into the lagoon, and were then covered by the coarser debris. Each dredge ploughed through the valley alluvium, leaving its own sinuous ridge of tailings and debris to mark its route. The upper coarse material was then washed through by rainfall, to leave the crenulated banks of clean cobbles that distinguish the goldfields today (Fig. 11).

Patterns of gold production

The Klondike has yielded a total of more than 300 tonnes of gold. Annual yields have fluctuated with the changes in mining methods and also with variations in the price of gold (Fig. 12). Even today the annual gold yields are maintained by a number of small hydraulicking and cat mining operations. Production has been good in recent years, but the fall in the gold price to less than $300 per ounce in late 1997 must herald a cutback; some mines will close down, but others will just mothball their plant until they can re-open when the gold price recovers.

Gold yields with the big dredges averaged about one part per million, but this was obtained from the leaner material left behind after the initial rush. It is difficult to know what yields the first miners achieved by picking off the rich pay streaks, but they were orders of magnitude better; the best claims on Bonanza and Eldorado Creeks were the richest the world has ever known. But the total amount of rock, gravel, sediment and dirt shifted and sluiced by the Klondike miners probably exceeds 100 million tonnes. Men have moved mountains for gold, and none more than on the Klondike.

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