KENNECOTT, ALASKA

Historic American Engineering Record
Recording Project

Compiled by

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Frontispiece: Kennecott ca. 1917. Courtesy Cordova Historical Society.

All HAER record photographs by John T. "Jet" Lowe, III.
Preface

This brief Historic American Engineering Record project report is the culmination of a summers work at Kennecott, Alaska, a National Historic Landmark located within Wrangell-St. Elias National Park and Preserve. Much of this historic mining camp remains, but because of the limited duration of the project, the team focused on the recording of the significant mill at Kennicott. It is the best extant example of an early twentieth century copper concentrator. Since the significance of the mill is the information it displays of the mineral benefaction process, the record depicts this process rather than the structural components of the mill. Original design drawings of the mill are at the University of Alaska-Fairbanks.

Seasonal historical architects Dave and Nan Anderson prepared the record drawings, while Historic American Engineering Record photographer Jet Lowe prepared the record photographs. Seasonal historical architect Ken Martin finished the drawings and completed site plans. The project was directed by regional historian Robert Spude with the assistance of Dave Snow, regional historical architect, Richard Anderson, HAER architect from the Washington Office, and Robert Vogel of the Smithsonian Institution. The staff of Wrangell-St. Elias National Park and Preserve provided work space and field assistance.

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Copper Experts at future site of Kennecott, 1902.
Courtesy National Archives.
Kennecott: Historical Overview

During the two decades preceding and those following World War I, when the United States produced more than half the world's copper, the mines at Kennecott, Alaska were among the nation's largest, and contained the last of the great high grade copper ore deposits discovered in the American West. Just as mining technology was gearing up to exploit the low-grade ores that remained in the West, the Kennecott mines exposed an ore deposit of a quality unequaled anywhere in the twentieth century. Mining journals and mining engineers used superlatives to describe the rich deposit found at the Kennecott mine. Competition for the ownership and the development of the mine affected territorial and national politics and led to the Ballinger-Pinchot affair.

On July 4, 1900, Clarence Warner and "Tarantula Jack" Smith staked the Bonanza mine outcrop. By mid-August they and nine of their partners had staked much of the ground which would become known as the Kennecott mines. A young mining engineer, Stephen Birch, was in the area and acquired options on the claims. Backed by Henry O. Havemeyer, a New York investor, Birch formed the Alaska Copper and Coal Company which was promptly sued by others claiming ownership of the rich deposit. From 1901 to 1904 the Chitina Exploration Company, which claimed to have grubstaked the prospectors, and the Copper River Mining Company, which claimed legal title, dragged the suit through territorial and federal court and were denied judgement in their
favor. The Supreme Court of the United States refused to hear the case.

In 1905 the Alaska Copper and Coal Company was reorganized as the Kennecott Mines Company. The Guggenheim family, controllers of the American Smelting and Refining Company (ASARCO) smelter monopoly, and J.P. Morgan, another wealthy industrial investor, entered the enterprise and organized the "Alaska Syndicate" to fund the mine's development. Between 1905 and 1911 the syndicate spent $25 million to build mine and mill works, a 196-mile railroad, and organize a steamship line connecting the copper port of Cordova with ASARCO's Tacoma smelter. All this occurred prior to the first shipment of copper.

On April 8, 1911, the first trainload of copper, worth $250,000, was shipped from Kennecott in 32 railroad cars. By 1916 production had reached 108,372,783 pounds of copper worth $28,042,396. Kennecott was classed among the nation's largest mines, with those at Butte, Montana, Bisbee, Arizona, and Bingham Canyon, Utah. During 1915-1922 it ranked 3rd to 7th in production. With the building and operation of the mines and their supply line - the Copper River and Northwestern Railway - this was the largest, most costly, and complex mining enterprise in Alaska. But Kennecott's significance lies more in the quality of its ore. Despite the general assumption that Alaska's gold was preeminent, no single Alaskan placer gold district or gold lode entity was as productive of mineral wealth as the Kennecott.
Kennecott mill, 1912.
Courtesy Museum of History and Industry, Seattle.
At the same time, the Guggenheim's acquisition of fraudulent coal claims in the nearby Bering River coal fields caused a feud between Secretary of Interior Richard Ballinger and the head of the Forest Service, Gifford Pinchot. President William H. Taft inflamed the feud by firing Pinchot, but declared the coal claims invalid over Ballinger's protests. Taft's action effected the upcoming presidential election. The Alaska Syndicate failed to acquire the coal needed to fuel their railroad and mill and became, to many people, a monstrous grabber of Alaska's resources.

To meet the changing political and mining world, on April 12, 1915, the Guggenheim and Morgan interests formed the Kennecott Copper Corporation. Stephen Birch became the first president and saw to the transfer of the Alaska Syndicate holdings—the Kennecott Mines Company, the Copper River and Northwestern Railway, the Alaska Steamship Company, and the Beatson Copper Company, all in Alaska--into the new corporation. The phenomenal profits from the Alaska mine provided the capital to fund Kennecott's purchase of the Bingham Canyon mine in Utah and other low-grade mines in Nevada, Arizona, and New Mexico. By the 1930s, while the deposit in Alaska was nearing exhaustion, the corporation had expanded to become the nation's largest copper company and an international force in the metals market. The Kennecott business organization had met the shifting realities of the mining world.

The structures at Kennecott, cumulatively, are a true vestige of an early twentieth century copper mining camp. The mill represents mining technology of the era. The copper industry was transformed
Bonanza Mine, ca. 1920.
Courtesy Cordova Historical Society.
during the first quarter of the twentieth-century by the ability to work large deposits of low grade ore by concentrating 2% or lower grade ore up to 50% to 80% copper concentrate, which then went to the smelter. Among other innovations were "leaching," where chemicals acted to dissolve out the mineral, then precipitate it into a concentrate, and "flotation," where oil or grease was used to separate, through a bubbling action, the mineral from its host rock. All these processes are represented at Kennecott; the ammonia leaching process was first successfully used on a commercial scale at Kennecott. E. Tappan Stannard perfected the process in 1915 and enabled the company to work its "low grade" (8%) ores. A flotation plant, planned earlier but delayed because of litigation between the patent holder and a number of western mining companies, was built in 1922-1923 (the year of an out of court settlement). Thus by 1924 the milling plant equalled, if not in size at least in function, all western copper mills. That year was the last year of major mining discoveries at Kennecott.

The Kennecott deposit, though rich, proved limited in extent. The operation closed in 1938 (producing an estimated $200 to 300 million worth of copper in 28 years); the company vacated the camp and donated its railroad to the territory.

Unlike most Western mining companies capable of working with only geographically isolated, high grade ore deposits, the Kennecott Copper Corporation (backed by the Guggenheims) was able to reorient into an international conglomerate owning long-term, low grade ore mines. By designing the
Kennecott at its zenith, ca. 1925.
Courtesy Alaska Historical Library.
world's first ammonia-leaching plant at the Kennecott site, the corporation was able to extract higher mineral values from the low-grade ores which were once discarded, ensuring further profits. Increased profits allowed investment and expansion elsewhere.

The camp of Kennecott is little changed since the 1938 closing and today provides a window into the technology and work environment of the early twentieth century. Technological artifacts remain in situ due to the site's remoteness. The mining camp, with its striking red buildings with white trim, dominated by the woodframe fourteen-story concentrator, is overwhelmed by the Kennecott Glacier and the Wrangell Mountains, which stand 14,000 feet above the camp. The camp is within the Wrangell-St. Elias National Park and Preserve/Kluane National Park (Canada) area, a World Heritage Site noted for its geology.
Bibliography


"Kennecott: Alaskan Origins of a Copper Empire, 1900-1938," The Western Historical Quarterly vol. 9, no. 2, April 1978, pp. 197-211.


In 1900, prospectors discovered the copper outcrops located atop Bonanza Ridge in the Wrangell Mountains, Alaska. The high-grade surface ore, assaying up to 70% copper, astounded the mining world, but years of litigation over ownership and the distance from cheap transportation delayed development of the mines. In November, 1906, the House of J.P. Morgan and Company and the Guggenheims united to consolidate ownership of the richest claims, fund mine work, build a milling plant, and complete the Copper River and Northwestern Railway from the coast to the Kennecott mines. The railroad reached Kennecott on March 29, 1911, and full scale production began.

The high-grade ore was shipped directly to the Guggenheims' Tacoma smelter, while low-grade ore was first processed in the concentration mill below the mines. The mill town and mines were equipped with advanced machinery and the latest technological innovations in mineral benefaction. The first successful application of the ammonia leaching process occurred here in 1915.

In 1916, the most productive year, the copper produced amounted to 55,085 short tons, making the Kennecott mines the third-largest producer in the United States. That year, the newly formed Kennecott Copper Corporation began acquiring other properties which would eventually include mines throughout the world.

The Kennecott deposit, though a unique, high-grade deposit, proved to be of limited extent. Altogether, $300 million worth of copper and silver were produced by the time Kennecott closed the mines in 1938. Standing above the mill town, the mill and its machinery remain today, a classic example of early twentieth century mining technology, while the Kennecott Copper Corporation continues as an international mining conglomerate.
The "Million Dollar Bridge. Former Copper River and Northwestern Railway bridge across the Copper River. Miles glacier in the distance. 1985.
COPPER ORE TRANSPORTATION
1911-1938

Three modes of transportation carried Kennecott ore from mine to smelter:

1. Aerial Tramways (manufactured by the Trenton Iron Company)
2. Railroad (the Copper River & Northwestern Railway, a 196 mile line from Cordova to Kennecott, completed in 1911 at a cost of $23,000,000)
3. Steamship (operated from Cordova to Tacoma by the Alaska Steamship Company)

All three systems were controlled by the Alaska Syndicate, an organization consolidating the backing of H.O. Havemeyer, the House of Morgan, the Guggenheim and the Kuhn Loeb Company. In 1915 the syndicate incorporated as the Kennecott Copper Corporation.

Trams and the railway both ceased operations in 1938 when Kennecott closed its mines.

Only the Alaska Steamship Company continued servicing Alaska's coast until superseded by air transport in 1971.

NOTE: Though the plant is spelled Kennecott, the company name is spelled Kennicott.
The Kennecott mines were located near the summit of Bonanza Ridge, in the Christine limestones deposit at about the 6000 foot elevation. Aerial tramways connected the mines to the mill at the railroad. Ore from the Mother Lode and the Era mines went by underground hoistage tunnels to the Bonanza and Jumbo trains. The 12,000 foot Jumbo-Era hoistage was the longest of three. By 1938, when the mines were closed, seventy miles of underground workings honeycombed Bonanza Ridge.
*Bonanza ridge and Kennicott from Kennicott Glacier moraine. 1985.*
KENNICOTT MILL TOWN
Tramway terminus, rear of mill.
In 1938, the concentration mill process was divided into four departments.

1. Crushing (1911)
2. Gravity Concentrating (1914)
3. Ammonia Leaching (1916)
4. Flotation (1928)

High grade ore, 60 to 65 percent copper, was hand sorted after the primary crushing and main ore bin. This high grade ore was unique to Kennecott and was shipped directly to the Tacoma smelter. Most of the copper ore occurred as enargite and azurite, the remainder being malachite and chalcocite. Sulphides were easily recovered by gravity concentration.

Ammonia leaching, a process developed at Kennecott by E.T. Stimson in 1916, was incorporated to treat the colorless gangue and retrieve the carbonates. The leaching plant, however, could not treat the minus 2 mm sand and silts. Until 1925, the finer material was screened from the mill feed and shipped directly to the smelter. In 1925, the flotation plant was added for treatment of the copper carbonate slime. After the flotation plant's installation, only minor mill alterations were made. Characteristically, these later developments had a jury-built quality. The mill retains its overall configuration and is the most complete example of an early twentieth century copper concentrator.
Buchanan Jaw Crusher.
CRUSHING DEPARTMENT

Ore trimmed from the mine was dumped into two Buchanam Jaw crushers, the primary crushers, which reduced the ore to golf ball size in preparation for the secondary crushers. From the main ore bin the ore passed by a hand sorter, who picked high-grade ore for direct shipment, then continued on through the Symons disc crusher. The crushed ore was dropped by an elevator to the vibrating screens located in the mill's upper floors. Finer ore was screened for chuting on to the gravity concentration department while coarser ore was directed to the Traylor roller mill for recrushing. The roller crusher continued the fine milling until a sand was produced. Sands and gravels passed via the vibrating screens to the gravity concentration department which was divided between Hancock jigs, which separated the shipping copper from pebble-size ore sent to the leaching plant, and the concentration tables.

NOTE: Machinery is drawn to scale. Locations are approximate.

SCALE: 1/4 = 1' - 0"

Drake Dewaterer & Richards Hindered Settling Classifier

Hancock Jig

Symons Disc Crusher

Traylor Roller Mill

Trommel

Elevator

Vibrating Screens

Main Ore Bin

Aerial Trommel

54 cu ft per elevator

NOTE: Screen opening size not to scale

o 1' - 0"

0 - 0.15 mm

1'/8" - to flotation

overflow to flotation

38% copper concentrate

to sacking via bull jig

to concentration tables

1" and smaller from trommel

1 - 1.5"

to leaching plant, and the concentration tables.
Plat-O Slime Tables.
CONCENTRATION DEPARTMENT

Gravity concentration of ore is a purely mechanical operation. Its purpose is to separate the ore into two portions:
1) a small part which contains 60 to 95 percent of the valuable minerals, and
2) a large part which can be discarded as waste.
Although concentration at Kennecott included all operations in the mill, the primary process was in the gravity concentration plant, built in 1911 and expanded through the 1920's. The sands from the crushing department arrived via the Richards Hinderred Settling Classifier, which prepared the ore for the 30 concentration tables. The table's vibrating action separated the heavier material from the lighter waste rock, which always carried with it a slight percentage of copper. The series of tables removed the copper from the waste until the point of diminishing returns was reached. Tailings were sent to the leaching or flotation plant, while the copper washed into the concentration tanks. A plug in the tank was removed and the concentrate slided into sacks for shipment to the smelter in Tacoma.

Note: Machinery is drawn to scale. Locations are approximations.
Janney Flotation Cells.
With a feed of 3-4% copper from the concentration tables, the flotation process mixed in reagents which removed more copper in a frothing action. After settling, filtering, and drying, a concentrate was produced that assayed 32-35% copper, ready for shipment.


NOTE: Dotted lines indicate equipment removed for setup.

FLOW CHART
1. Esperanza drag classifier
2. 2-1 tray Dorr thickeners
3. Dorr pump
4. 6 Standard 24" Jowney cells as rougher
5. 10" Elevator
6. 8" Centrifugal pump
7. 10" Elevator
8. 1 Standard 24" Jowney cell as cleaner
9. 1 Standard 24" Jowney cell as mixer
10. 10" Elevator
11. 25" Dorr thickener
12. 18" Dorr thickener
13. 12" Dorr thickener
14. Oliver filter, 4"x 8" diameter
15. Concentrate bin
16. Dredge dewaterer
17. 2 Mill table concentrate tanks, 12" diameter
18. 8" Cellox cones
19. 25" Dorr thickener
20. Ball mill

SCALE 1" = 1'-0"
Leaching Tank. Evaporators at rear.
AMMONIA LEACHING FLOW DIAGRAM

SOLUTION SECTION

(Showing 1 set of Evaporators, designated "A" & "B")

C1 21 tons of rich solution to "A & B.
C2 Steam into "A" vapor from "A" into "B" to condenser. Ammonia concentrates to storage tank (assay 17% NH3).
C3 After boiled out, solution assayed 0.2% NH3 in "A" Steam off "A" turned directly into "B".
C4 Solution from "A" dumped into filter. Filtrate pumped to settling box. Precipitate in filter assay 75% Cu (with 28% HCl).
C5 A recharged - same as C.
C6 Same as C (reversed).
C7 Filter streamed after receiving 3 dumps of 15 lb for 4 to 5 hours. Condensate to settling box.
C8 Precipitate (assay 75% Cu with 18% HCl) sacked and sent up to storage room for shipment to smelter.
C9 Precipitates from settling box pumped into filter at end of each month.

LEACHING SECTION

(Showing 4 of 7 solution storage tanks and 3 of 8 leaching tanks - Leaching tank No. 1 - Leaching tank No. 2 - "A")

A1 End of 32 hr circulating leach and start of pumping direct to LT No. 2. 34 tons solution (assay 2.45% Cu, 4.28% NH3).
A2 24 tons of wash solution pumped on top of charge after start of:"A" solution assayed 0.42% Cu, 1% NH3.
A3 35 tons of steam at 110 lbs pressure.
A4 After charge in LT No. 2 is covered completely, 45 tons of solution (assay 2.45% Cu, 4.28% NH3) is pumped off via pit condensers to make-up tank.
A5 46 tons of wash solution (assay 0.4% Cu, 10% NH3).
A6 Tails to waste.

B1 8 tons of diluted solution syphoned to wash tank by gravity (assay 0.4% Cu, 10% NH3). If syphoned to waste, which is not always practical being to varying amounts of H2O in tails, assay not to exceed 0.7% NH3.
B2 At end of 40 hour still leach, 44 tons of rich solution is pumped to storage tank for distillation (assay 6.6% Cu, 0.6% NH3). At same time 40 tons of ammonia concentrate is pumped on top of charge (assay 17% NH3).
B3 After concentrate is pumped on, 45 tons of make-up solution is added to recover charge as before B2 (assay 2.45% Cu, 4.28% NH3).
B4 32 circulating leach (assay at start 18% Cu, 6.2% NH3). Same as A1 (Leaching tank No. 1)
B5 24 tons of wash solution pumped on top of charge after start of B5 to leaching tank No. 3.
B6 35 tons of steam at 110 lbs pressure, same as A3 (LT No. 2).
B7 Same as A2 (Leaching tank No. 1) via pit condenser No. 2.
B8 Same as A2 (Leaching tank No. 1) via pit condenser No. 2.
B9 Same as A2 (Leaching tank No. 1) via pit condenser No. 2.

Note: This drawing represents one complete cycle in the leaching plant.

Based on KCC Leaching Plant Flow Diagram, 1921.
Tailings below Leaching Plant and Mill.
General Manager's Office below Mill.
National Creek Bunkhouse (left), Company Store, and West Bunkhouse from Mill. 1982.
West Bunkhouse and Refrigeration Plant.