ALASKA GOLD DREDGING

Clark C. Spence

AT THE BEGINNING of the twentieth century, two new mass-production techniques were beginning to revolutionize the mining industry. One was the low-grade copper technique pioneered by engineer Daniel Jackling in Utah. The other was the gold dredge, first successful in New Zealand and imported into California. Both methodologies were based on massive machinery and the economies of scale. With patience, careful drill prospecting, and adequate capital, skilled engineers could predict results. No longer did it have to be said that the miner could see no farther than the end of his pick. Both dredging and the low-grade copper approach enabled the profitable working of ground once considered worthless; and both were global in their impact.

The gold dredge applied Henry Ford's production line to placer deposits. A single, complex machine combining a number of basic functions, it consisted of a floating hull, equipped with a digging ladder, an endless chain of digging buckets, screening or sorting equipment, gold-saving devices and a means of dumping debris. Ugly and relentless, stinking of oil and muck and scum, it moved along on its own dirty pond, producing not only gold, but also a "tremendous air-shaking medley of sounds:--"the crunching, groaning, roaring, grinding, clattering of stones" falling on metal screens and then onto gold-saving tables.[1] As Robert W. Service described it,

> It wallowed in its water-bed; it burrowed, heaved and swung;
> It gnawed its way ahead with grunts and sighs;
> Its bill of fare was rock and sand; the tailings were its dung;
> It glared with fierce electric eyes.[2]

When the first successful American gold dredge was launched on Grasshopper Creek in Montana in 1895, three years before one proved its prowess in California and four years before one was introduced into Alaska, there were already more than half a hundred operating on a seventy-mile stretch of the Clutha River in New Zealand.[3] In California, the Down Under model and a pioneer Montana version were quickly amalgamated into what would soon be known as the California-type of gold dredge, soon standard throughout the mining world.

These events coincided with the discovery of the golden beaches at Nome. Beginning with the *Wisconsin*, which was towed from Seattle to Nome in time for the end of the 1899 season, countless get-rich-quick specialists attempted to apply at least somebody's version of the new dredge techniques to the Far North. The sands of Nome were soon strewn with derelict "jackass machinery," "wonderful to behold," and about "as well fitted to operate in gravel deposits as to prepare ground for planting cabbages," according to one onlooker. The shore of the lagoon west of town was decorated "lugubriously" with what to a California dredge man "would seem like the nightmares of a distempered dream."[4] Young Rex Beach had abandoned law school, found financial backers and an engineer to design a dredge contraption and joined "the hysterical army" that was dumped ashore. "Our intention," he said, "was to reach out into the surf with our dredges and sand suckers and rob the ocean bed of its virgin wealth. There were scores of different devices but the only suckers that really worked were the owners." Moreover, it was hard work. "Constant immersion turned me blue," he reported. "I took on the coloring of a tuna and got so I

CLARK C. SPENCE is Professor Emeritus of History at the University of Illinois at Urbana-Champaign. He is the author of *Mining Engineers and the American West* and many other mining studies, including a coming volume on Alaska gold dredges.

darted at schools of bait."[5]

Others of the big beach machines were likened to centipedes or caterpillars. Some were self-propelled, moving on steel rails, on tripods or barrels, too ponderous to move. Lane's "big scoop dredge," drew the digging apparatus through the sea by cable, while the "Dredging Wagon" of the Soo Nome Mining Company of Alaska, stood on its eight-foot wheels, two feet wide, tried unsuccessfully to suck up sand through its flexible hose. Undersea divers worked under the sea or inside caissons, with suction pumps--all without success.[6]

After the initial fiascoes at Nome, the situation looked dubious. In the summer of 1904, one of the world's most prominent dredge experts, Chester W. Purington, surveyed the region and shook his head. While he did not preclude working some of the wide, shallow creek deposits of the Nome area, he saw no future for the Seward Peninsula as a successful dredging province. For that region, "the field for dredges in placer mining is extremely limited," he reported.[7]

But Purington was wrong. What he did not foresee was the period of the Pony dredges--small, relatively simple, comparatively cheap rigs between 1910 and 1920. Less complex than the California-type machines, these vest pocket dredges of from thirty to fifty tons worked naturally thawed shallow gravel deposits along the streams--with varying degrees of success, although boosters believed the millenium was at hand. "Dredging has been an unqualified success since the first dredge was taken to Alaska," said Governor J. F. A. Strong in 1914.[8] Another believed there was dredging ground enough on the Kenai River "to run a thousand dredges for a hundred years."[9] But realists like vitriolic engineer-editor Thomas A. Rickard, knew better. Of the sixty-five dredges in Alaska and the Yukon in 1908, thirty-five were "things to avoid," and only a dozen could be "rated as successes, both technical and financial" and only one of those was on the Seward Peninsula.[10]

Rickard's example of virtue was not a pony dredge. It was a California-type with a belt stacker and had been installed on the Solomon River by W. H. Leland and the Three Friends Mining Company in 1905. In 1912, it was one of thirty-six ready to operate in Alaska at a time when California had sixty-one, Russia sixty and New Zealand an even hundred.[11] Clearly dredge technology was a global matter. Four years later, Alaska had fifty-two dredges, of which forty-four were on the Seward Peninsula, three near Iditarod and one each near Suisitna, Circle, Hope, Ruby and Fairbanks. With some exceptions (including the Three Friends dredge and that of the Yukon Mining Company at Flat), small, flume-type machines predominated. Most were new, with buckets that ranged from one cubic foot (Oro Mining Company) to three cubic feet and manned by crews of three or four. Costing between $35,000 and $60,000 a few were steam-or electric powered, but most burned distillate, a generic term for any petroleum-based fuel from crude oil to gasoline. With a few exceptions, they were designed for shallow digging in most instances. Their buckets generally dumped gravel either directly into a flume or sluice, whence the gold was caught and the tailings dumped out the rear.[12]

Beginning in the twenties, the modern dredge era came to the territory. It coincided with the solving of a number of specific problems. The coming of the Alaska Railroad in 1923 linked Seward and Fairbanks and cheapened and expedited the transportation of heavy equipment into the interior. Mining men learned how to handle the harsh environment better. Instead of limiting themselves to shallow naturally thawed gravels, they learned how to strip the overburden--the muck, which ranged from a few feet to nearly two hundred--to uncover the deep deposits, then thaw them artificially to bedrock. They moved from trial-and-error to proven techniques of large-scale industrial dredging that took technical expertise and took capital. They applied what was now the accepted standard of world dredging, the California type, to Alaska's deep gravels.

The predictability of scientific dredging made it attractive. Now, in a departure from the "by guess and by God" approach to mining, by prospecting extensively, by dropping a pattern of drill holes and sampling systematically, engineers could estimate with remarkable precision not only how much gold was in a given body of gravel but also the volume of muck to be stripped and gravel to be thawed. Over a period of thirty-five years, one major operator, the Fairbanks Exploration Company recovered $125 million, 108.5 percent of the prospect value.[13]

In California, dredgers made a profit out of gravel paying eight cents a cubic yard, in Alaska the need to strip the ground and thaw the gravel and the short working seasons required values of fifty or sixty cents a yard. Frozen ground was like dredging reinforced concrete and was always a bugaboo. A few experimented with expensive steam or hot water thawing of gravel. In the spring, advance crews thawed the dredge by pumping water into the hull and heating it nearly to the boiling point with steam at the same time chopping ice away from the sides, although the large concerns would use more sophisticiated procedures, with explosives, steam ice cutters, power saws and hoists to remove blocks of ice.[14] But even with such well-honed techniques, little could be done to extend the dredging season beyond the normal five or six months at the most and ground had to be correspondingly rich.

Dredge mining requires substantial amounts of water for floating the dredge itself, for pumping water to screen the dirt, and in Alaska to wash away the

muck--the overburden--with hydraulic monitors, and once that had been accomplished to thaw the gravel itself. After considerable experimenting, dredgers in the mid-twenties were using cold-water thawing techniques, most often that patented by J. H. Miles, whose rights were acquired by Hammon Consolidated Gold Fields at Nome and passed on to Fairbanks Exploration Company. Water under pressure was driven through bristling forests of pipes and points set in a regular pattern at given intervals into bedrock or near the bottom of frozen gravel, which thawed and loosened the ground at a cost of from five to fifteen cents per cubic yard and the trick was to have enough thawed ground ahead to keep the dredge running without interruption during the warm season. More than one dredge operation foundered on an inability to thaw more than it could dig.

Control of water sources was a must. Thus when Hammon Consolidated Gold Fields acquired holdings of the Pioneer Mining Company in the Nome area in 1922, it procured control of the complex, if dilapidated, ditch system of nearly 100 miles. Likewise, when Fairbanks Exploration come into the Fairbanks area shortly thereafter, it proceeded to build one of the marvels of the age, the Davidson Ditch, later studied carefully by engineers planning the Alaska oil pipeline. Costing "in the neighborhood of ten million dollars," according to an official, and built over four years under adverse winter conditions in part by steam shovels used in digging the Panama Canal, the Davidson Ditch crossed fifteen creeks, included six miles of siphon, and brought water from near the headwaters of the Chatanika River some ninety miles to Cleary, Goldstream and other creeks near Fairbanks.[15] And when the company later needed additional water for new dredge ground at Ester, Gold Hill and Cripple, it built a battery of ten massive pumps on Chena Slough to supply the demand.

In addition, heavy equipment was often needed to strip the muck. At Cripple, fairly late in FE operations, 1940, where some muck went down 140 feet and high banks became risky for pipers handling hydraulic nozzles to wash it away, the company maintained a pillar artificially frozen between the pond and the high bank, using large refrigeration units. Also, a giant Bucyrus-Monighan walking dragline, "the daddy of all mining machines of its kind on the continent," sat high on the bank above visitors "like a great modern man-made dinosaur surveying the landscape it was planning to devour." And devour it did, helping strip the barren ground and dumping the material onto a conveyor belt system mounted on crawler tracks which removed it from ahead of the dredge, a million-dollar ten-foot Yuba.[16]

Most of the big new dredges of the twenties and after were electrically operated, except for those in extremely isolated areas, like the two diesel-driven Patty-McRae machines on Woodchopper and Coal creeks in what is now the Yukon-Charley National Preserve. Hammon Consolidated at Nome utilized diesel-fueled generators to provide power to its dredges five miles away. Fairbanks Exploration built a huge $1.5 million coal-powered plant at Fairbanks to serve its numerous dredges, except the two distant machines, one at Hogatsa 750 miles to the northwest and the other in the Fortymile District half that distance to the east. This too was a monster outlay, but one which added predictability--and indeed, during World War II, when gold mining was banned as non-essential, provided power to the town and to military instillations in the area.

Alaska dredges of the new era were medium-sized, with crews ranging from six to a dozen men per shift. Their six-to ten-cubic feet buckets normally dug to a depth of from 40 to 80 feet, whereas the eighteen-cubic footers in California often went down to 100-125. Apart from the giant United States Smelting, Refining and Mining Company, the parent of both Hammon Consolidated and Fairbanks Exploration, most Alaska dredge firms ran one or at most two dredges. Hammon Consolidated put four new Yuba dredges into the Nome area in a few years and Fairbanks Exploration bought dredges like bananas--by the bunch: in 1927, the company signed a contract with Bethlehem Steel Company in San Francisco to build seven dredges, paying in the strange ways of the dredge world $297.76 a ton for the machinery and $129 a ton for the hulls on the first three. Only five Bethlehem boats would actually be built, but later the company would add two new Yubas, one at a cost of about $1 million, so that at peak it had eight machines working.[17] The largest dredge operation in Alaska, this was indeed big business. At Fairbanks, in its ditch, power plant and dredges, U. S. Smelting, Refining and Mining Company invested an estimated $15 million before it ever dug a foot.[18]

Using up-to-date technology, the dredge experts of the new era proceeded systematically, keeping careful and detailed notes. Because the pulse of the dredge was its time-lost record, especially important because of the short working season, dredgemasters kept a day-by-day log of all stoppages and their causes. The ideal was a twenty-four hour operating day, but an average of ninety percent of that was good. Especially in the earlier period, down-time was high: between 1911 and 1924, for example, the Wild Goose dredge No. 1, one of the better operations, ran on the average seasons of 127.5 days, with 80.5 percent working time.[19] Most large dredge concerns maintained a complete machine shop, with thousands of dollars of parts in stock--$140,000 worth in the case of Fairbanks Exploration--though major repairs and replacement of worn working parts

were taken care of at the end of the season, wherever possible. In a big outfit like Fairbanks Exploration each department--dredging, thawing, stripping, prospecting, power, water, transportation and labor--gave a detailed weekly report. The company's accounting department broke down its meal expenses, 1929-1942, into costs per meal--and into component costs for steward, labor, provisions, fuel, haulage--computed for all of its mess houses, which ranged from eight to thirteen at different times. Officials who followed the building of dredge No. 6 on Goldstream Creek in 1929 knew from the daily construction log that she had been completed in 105 days and that crews had driven a total of 89,911 rivets in that period.[20] Or they learned that in the 1947 season, crewmen on dredge No. 3 consumed 5.3 pounds of coffee each per month, while those on No. 6 used only 3.4 pounds apiece.[21]

With such organization and efficiency, with specialized crews to handle repairs in the field when necessary, with every effort made to monitor and replace wearing parts before they gave way, and with advanced techniques for clearing the pond ice in the spring, Fairbanks Exploration built up an enviable record, in one memorable season dredging for 275 days.[22]

Not all operators were as successful, but a number of machines, like those of the Wild Goose Company near Council, the J. E. Riley Investment Company in the Iditarod country, and the J. E. Berry Dredging Company southwest of Circle, had long runs of digging in good pay dirt and substantial reward for their operators. Over a five-year period, the Yukon Mining Company produced 263,028 ounces from Flat Creek, also in the Iditarod, taking out $971,071 in the single year, 1917.[23] U. S. Smelting's operations at Nome, proved highly successful over several decades, as did the Patty-McRae ventures farther north and the New York-Alaska Dredging Company in the lower Kuskokwim region.

Many other enterprises foundered for one reason or another and were short lived. A few, like the big Bessie dredge on the Seward Peninsula, were promotional schemes and were never finished. Two big boats of Ellis Powell's companies in the same general region violated what Thomas A. Rickard referred to as the "A B C of dredging in Alaska: careful prospecting before building a dredge, the need for a well-designed, well-constructed machine, an experienced crew and the avoidance of frozen ground." Insolvency was the end result, although some of the ground proved valuable.[24]

Few of the pre-World War I dredges projected as negative an image as those of Powell, but plenty of others were financial failures. Joseph Plein was lauded in 1912, after his dredge paid off a $20,000 debt, plus "a substantial dividend" to shareholders, but within three years Plein had unmet obligations of $17,360 and his boat was on the block to satisfy creditors. After six years digging on the Solomon, Charles Sievertsen was considered to have done fairly well, but was "in the hand of the bank," as one observer put it in 1914. The Gold Beach Dredge, built on Dry Creek, moved to Osborn Creek, where after two seasons it sank and was forsaken in 1913. After three working seasons, the Sioux-Alaska Mining Company boat in Moss Gulch struck frozen gravel and was abandoned. It was reported in 1914 that many of the Peninsula dredges ran at a loss "as heretofore"; that both Teller tin dredges were idle--"no pay in sight"; and that at least four machines had worked out their ground that season.[25]

Nature did not always cooperate. Dry years like 1908, 1909 and 1913 hampered dredging and reduced gold production. Crews might have to build dams to raise the water level high enough for the hull to clear and the bucket line to operate. By contrast, excessive snow, as in 1916, brought a late start, and the unfortunate Flowers dredge on Shovel Creek was sunk by a June overflow. Many dredges in 1924 had a difficult time when sudden floods washed out dams and equally sudden droughts dried up their ponds.[26]

Frozen ground could not be worked. "The gravel that is cemented by ice is no more suitable for dredging than is reinforced concrete," Thomas Rickard pointed out, yet few of the early Peninsula dredges could afford the luxury of thawing ground. Although the first manager of the Tanana Valley Gold Dredging Company, Ltd., a British firm in the Fairbanks area, boasted that he could dredge frozen ground, attempting to do so meant excessive wear and tear and often broken machinery; thus until economical cold water thawing was developed, the small early dredges confined themselves mainly to the naturally thawed shallow deposits along the streams.[27]

When water freezing in the pond shut down operations for the winter, crews could only hope for an early start in the next season, after unthawing the hull and the digging ladder. Sometimes the ice was so bad that delay was the only answer. Successive overflow on creeks fed by springs sometimes built up thick "glacier ice" that might cover an entire valley. In the early twenties, the spring ice on Shovel Creek was fifteen feet thick and "virtually covered" one dredge, to which it did substantial damage, and postponed digging until August, when seasonal frost began to cause more difficulties.[28]

Like most Alaskan dredges, the big Fairbanks Exploration boats had boilers aboard to thaw the digging ladder, the pumps and the stacker, the latter usually housed in canvas. Their main ice problems stemmed from slow or inadequate thawing and from working too late in the season. When the ponds froze early and management insisted that yardage be main-

tained, crews used dynamite and some winchmen used the dredge "as a battering ram against the ice at the shore sides," sometimes weakening or damaging equipment, until a sensible set of operating rules were laid down and enforced.[29]

Such streams as the Fortymile River, Cache Creek, Mastodon Creek or a number on the Seward Peninsula, carried large boulders which had to be removed with a sling or broken with dynamite before dredging could continue. Sometimes bedrock was so high that the boat could not float over it, at which point the water level had to be raised by building a dam, although in one instance, in 1954, Morrison-Knudsen abandoned its Nome Creek dredge when its advance was blocked by high bedrock.[30]

At other times, dredges were compelled to dig across ground that had already been worked by other methods in order to reach productive gravel, with much reduced gold recovery. In a few cases, dredges digging downstream encountered a problem with sand, unless equipped with sand elevators. Fine silt or sand in the dredge pond could clog pumps.[31]

Equipment breakage or malfunction was common. Dredges burned, as did the Nome Creek boat in Tolovana District in 1932. They capsized or sank, as did Fairbanks Exploration No. 2 in 1959, when an oiler trying to loosen ice in the rock chute exploded a stick of dynamite and ripped a hole the size of a washtub in the hull below the water line. Salvage cost $49,030.31, but the company estimated its loss from not digging for the rest of the season to be close to an additional $435,000.[32]

Perhaps litigation might also be considered one of the obstacles to gold dredging, although Alaskan operators spent far less time in the courtroom than did owners of lode mining properties. They were involved in all kinds of lawsuits--non-payment of bills or of loans, salary or wage disputes, receiverships brought by creditors or shareholders, compensation for workers' injuries, damage by debris to adjoining ground or destruction of company property and inevitable conflicts over title to placer ground.[33] Sometimes such litigation hampered dredge operation, as it did when the Bartholomae Oil Corporation in Port Clarence District in 1937, was closed down most of the season by a legal squabble over the ground it was working.[34] Sometimes an understanding court softened the impact of such disputes, as in a 1916 case when the judge refused an injunction to halt dredging in the contested claim on the grounds that it would work an undue hardship on the company by causing it to lose most of a season's work, and instead appointed a receiver to hold in escrow the gold taken out until the title question was settled.[35] In some instances, litigation did provide compensation to wronged parties without actually hindering dredging, even though justice moved slowly. A 1913 dispute over ownership of two claims on Otter Creek in the Iditarod was finally brought to a successful conclusion by the Yukon Gold Company in 1918, the decision coming on the same day that the courts settled a skirmish of several years' standing between the Fairhaven Mining Company and the Inmachuk Dredging Company over title of two placer claims on the Inmachuk Dredging Company over title of two placer claims on the Inmachuk River.[36] In the 1930s Walter Sakow's charge that the J. E. Riley Investment Company had dredged his Good Hope claim was settled only after two mistrials with hung juries, a third decision in favor of Sakow, which was reversed on appeal, and yet another trial which awarded Sakow $45,000 and denied a rehearing.[37] In general, few of the lawsuits hampered actual dredge activity, either because the claims were relatively minor or the dredges were already out of business by the time verdicts were handed down.

The ultimate obstacle was to run out of dredging ground. When that happened the boat was either abandoned or recycled. New dredges were expensive and none was built for Alaska after the early forties. If not left to rust and to moulder, the existing ones were cannibalized and shifted. The machinery might be transferred elsewhere to a new hull or the whole moved to new ground, often a complex and expensive business. C. L. Morris Transfer of Nome had moved thirteen dredges in knocked-down condition between 1909 and 1912, using as many as sixty-eight horses for sections of fifty tons and in one instance, had to take possession and operate a dredge in lieu of payment.[38] Some dredges chewed through several miles of ground to new locations; other small ones, might be moved without dismantling, but most had their hulls cut in half lengthwise. A five-foot Risdon was brought by sea from Hope on Turnagain Arm to the Solomon River; another, the Ernst dredge was lost while being towed from Nome to Bluff.[39] One of the most complex moves was in 1912, when the Yukon Gold Company dismantled an 850-ton Marion dredge at Dawson, floated it on barges down the Yukon, transferred it on small gas boats at Dikeman, moved up to the head of navigation on the Iditarod River for delivery in small lots to Iditarod. From there it went by a tramway to the mouth of Flat Creek and on to the dredge site over a four-mile wagon road built by the company.[40]

Moving a heavy dredge took months, sometimes years of study and planning. Before Hammon Consolidated moved its 1,600-ton No. 2 dredge some 7,200 feet at Nome in 1931, it considered three separate methods, including an elaborate series of portable locks, but finally settled on hiring a Seattle house mover to do the job for $70,000.[41] Prior to moving dredge No. 5 from Upper Cleary Creek to Eldorado Creek in 1945, Fair-

Gold Recovered by dredges in Alaska, 1903-1940[44]

Year	No. of Dredges	Gold Value	Gold Value per Cu. Yd. (cents)
1903	2	$20,000	
1904	3	25,000	
1905	3	40,000	
1906	3	120,000	
1907	4	250,000	
1908	4	171,000	
1909	14	425,000	
1910	18	800,000	
1911	27	1,500,000	
1912	38	2,200,000	
1913	36	2,200,000	
1914	42	2,350,000	
1915	35	2,330,000	
1916	34	2,679,000	69
1917	36	2,500,000	68
1918	28	1,425,000	57
1919	28	1,360,000	77
1920	22	1,129,932	69
1921	24	1,582,520	57
1922	23	1,767,753	55
1923	25	1,848,596	40
1924	27	1,563,361	36
1925	27	1,572,312	50
1926	32	2,291,000	40
1927	28	1,740,000	29
1928	27	2,185,000	34
1929	30	2,932,000	33.6
1930	27	3,912,600	39.5
1931	28	3,749,000	36.7
1932	25	4,293,000	41.6
1933	25	4,146,000	46.6
1934	30	6,725,000	64.4
1935	37	7,701,000	59.6
1936	39	8,905,000	60.9
1937	41	8,743,000	52.4
1938	44	9,845,400	49.1
1939	43	10,677,000	53.8
1940	48	12,186,000	55.8
Total		$119,884,000	50.1

banks Exploration engineers mulled over five alternative methods and ultimately dismantled it and chopped the hull and superstructure into five parts, before dragging it on 100-ton logging sleds drawn by D-8 Cats for 9.4 miles--at a cost of slightly more than $162,500. The longest move by the same company was the Livengood dredge, purchased in the 1950s, dismantled and moved by truck to Fairbanks, where it was renovated and shipped by barge on the Yukon, Koyukuk and Hog rivers to its new site at Hogatza some 700 miles away--at an estimated cost of $400,000.[42] The most spectacular move, however, was taking No. 6 some five-and-a-half miles from Gold Hill to Sheep Creek in the winter of 1958. The 1,200-ton rig was stripped to a bare 680-ton hull which was then hauled intact on four sleds by eighteen Cats at a total cost of $190,364.68.[43]

But eventually there came a time when the moves ceased, and the great dredge era became but a shadow of its former self. Even with the increased price of gold to $35 an ounce in 1934, paying dredge ground played out. From a peak of eight in 1940, Fairbanks Exploration was down to half of that by 1964, when it closed its operations in the Fairbanks area. Two years earlier its Nome branch had shut down, although dredges No. 5 and No. 6 would continue intermittently after gold prices were allowed to float free on world markets in 1967.

In the early 1960s, new mining regulations opened off-shore lands for prospecting from the Alaska Division of Lands, and a number of oil and other companies acquired permits to search for gold deposits under the sea near Nome and in Norton Sound. No actual dredging transpired at that time, although one free-floating Alaska dredge started up in 1966 without much success.[45] Twenty years later, however, a gigantic newcomer arrived, when Inspiration Mining's 12,000-ton dredge, *BIMA*, made its appearance off Nome. The largest dredge in the world, *BIMA* was constructed in 1972 for the extraction of tin in the Tiau Archipelago of Indonesia, where it worked for a few years. Subsequently it was modified for the dredging of gold and brought to Alaska. There, in its first season (1987), working on an off-shore ledge in the Bering Sea, this fourteen-story monster and its crew of 124 took out nearly 36,000 ounces of gold, which at the going rate of $450 an ounce was worth more than $15 million. The 1988 take was only around 30,000 ounces, but still not a bad five months' work. The dredge changed ownership, but shut down in 1990, after producing 126,924 ounces of gold in five seasons, only two of which were profitable.[46]

In his quest for gold, the dredge operator, both literally and figuratively, left "no stone unturned": wherever they went, the giant dredgers left in their wake acre after acre of ugly tailings; unsightly windrows piled high with rocks. One writer in 1919 complained that earlier a dredge "right on Front Street" in Nome, "was scooping up the earth, washing out its gold, and leaving the debris in unsightly tailings along its course." Another described a dredge at work a few miles away: "On either side of the road I could see a wasteland of tailing piles, the pebbles washed of their last trace of color. They looked like the bare bones of a carcass picked clean and left to bleach in the sun."[47]

If the boats despoiled the landscape and left gigantic fields of unattractive rubble behind; if the pipers washed millions of tons of silt down unspoiled streams; if areas, especially retorting sites, were left impregnated with deadly mercury; or if company trucks and Cats drained their engine oil wherever was convenient, these were regarded as merely the price for progress. During the heyday of Alaskan dredging, environment was not a particular concern, either of dredgemen or others. Like mining people elsewhere, dredge operators emphasized the positive aspect of the economic use of land that was generally idle, isolated and worthless for any other purposes.

Only after the heyday of the dredge era was over, did environmentalism become a significant factor, although in an isolated instance in 1941, the district court at Nome upheld the federal government effort to ban the Lucas dredge from digging on the Nuiklul River, half a mile below Council, after a former missionary had complained that dredging the river bed would destroy the spawning ground of salmon.[48] Dredging spokesmen at Fairbanks argued that washing millions of cubic yards of debris away into Alaska's streams posed no environmental problems because most was fine silt and the streams moved with rapid currents, but at least one private citizen won a judgment against Fairbanks Exploration on the grounds that the company's stripping, thawing and dredging debris "had filled and obliterated the channel" of Goldstream Creek and ruined mining claims below.[49]

With increasing environmental concerns, by the sixties and seventies regulations at all levels were hemming in the dredge operators, much to their distress, especially as the Environmental Protection Agency sought to enforce the turbidity requirements of the Clean Water Act of 1971 and to require environmental assessments for mining projects on federal land--a stiff new hurdle.[50] If controversy accompanied the state's granting permission in 1984 and 1985 to the Northland Gold Dredging Company to divert more than a mile of the Tuluksak River in order to dredge the old channel, despite complaints of villagers that the operation would pose a threat to one of the richest salmon habitats in western Alaska, in another heated debate a few years later, officials denied a Colorado firm a permit to dredge more than 100,000 acres on the Cook Inlet sea floor, and especially a 30,000-acre tract between Ninilchik and Anchor Point, an area well known for its good halibut and salmon fishing.[51]

Later in the same year, 1987, the EPA levied the largest fine for environmental pollution ever assessed against an Alaska placer operation. The Alaska Gold Company, the corporate successor of Hammon Consolidated Gold Fields and the Nome Department of U. S. Smelting, agreed to pay $100,000 on charges of having discharged mercury, arsenic and other pollutants from the dredges and its gold-processing plant near Nome. Alaska Gold, now a subsidiary of Miami-based Sharon Steel Corporation, had been dredging in the Nome area only since the middle 1970s, and much of the contamination was believed to have occurred in the 1930s and 1940s as part of U. S. Smelting's operation. Hence

Alaska Gold was paying for the sins of its predecessors.[52]

So what did it all mean--besides all those massive steel flower pots around the state, the site of a good restaurant at FE's old Chena Pump House in Fairbanks and the long rows of tailings once described by John Gunther as resembling "the kind of furrow that an enormous un-housebroken, worm might leave"?[53] Obviously the gold dredge was a shot in the arm of the Alaskan economy. At Fairbanks especially the dredge industry "has worked about possibly the greatest rejuvenation that any placer camp in Alaska has ever known," one newspaper reported in 1937. Where the town's population had dropped from 3,541 in 1910 to 1,155 in 1920, in the 1930 Census it had climbed back to 2,101 and on the eve of World War II was at 3,540, with the Fairbanks Exploration Company the major employer, with more than 800 on its payroll.[54]

One dredge, Fairbanks Exploration No. 8, eventually became a popular tourist attraction at Fox; another, the Patty-McRae boat on Coal Creek in the Yukon-Charley Rivers National Preserve, would be named a National Historic Site. The other hundred or so rusting dredge hulks that dot the Alaska landscape became monuments in a more casual sense, memorials to an earlier era, when the "Ships of Gold" plied their trade, each one reflecting in its own way the dreams or the frustrations of its backers. Many a dredge enjoyed a long, successful run, but many another had her brief moment, then languished, abandoned and forgotten.

> Now, broken and worn, the object of scorn,
> She bows to calamity sold,
> A derelict wan, bleak, battered and gone,
> Unknown to her lovers of old![55]

Between 1880 and 1968 the region produced some 29,944,000 ounces Troy of gold, and from 1906 to 1968, another 19,075,000 ounces of silver, much of it as a byproduct of gold mining.[56] Most of this was from placer deposits, and it was the dredges that made possible the profitable working of at least half of those grounds--a triumph in the adaption of a technology to what was at best an inhospitable environment. The impact on Alaska was substantial, especially in the pre-World War II decades, the years before tourism, federal defense contracts and North Shore petroleum became such important parts of a more diversified economic base.

ENDNOTES

[1]"Flagships of the Gold Fleet," *Popular Mechanics*, LXIX (May, 1938), pp. 30, 32; H. H. Dunn, "Eight-cent Gold-Digger Earns Millions," *Popular Mechanics*, XLIX (January, 1928), pp. 75-76.

[2]"The Prospector," Robert W. Service, *Ballads of a Cheechako* (New York, 1909), p. 83.

[3]See Clark C. Spence, "The Golden Age of Dredging: The Development of an Industry and Its Environmental Impact," *The Western Historical Quarterly* XI (October, 1980), pp. 403-405; *Mining and Scientific Press*, LXXII (June 20, 1896), p. 405.

[4]*Nome News*, June 23, 1900; *Mining and Scientific Press*, XCVII (November 18, 1908), p. 734; *The Nome Nugget: Mining and Dredging Edition* (1910), p. 22; Charles Janin, "Gold Dredging in Alaska and the Yukon," *The Mining Magazine*, VI (January, 1912), p. 45; Howard N. & Lucile L. Sloane, *A Pictorial History of American Mining* (New York: Crown Publishers, 1970), p. 301; David Gore, "The Gold Sifters of Alaska," *Alaska-Yukon Magazine*, XIII (March, 1912), p. 159; Thomas A. Rickard, "Dredging on the Seward Peninsula," *Mining and Scientific Press*, LXXXXVII (November 18, 1908), p. 734; Thomas A. Rickard, *Through the Yukon and Alaska* (San Francisco: Mining and Scientific Press, 1909), p. 311.

[5]Rex Beach, *Personal Exposures* (New York & London: Harper & Brothers, 1940), pp. 27, 28-29.

[6]May Kellog Sullivan, *A Woman Who Went to Alaska* (Boston: James H. Erle Company, 1903), pp. 121-122; Jack Hines, *Minstrel of the Yukon* (New York: Greenberg, 1948), pp. 2-3; L. H. French, *Nome Nuggets* (New York: Montross, Clarke & Emmons, 1901), pp. 25, 33-34, 38, 41-43; Lanier McKee, *The Land of Nome* (New York: Grafton Press, 1901), pp. 45-46; *Nome Nugget* (weekly), March 1, 1902 & June 17, 1903; Ross Hoffmann to J. P. Hitchins (Oakland, March 17, 1910), copy, Ross Hoffman MSS, Box 3, American Heritage Center, University of Wyoming; *Mining and Scientific Press*, LXXXVIII (November 16, 1904), p. 363; XCVIII (May 22, 1909), p. 714; XCIX (July 31, 1909), p. 145; *Engineering and Mining Journal*, LXXI (June 22, 1901), p. 785; F. H. Chase, "Perilous Mining," *The Alaska-Yukon Magazine*, II (October, 1906), pp. 81, 83; *The Nome Nugget: Mining & Dredging Edition* (1910), pp. 30-31; Elmer E. Carey, "Submarine Gold Dredging at Nome, Alaska," *Mining World*, XXXII (March 19, 1910), pp. 614-615; *Nome News*, June 23, 1900.

[7]Chester Wells Purington, *Methods and Costs of Gravel and Placer Mining in Alaska*, U.S. Geological Survey *Bulletin* No. 263 (1905), p. 37.

[8]*The Alaska and Northwest Mining Journal*, V (March, 1914), pp. 56-57.

[9]*Seward Weekly Gateway*, October 1, 1910.

[10]*Mining and Scientific Press*, XCVII (November 28, 1908), p. 734.

[11]*Mining and Scientific Press*, LXXXXI (November 18, 1905), pp. 345-346; LXXXXVII (November 28, 1908), p. 740; (January 6, 1912), p. 72; CV (September 28, 1912), p. 396; Alfred H. Brooks, *Blazing Alaska's Trails* (2d ed., Fairbanks: University of Alaska Press, 1973), p. 398; Lewis E. Aubury, *Gold Dredging in California*, California State Mining Bureau *Bulletin* No. 57 (1910), p. 267; A. G. Kingsbury, "Northern Alaska To-day," *New England Magazine*, XXXV (September, 1906), p. 16.

[12]Sumner S. Smith, *Mining Industry in the Territory of Alaska in 1916*, U. S. Bureau of Mines *Bulletin* No. 153 (1917), pp. 76-77.

[13]John C. Boswell, *History of Alaskan Operations of United States Smelting, Refining and Mining Company* (Fairbanks: University of Alaska, 1979), p. 15.

[14]William F. Lanagan, "Notes on Winter Trip From Nome through Council, Candle, Kugruk, Inmachuk, Kougarok, Districts" (April, 1910), no page numbers, typed copy, Fred L. Morris Mss, Box 1, Bancroft Library.

[15]Roy B. Earling to Rebie Herrington (Fairbanks, May 21, 1935), copy Alaska Gold Company MSS, Fairbanks.

[16]Harry A. Franck, *The Lure of Alaska* (New York: Frederick A. Stokes Co., 1939), p. 17; Boswell, *History of Alaskan Operations*, p. 29; James D. Crawford and John C. Boswell, "Dredging for Gold in Alaska," *Mining and Metallurgy*, XXIX (October, 1948), p. 576; Philip S. Smith, ed., *Mineral Industry of Alaska in 1940*, U. S. Geological Survey *Bulletin* No. 933A, p. 39; Otto Duke to George W. Rathjens (San Francisco, April 12, 1939), copy; G. R. Watkins to Rathjens (n. p., December 12, 1938), copy; "Comparison of Dredge Costs: (September 12, 1945), copy, all in Sharon Steel Company Papers, Midvale, Utah.

[17]George W. Metcalfe to Leslie D. Anderson (Boston, February 23, 1927); Peter Jurs to Fairbanks Exploration Company (n. p., October 7, 1927), copy; Otto Duke to George W. Rathjens (San Francisco, April 12, 1939), copy, all in Sharon Steel Company Papers, Midvale.

[18]*Engineering and Mining Journal*, CXXVI (December 1, 1928), pp. 861; *The Alaska Weekly*, October 5, 1928; Otto Halla to Charles Janin (Nome, November 17, 1929), Charles Janin MSS, Box 5.

[19]Norman L. Wimmler, *Placer-Mining Methods and Costs in Alaska*, U. S. Bureau of Mines *Bulletin* No. 259 (1927), p. 199.

[20]O. B. Hart to J. E. Hopkins (Fairbanks, December 6, 1929),. copy, Alaska Gold Company MSS, Fairbanks.

[21]L. E. Linck Memorandum (April 26, 1948), copy, Alaska Gold Company MSS, Fairbanks.

[22]Philip S. Smith, *Mining Industry of Alaska in 1934*, U. S. Geological Survey *Bulletin* No. 868A, p. 58.

[23]Thomas K. Bundtzen, Marti L. Miller, Gregory M. Laird & Katherine F. Bull, *Geology and Mineral Resources of Iditarod Mining District, Iditarod B-4 and Eastern B-5 Quadrangles, Southwestern Alaska*, State of Alaska Division of Geological & Geophysical Surveys, *Professional Report* No. 97 (1992), pp. 24-25; *Engineering and Mining Journal*, CIII (May 12, 1917), p. 843.

[24]*Mining and Scientific Press*, XCVII (November 28, 1908), p. 735-736; CIX (December 12, 1914), p. 909; Alfred H. Brooks, et al., *Mineral Resources of Alaska, 1909*, U. S. Geological Survey *Bulletin* No. 332, p. 357; Ellis E. Powell to William T. Perkins (Nome, August 25, 1908 & October 9, 1911), William T. Perkins MSS, Box 3, University of Washington Libraries; Reed v. Alaska Mines Corporation, 6 *Alaska Reports* (1921), pp. 370-373.

[25]W. A. Oliver to Charles Janin (Nome, August 24, 1914), Charles Janin MSS, Box 19, Huntington Library; Leonard Smith, *History of Dredges in Nome Placer Field* (March, 1926), pp. 1-2; *Mining and Scientific Press*, CIV (January 6, 1912), p. 48; *Engineering and Mining Journal*, LXXXXIX (January 9, 1915), p. 118; Alfred H. Brooks, et al., *Mineral Resources of Alaska, 1914*, U. S. Geological Survey *Bulletin* No. 622, p. 370; Murray v. Sioux-Alaska Mining Company, *et al.*, 4 *Alaska Federal Reports* (1917), pp. 522-523, 526-527.

[26]*Mining and Scientific Press*, XCVII (October 3, 1908), p. 440; CVII (August 16, 1913), p. 279; CVII (January 10, 1914), p. 96; *Engineering and Mining Journal*, LXXXI (January 20, 1906), p. 124; XC (October 19, 1910), p. 860; Alfred H. Brooks, *et al.*, *Mineral Resources of Alaska, 1913*, U. S. Geological Survey *Bulletin* No. 592, pp. 45, 392-293, 394; *The Nome Nugget: Mining & Dredging Edition* (1916), p. 44; Wimmler, *Placer-Mining Methods and Costs in Alaska*, p. 187; Philip S. Smith, et al., *Mineral Resources of Alaska, 1924*, U. S. Geological Survey *Bulletin* No. 783, p. 19.

[27]John A. Clark to G. Lionel Whitworth (n. p., July 31, 1926), copy; John Howorth to Whitworth (Fairbanks, September 28 & 30, 1927), copies, Eugene Dawson to Tanana Valley Gold Dredging Company, Ltd. (n. p., August 2, 1928), copy, all in Tanana Valley Gold Dredging Company, Ltd. MSS, Rasmuson Library, University of Alaska; *Mining and Scientific Press*, XCVII (November 21 & 28, 1908), pp. 703, 737; Alfred H. Brooks, *et al.*, *Mineral Resources of Alaska, 1907*, U. S. Geological Survey *Bulletin* No. 345, pp. 72-73; Alfred H. Brooks, *et al.*, *Mineral Resources in Alaska, 1908*, U. S. Geological Survey *Bulletin* No. 379, p. 41; *The Nome Nugget: Mining & Dredging Edition* (1914), p. 34.

[28]Wimmler, *Placer-Mining Methods and Costs in Alaska*, p. 191.

[29]William M. Rosewater, "Second Addendum to Report on Fairbanks Dredge Operation & Maintenance: (Salt Lake City, April 12, 1931), copy; Rosewater, "Addendum--Re. (7)--The Trouble With the Interior Framing at the Ladder Well," copy; Rosewater to George W. Rathjens (Los Angeles, May 6, 1931), all in Sharon Steel Company Papers, Midvale.

[30]John B. Metcalfe to James D. Crawford (Boston, August 5, 1954); Patrick H. O'Neill to John C. Boswell, "Report of Dredge Department Week Ending July 18, 1953); William LaFon to Boswell, "Report of Dredge Department Week Ending June 4, 1955"; Week Ending August 3, 1957; Week Ending May 31, 1958, all in Alaska Gold Company MSS, Fairbanks.

[31]Charles Francis Herbert, "Gold Dredging in Alaska," pp. 33-34, 48 (Bachelor of Science in Mining Thesis, Alaska Agricultural College and School of Mines, 1934); Eugene Dawson to Tanana Valley Gold Dredging Company, Ltd. (n. p., September 13, 1928), copy, TVGDCMSS, Box 1; Patrick H. O'Neill to John C. Boswell, Report of Dredge Department Week Ending June 20, 1953; William LaFon to Boswell, Report of Dredge Department Week Ending September 19, 1953; Week Ending June 26, 1954 & Week Ending July 24, 1954; James D. Crawford to Roy B. Earling (n. p., November 3, 1952), copy, all in Alaska Gold Company MSS, Fairbanks; Wimmler, *Placer-Mining Methods and Costs in Alaska*, p. 187.

[32]Philip S. Smith, *et al., Mineral Industry of Alaska, in 1931*, U. S. Geological Survey *Bulletin* No. 944A, p. 35; Herbert, "Gold Dredging in Alaska," p. 92' *Engineering and Mining Journal*, CXLIII (August, 1942), p. 141; James D. Crawford to Fred S. Mulock (n. p., May 1 & June 5, 1959), copies; William A. LaFon to John C. Boswell (n. p., January 8, 1960), copy, all in Alaska Gold Company MSS, Fairbanks; Patricia E. Sather to Albert J. Watson (Fairbanks, June 28, 1959), Fairbanks Gold Dredging Company, Ltd. MSS, Box 3, Rasmuson Library.

[33]Murray v. Sioux Alaska Gold Mining Company, *et al.*, 4 *Alaska Federal Reports* (1917), pp. 522-527; Blue Goose Mining Company v. Northern Light Mining Company, 4 *Alaska Federal Reports* (1917), pp. 629-634; American Manganese Steel Company *v.* Alaska Mines Corporation, *et al.*, 4 *Alaska Federal Reports* (1918), pp. 684-687; Greenberg *v.* Alaska Mines Corporation, 6 *Alaska Reports* (1919), pp. 163-164; Reed v. Alaska Mines Corporation, 5 *Alaska Reports* (1921), pp. 370-373; Reinhold Newberg *v.* Cordovado Gold Dredging Company, 15 *Alaska Reports* (1954), pp. 232-247; *Mining and Engineering World*, XXXXIII (July 10, 1915), p. 70; Complaint, Ellen Reidy, administriatrix of Estate of John Griffin, plaintiff, vs. Chas. Holky, Arthur Schonsbeck & Joe Ramstad, co-partners under name Holky Dredge Co., in District Court for the Territory of Alaska, 4th Judicial Division, n. d., in TVGDC MSS, Box 11; *EMJ*, CXLVI (October, 1945), p. 137.

[34]Philip S. Smith, *Mineral Industry of Alaska in 1937*, U. S. Geological Survey *Bulletin* No. 910A, p. 71; Philip S. Smith, *Mineral Industry of Alaska in 1939*, U. S. Geological Survey *Bulletin* No. 926A, p. 65.

[35]McMonigle *v.* Behring Dredging Company, 5 *Alaska Reports* (1916), pp. 513-514.

[36]Adams *v.* Yukon Gold, *et al.*, 4 *Alaska Federal Reports* (1918), pp. 692-697; Adams *v.* Yukon Gold Company *et al.*, 251 *Federal Reporter* (1918), pp. 226-230; Fairhaven Mining Company *v.* Inmachuk Dredging Company, 5 *Alaska Reports* (1916), pp. 462-262; Fairhaven Mining Company *v.* Inmachuk Dredging Company, 4 *Alaska Federal Reports* (1918), p. 691.

[37]J. E. Riley Investment Company, *et al.*, *v.* Sarow, 9 *Alaska Reports* (1938), 9 *Alaska Reports* (1939), pp. 433, 455-456; J. E. Riley Investment Company, *et al.*, 9 *Alaska Reports* (1940), pp. 666, 669; J. E. Riley Investment Company, *et al.*, Petitioners *v.* Walter Sakow, 10 *Alaska Reports* (1940), p. 11; J. E. Riley Investment Company, *et*

al., v. Walter Sakow, 311 *U. S. Reports* (1940), p. 659; J. E. Riley Investment Company (Harry P. Sheppard and Harry Donnelly, Appellants *vs.* Walter Sakow, Appellee, #9237 in U. S. Circuit Court of Appeals for Ninth Circuit, October, 1939, Brief for Appellants, pp. 2-4, 14-15, 21, in TVGDC MSS, Box 10.

[38]See full-page advertisement, *The Nome Nugget: Mining & Dredging Edition* (1912), p. 65.

[39]*Engineering and Mining Journal,* LXXXV (January 4, 1908), p. 48; XC (October 29, 1910), p. 864; *Mining and Scientific Press,* XCVII (October 3 & November 28, 1908), pp. 470, 738; C (January 1, 1910), p. 47; *The Nome Nugget: Mining & Dredging Edition* (1910), p. 12.

[40]*Mining and Scientific Press,* CV (August 17, 1912), p. 220; CVI (April 26 & 28, 1913), pp. 638, 981.

[41]Agreement of July 29, 1930, between Hammon Consolidated Gold Fields and Curtis Bros., Inc., copy, Sharon Steel Company Papers, Midvale; *Engineering and Mining Journal,* CXXXII (July 13, 1931), p. 11.

[42]James D. Crawford to Fred S. Mulock (Fairbanks, January 29 & February 25, 1955, copies; Crawford to C. G. Rice (n. p., December 15, 1959), copy, all in Alaska Gold Company MSS, Fairbanks.

[43]William A. LaFon & J. C. Johnston, "Report on Moving Dredge No. 6 From Gold Hill to Sheep Creek, 1957-1958" (December 15, 1958), Alaska Gold Company MSS, Fairbanks.

[44]Alfred H. Brooks, *et al., Mineral Resources of Alaska in 1916,* U. S. Geological Survey *Bulletin* No. 662, p. 19; Philip S. Smith, *Mineral Resources of Alaska, 1940,* U. S. Geological Survey *Bulletin* No., 933A, p. 65.

[45]*Engineering and Mining Journal,* CLXIII (April, 1962), p. 149; CLXVI (May 1965), p. 85; CLXVII (August, 1965), p. 84; CLXIX (January 1967), pp. 85-87.

[46]*Anchorage Daily News,* June 7, 1987 & January 10, 1988; A. G. Ziryanov, "Mining Industry in Alaska," *The Alaska Miner,* XVII (October, 1989), p. 10; 1987 *Annual Report on Alaska's Mineral Resources,* U. S. Geological Survey *Circular* No. 1012, p. 29; *1988 Annual Report on Alaska's Mineral Resources,* U. S. Geological Survey *Circular* No. 1023, p. 28; *1989 Annual Report on Alaska's Mineral Resources,* U. S. Geological Survey *Circular* No. 1040, p. 38; *1991 Annual Report on Alaska's Mineral Resources,* U. S. Geological Survey *Circular* No. 1072, p. 38; *1992 Annual Report on Alaska's Mineral Resources,* U. S. Geological Survey *Circular* No. 1091, p. 38.

[47]Agnes Rush Burr, *Alaska Our Beautiful Northland of Opportunity* (Boston: Page Co., 1919), p. 201; Klondy Nelson (with Corey Ford), *Daughter of the Gold Rush* (New York: Random House, 1958), p. 159.

[48]H. L. Faulkner to Roy B. Earling (Juneau, August 8, 1941); O. D. Cochran to Earling (Nome, September 18, 1941), both in Alaska Gold Company MSS, Fairbanks.

[49]James D. Crawford and John C. Boswell, "Dredging for Gold in Alaska," *Mining and Metallurgy,* XXIX (October, 1948), pp. 575, 576; Mike Erceg *v.* Fairbanks Exploration Company, 9 *Alaska Reports* (1935-1940), pp. 264-279; Mike Erceg, Guardian, etc., Petitioner *v.* Fairbanks Exploration Company, 50 *Supreme Court Reporter* (1938), p. 74; Mike Erceg *v.* Fairbanks Exploration Company, 305 *U. S. Reports* (1938), p. 615.

[50]*Anchorage Daily News,* June 7, 1987.

[51]*Anchorage Daily News,* May 12, 1984 & November 9, 1986; *1985 Annual Report on Alaska's Mineral Resources,* U. S. Geological Survey *Circular* No. 970, p. 43; *1986 Annual Report on Alaska's Mineral Resources,* U. S. Geological Survey *Circular* No. 983, pp. 27-28.

[52]*Anchorage Daily News,* September 1, 1987.

[53]John Gunther, *Inside U. S. A.* (New York, 1947), p. 159.

[54]*The Mining Record,* April 26, 1941; unidentified clipping (1937), in Scrapbook, Yuba Manufacturing Company Papers; *Fourteenth Census of the United States Taken in the Year 1920* (Washington: Government Printing Office, 1921), I, p. 680; *Sixteenth Census of the United States: 1940* (Washington: Government Printing Office, 1942), I, p. 1191.

[55]From "An Old Gold Dredge," in Harold Salisbury, *Alaskan Songs & Ballads* (Portland: Metropolitan Press, 1967), p. 47.

[56]Arlon R. Tussing & Gregg K. Erickson, *Mining and Public Policy in Alaska* (College: Institute of Social, Economic and Government Research, 1969), p. 124.

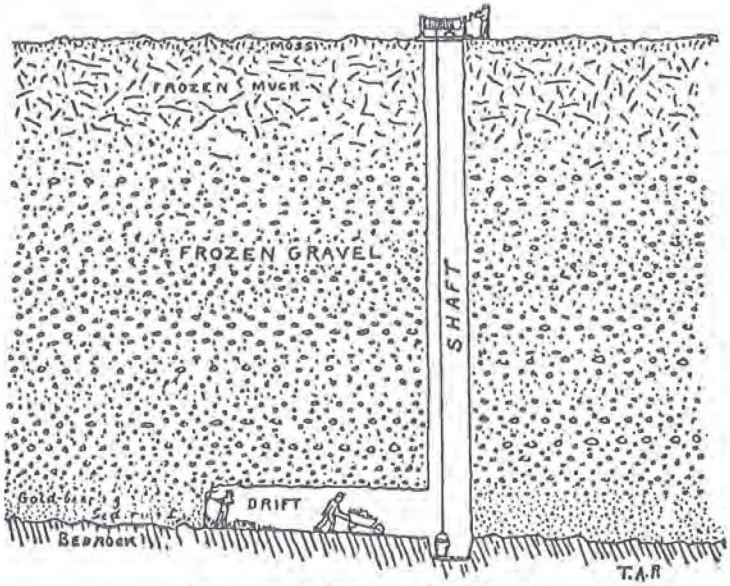

FIG. 105.—A drift mine in frozen gravel.

From T. A. Rickard, The Romance of Modern Mining, *p. 1021.*