ONE HUNDRED YEARS and more have passed since brothers Fred and Moses Manuel, adventurers and prospectors, entered the gold rush country of the Black Hills; and with a partner, Hank Harney, subsequently staked the HOMESTAKE CLAIM on APRIL 9, 1876.

With that discovery began our saga, the story of the oldest operating gold mine in the Free World, HOMESTAKE!!

GOLD! The “first” metal!

"... the whole land of Havilah, where there is gold; And the gold of that land is good; ..." [Genesis, Chapter 2, Verses 11 & 12]

GOLD! The metal that people have willingly accepted for hundreds of centuries in exchange for their possessions or their labor!

GOLD! The one metal chemically inert to all atmospheric elements and thus widely used in the chemical, medical, electrical, electronic, automotive, aviation and space industries!

Indeed we take pride in producing this much-needed metal, and we herewith describe how it is accomplished.
WILD! RUGGED! A PATHLESS WILDERNESS!
That was the Black Hills of Dakota Territory in the early 1870's. It was an untrodden and untamed mountainous region far from the paths of civilization — where fortune beckoned with a glittering smile, after General George A. Custer's Military Expedition in 1874 found gold and announced it to the entire World! And, within four years, one of the world's major gold deposits had been discovered, the Homestake Company organized, and machinery installed to mine and treat the ore from the hard ledges in the ancient rocks. Truly, the Homestake was a contemporary of the roving Sioux, the grizzled prospector, the plodding ox team and the hardy pioneer.

The original discovery site and all the early day hoists and mills disappeared years ago. In their place has risen a progressive industry geared to modern engineering endeavors and proven scientific techniques, led by wise management and an excellent work force. These all teamed together have developed better mining and milling methods, improved skills and tools so that the Homestake Gold Mine could enter into its second century of economic importance to South Dakota and the Nation!
 wins food, clothing and shelter from the products of the soil; the miner produces the raw materials from beneath the surface of the earth to make mankind's tools and many of life's necessities. If mankind didn't take minerals and metals out of the ground and make them into useful products, his existence would indeed be primitive. Imagine a modern farmer without tractors or trucks, cornpickers or combines, hoists or haystack movers? Imagine a house without a stove, a refrigerator, a television set? Everything that can be seen comes out of the ground. The automobiles, the buildings, even the pavement — they too have all come out of the ground. The farmer and the miner have much in common. Through the ages, they have wrested their livelihood from Mother Earth by dint of their heavy toil and the skills developed by them through the centuries. Truly, they have a common heritage. One threshes his grain crops to get them into usable form; the other crushes and grinds his ore to extract its minerals and metals. But there are two great differences. For example, farming by proper soil conservation, fertilization, and crop rotation may be carried on for generations. On the other hand, every producing mine eventually runs out of ore. Furthermore, for every worthwhile producing mine, there have been nearly five thousand prospects on which heavy expenditures of money and effort have been made without return. Without question, both the farmer and the miner are entitled to just returns on their participation in risky ventures; the farmer for his investment in land, tools, supplies and for his labor. The miner, as represented by the thousands of shareholders who have invested in his enterprise, is entitled to recover the capital expended on the venture plus a just return in keeping with the very nature of the unique operation that eventually expires.
Early History

GOLD! In a ceaseless quest that had its beginning long before the dawn of civilization, mankind has striven for gold — has sought it on every continent and in every climate — has faced every obstacle. Mankind’s urge to acquire this precious, rare, beautiful metal has had a profound influence upon the destiny of nations and the course of history. The early Greeks washed rough nuggets from gold-bearing gravels which were stamped to form the earliest coins of Lydia. Allusions to gold ore are found in the Old Testament which reveal the hold it possessed, even then, on the imaginations of men. Excavations of early Egyptian tombs disclose the art of the goldsmith was highly developed in those distant days, as it was also by the Incas and Aztecs who had collected their fabulous golden treasures long before the coming of their conquerors. In the history of our own United States, the prospector has played an important role. During the Civil War, gold from California and Nevada aided materially in the preservation of the Union, and since that time production of the metal from our Western states has been important in the growth of the United States into a world power.

GOLD’S most lasting value to mankind comes not alone from its beauty, its scarcity, or its special place as the universally accepted monetary commodity, or as a measurement of relative values of materials and services, or in the preservation and employment of wealth. Quite apart from its acceptance as money, gold has unique chemical and physical properties that are most important to modern space-age science and technology, where only gold alone can render highly specialized services.
Discovery in the Black Hills

The date when gold was discovered in the Black Hills of Dakota Territory is a moot question. Captain Seth Bullock, frontiersman and the first sheriff of Deadwood, reported in his diary that:

"Shortly after the close of the Civil War, Father DeSmet, the heroic missionary, stated at a dinner party in the home of General Ewing at Columbus, Ohio, that he had repeatedly seen gold dust in the possession of the Sioux Indians. They told him that they got it in the Black Hills and that there was 'heap plenty of it'. Where and how the Sioux got the gold which they had from time to time, is a controversial matter. If it was from the Black Hills, it is an almost assured fact that it came from the section now embraced in the county of Lawrence, as their trail through the Hills, skirted Deadwood Gulch, crossed the Homestake Belt and the rich placer deposits in the gravels near Central City."

Father DeSmet was "around" the Black Hills in 1848 and again in 1851, 1864 and 1870.

An account of the source from which the Sioux may have obtained gold is contained in the incomplete record inscribed on a stone tablet which was found in 1887 by Louis Thoen near the town of Spearfish. It is a piece of sandstone, on one side of which has been scratched, seemingly with a knife, the following:

"Came to these hills in 1833 seven of us DeLacompt. Ezra Kind, G.W. Wood, T. Brown, R. Kent, Wm. King, Indian Crow, all died but me Ezra Kind. Killed by Ind behind high hill. Got our gold dust June 1834."

On the reverse side was scratched:

"Got all the gold we could carry. Our ponies all got by the Indians. I have lost my gun and nothing to eat. The Indians hunting me."

The year 1834, in which the gold was mined according to the tablet, was fifteen years before the discovery of gold in California. The stone, when found, had the appearance of having been there for many years. It was hidden by grass and brush which apparently had grown up around it. Further evidence of its authenticity lies in the fact that it was found near the trail on Spring Creek which led from a fur trading post at the mouth of the Redwater (the present site of Belle Fourche) to the main Indian trail up Deadwood Gulch.

There were others who also touched the Black Hills in the pre-Civil War days. A fur trader, Jeremiah Proteau, of the American Fur Company, in 1854 reached the northern Black Hills foothills where the streams came tumbling onto the prairie. A geologist, Dr. Ferdinand V. Hayden, explored the edges of the region in 1855 and the innards in 1856. Ten years later, he reported to the Dakota Historical Society that: "the lowest Silurian period, or gold-bearing strata, are well developed in these hills." During the Civil War two men, G.T. Lee and Toussaint Kemsler, claimed separately to have found gold therein.

Other evidence such as rusted hatchets, mining picks, and abandoned shafts, found in the 1870's points to adventurers and prospectors having entered the Black Hills many, many years before the 1875-76 rush, and seeking GOLD!
Custer Military Expedition

In June of 1874, special military orders were delivered to Lt. Colonel George A. Custer at Fort Abraham Lincoln, across the Missouri from Bismarck, now North Dakota’s capitol. These orders instructed him to prepare an expedition for exploration of the relatively unknown Black Hills.

It was July 2, 1874, when the expeditionary force left the military post amid great fanfare with more than a thousand men in all, and six-mule teams drawing 110 wagons, followed by 300 head of beef. Included with the military personnel were engineers, geologists, naturalists, practical miners, Indian scouts, a newspaperman and a photographer.

Historians disagree as to the exact date, whether it was late July or early August, 1874, when Horatio N. Ross, one of Custer’s practical miners, found gold along French Creek in the central Black Hills.

Even before the expedition’s official reports on this unknown region were published, the rumors that gold had been discovered gave impetus to a rush that by 1876 had become a stampede.

In those gold rush days, placer claims were located on practically every creek in the Northern Black Hills.

Chief among these was Deadwood Creek, which flows through Central City and Deadwood. Several of the claims were very rich, notably the Wheeler Claim from which approximately $100,000 was panned during the season of 1876.

The operation of placer mining, i.e., washing the gold from coarse gravel of the creek beds, was short-lived. Within a few years the bewhiskered individual with pick, shovel and gold pan had fulfilled his mission. The placers were worked out and the stage set for the mining of gold ore in the hard rocks from which the gravels had been derived. Even as early as the summer of 1875, a few of the more venturesome souls were investigating the possibility of quartz lode claims. Among them, Moses and Fred Manuel were the most fortunate. On reading newspaper stories of General Custer’s expedition, Moses Manuel left Portland, Oregon, for the Black Hills. Enroute he was joined at Helena, Montana by his brother, Fred. They reached Custer in December, 1875. They found nothing of interest in that vicinity, whereupon they went to the Northern Hills. After a winter of prospecting, they discovered on April 9, 1876, the Homestake Ledge or Lead (pronounced “Lead”). A ledge or outcrop of ore was termed a “lead”. Hence the town’s name. They sank their discovery shaft in the side of a draw, built a crude mill and during the spring of 1876 took out $5,000 worth of gold.
Homestake Organized

In June 1877, L.D. Kellogg, an experienced practical miner representing a group of California mining men, came to the Black Hills to investigate promising reports of new gold discoveries. Following a brief investigation, he optioned the Homestake and Golden Star claims for $70,000, less a strip of land 10-feet wide originally deeded by the owners to H.B. Young. This strip was subsequently acquired. Kellogg then reported to his employers in California and they immediately took up these claims, purchased others in addition, and promptly undertook their development. The first two claims, comprising about ten acres, are a very small part of the eight thousand acres of patented mineral claims now owned by the Company.

These mining men incorporated their holdings as The Homestake Mining Company in California on November 5, 1877. This was almost 12 years to the day before the south half of Dakota Territory was admitted to the Union as the State of South Dakota. Such was the beginning of one of the great gold mining enterprises of the world. With the development of Homestake, the history of the Black Hills
and all of western South Dakota is closely interwoven.

The newly organized company purchased an 80-stamp mill from a San Francisco firm. It was shipped by rail to Sidney, Nebraska, from where it was hauled by ox teams a distance of almost 300 miles to Lead. The mill was completed and stamps began dropping on the mined ore on July 12, 1878. The construction of this mill, and the installation of boilers and other heavy machinery in this remote situation with such speed deserves to rank among the outstanding achievements of this great period of American mining history.

In January 1879, the New York Stock Exchange accepted Homestake stock on the open market, where it has remained ever since as an "open" corporation.

Within a few years, more stamps were dropping on the crushed ore and the mills were considered to be as modern as any, in which the appliances for reducing the ores and gathering the gold were of the best description. Thus a large tonnage enterprise had been created under pioneer conditions in a region that was extremely difficult of access.
LEAD CITY 1876 — Some historians insist that the original townsite was as pictured in the photo at left. Other historians disagree. They contend that the cabins in the photo at the upper right were first. The location at the left is what has long been known as Washington Addition. It is the only comparatively level spot in the community. The view at the right is looking down Mill Street towards the Open Cut.
THE CITY OF LEAD TODAY—A four-dimensional community! Over one mile above sea level, over one mile in length, over one mile in width, and well over one mile and a half in depth are Lead and Homestake. Lead is in the center of a beautiful year 'round recreation area—fishing—hunting—golfing—water-and-snow skiing—snowmobiling—boating—picnicking—hiking—all conveniently close by!
The gold-bearing rock was first mined in open cuts, but underground work was soon started through shafts. In the early years, the square-set method of mining (use of large timbers) was employed. This mining practice had been developed on the Nevada Comstock Lode for use in wide ore bodies, but with increasing experience, other systems of mining were added that took advantage of the relatively strong ground.

Four other companies of importance were also started in the early years in the Homestake Belt: namely the Highland, the Deadwood Terra, the Father DeSmet, and the Caledonia. They were consolidated with Homestake in 1901. The capacity of the mills was increased, additional water supply was piped to the plants, water power development commenced, and a start was made toward modernizing the hoisting equipment. Underground haulage by horses and mules was supplanted by air motors.

The extraction of the gold from the ore took a big step forward with the introduction of the cyanidation of the mill tailings about the turn of the century.

During the period from 1910 to the present, countless improvements have been made in every stage of the operation, from the deciphering of the complex geologic structure to which the distribution of ore is closely related, to radical changes in mining techniques and equipment, to the perfection of the mechanical plant by which the ore is transported and hoisted and the gold extracted and refined.

**HARD WORK**—Everything was done by hand in open-cut mining as well as underground mining in the almost quarter century before 1900 when pneumatic drills came into use.
THE FIRST LOCOMOTIVE
— Two views of it: one at work in the early 1880's pulling wooden ore cars in the Open Cut; the other as it looks today in the Adams Memorial Museum in Deadwood.
Important Historical Dates

HOMESTAKE ABOUT 1900
1874—Gold discovered in the Black Hills on French Creek near the present city of Custer by Ross and McKay, two miners attached to General Custer’s Military Expedition.

1876—On April 9, the Manuel Brothers, Moses and Fred, together with Hank Harney, discovered a ledge—an outcropping of ore termed a “lead” (pronounced “leed”)—in what is now the Open Cut. They named their claim “Homestake” and the mining camp which soon leaped to life took the name of Lead City.

1877—Homestake claim and another totalling 10 acres were purchased from the Manuels by a group of mining men, who on November 5, incorporated Homestake Mining Company.

1878—On July 12, 80 stamps of 750 pounds apiece started dropping in a new mill. The stamps had been hauled 300 miles by ox team from Sidney, Nebraska, nearest railroad point.

1879—January 22, Governing Committee of New York Stock Exchange accepted Homestake stock on the open market.

First hoist placed in operation at B&M Shaft No. 1.

1880—First railroad in the Black Hills was the Black Hills & Fr. Pierre, started by Homestake to bring cordwood fuel to the mills, shops and hoists, and timbers to the mine. Sold to Burlington Railroad in 1902. The line no longer exists.

1889—Nov. 2, South Dakota admitted to the Union.

1899—An experimental cyanide plant built to attempt recovery of the gold in the tailings after amalgamation had extracted the greater part. Followed in 1901 by the construction of fourteen 600-ton leaching vats for treatment of the sand tailings. Vats enlarged and additional ones installed, plant remodeled in later years.

1900—Pneumatic drills began replacing hand drilling in mining operations.

1901—Experiments with compressed-air locomotives successful. Placed underground, replacing horses and mules.

1906—Electrification of operations started with the first of three hydro-electric plants.

Plant built in Deadwood to treat the finer particles of the ore (“slime” fraction). Ceased operations in 1973 and replaced by carbon-in-pulp plant in Lead.

1916—First steam turbine electric generating plant placed in operation.

1918-1940—Old mills, hoistrooms, headframes, mechanical shops, warehouses, other buildings in the vicinity of Open Cut dismantled and removed. Replacement plants built on ridge southeast of the Open Cut. These included new metallurgical, mechanical, warehouse facilities; offices, etc.

1920—Geology Department organized; subsequently becoming an independent engineering unit.

First formal guided summertime tours of surface workings instituted. Since 1945, conducted by a local organization, the Lead Civic Association.

1926—Celebration held commemorating discovery of Homestake 50 years previous.

1934—The new Ross Shaft installation placed into operation.


1941—The new Yates Shaft installation completed and normal hoisting operations started on October 1, thus completing a major construction program begun in the 1920’s.

1942—In October, War Production Board Order L-208 suspended all gold mining in the United States. Mining stopped immediately, but broken ore in stopes milled until June 1943.

1945—On July 2, mining and milling operations resumed as a result of the rescinding of W.P.B. Order L-208.

1950-1970—Gigantic modernization program in mining and milling undertaken. New mining techniques, tools and equipment introduced. Ore-crushing and grinding plants completely rebuilt. Deep-level mine development began with underground shaft sunk from 4,850-foot level to the 6,800-foot level. New ventilating shaft sunk from surface to the 5,000-foot level; now bottomed on the 6,200-foot level.

1970-1976—Deep-level development continued with two new underground shafts sunk; one from the 4,550-foot level to the 8,000-foot level; the other from the 6,800-foot level to the 8,000-foot level.
TERRAVILLE AND HOMESTAKE ABOUT 1906—This no longer busy mining camp is nestled between steep mountain walls between Central City and Lead. Homestake's Old Brig hoistroom (foreground), the Pocahontas Mill (center) and the Monroe Mill (right) have long been gone.
REAL HORSEPOWER preceded mechanical horsepower when it came to moving mined ore. The loaded ore cars were leaving the tunnel that connected Homestake's operations in Lead and Terraville. "Teddy" was up for a July 4th celebration. The date? About 1900!
HOMESTAKE TODAY—Yates Shaft hoistroom and headframe, mechanical shops and warehouse, all are on ridge top. South Mill in center. Flat-roofed lower buildings are East and West sand treatment plants.
The Ore Bodies

Many modern-day citizens cling to a romantic picture of a prospector. In their minds the prospector is a rugged, hardy explorer carrying a pick and shovel, and not much else, moving in difficult mountainous terrain by primitive transportation, mainly "foot-power". This image certainly did have a solid historical base, because the discoverers of the Homestake ore body on April 9, 1876, Fred and Moses Manuel, and their partner, Hank Harney, were just such rugged, enterprising pioneers. And, it was their practical "grass-roots" understanding of geology that led to the discovery.

Mineral exploration, and for that matter further development of already-known producing mines, may retain some romance. But it takes much more today than the grizzled prospector who hoped to find an outcrop of "interesting" rock sticking out of the ground. Most of those exposed ore bodies throughout the world have long ago been discovered. Mineral searches or developments now require skilled, highly trained geologists using not only the accumulated knowledge of those who have gone before, but also using the latest techniques and equipment concerned with the space-age sciences of geophysics and geochemistry.

Mining companies, because of the non-renewable nature of mineral resources, must put back substantial amounts of profit into exploration and development. For example, for every ton of ore that is milled, another ton must be found to replace it, if the operation is to continue. Thus, it is the job of the geologists to locate the few places within the very complexly folded rock formation known as the Homestake Formation, to find the finely distributed gold which averages approximately one-quarter of an ounce or less to the ton of rock.
The citizens of Lead, the others living in nearby Black Hills communities, and those thousands of tourists who annually visit or pass thru the Mile-High City are well aware of the spectacular Open Cut. This colorful man-made phenomena marks the discovery location of the outcrop of the ore body and the subsequent birth of this world-famous mine. It is the oldest continuously operated gold mine in the world, and was already the site of a twelve-year-old organized company when the State of South Dakota was admitted to the Union in 1889. Most Western South Dakota citizens are well aware of the historical significance of this mine to the entire region's social and economic development.

Those who give more than just a passing notice to the Open Cut, the extensive surface plants, the shaft installations, shops, mills and supporting activities, cannot be other than impressed by this monumental development. But this is only part of what is present here. There are hundreds of miles of underground workings, extending down 8,000 feet beneath the surface. History has been written here, great technological advances have been developed here, and much of the 19th and 20th century history of the entire region is rooted here.

Geologic History —

But beyond all of this is still another story that started eons ago, far back in time, back in the primitive beginnings of this world, and part of this story can readily be seen in the Open Cut for it is revealed in the exposed strata of the rocks. Here, the reading, interpreting, and understanding of this story is the very special and fascinating realm of the geologists.

Most every person has an appreciative understanding of time as measured in years, decades, even centuries; but considering time in hundreds of millions and billions of years overwhelms and staggers the imagination. Yet the earth's history is indeed measured in such astronomical time spans. Geologic studies have shown the earth to be about 4.6 billion years old. It possibly, and some scientists say probably, originated through processes of accumulation from cosmic dust clouds.

The estimated age of the oldest rocks in the Lead area of the Northern Black Hills is based on limited data. The granites, such as Harney Peak, and others in the Southern Black Hills originated as molten masses within the earth's crust and intruded upward into and through overlaying older rocks similar to those in the Lead area. The oldest of these granites has been dated to be 1.7 billion years. Considering what is known about the regional geology of the Black Hills, it can then be reasoned that the rocks in the bottom of the Open Cut may be about 2 billion years old. These older rocks which the granites intruded were shales, silts and sands deposited in vast seas in which 25 to 30 thousand feet of sedimentary rock accumulated, and possibly much more. These very ancient rocks are termed Precambrian

Continued on Page 20
WHERE IT ALL BEGAN IN APRIL 1876! The Open Cut is one of the best known landmarks in the Black Hills of South Dakota. This colorful scene is a photographer’s delight as the exposed bands of cream, red and blue-green rock stand out against the azure sky.
Geologic History, continued—
in age, meaning they formed prior to the time when
fossils began to appear in the geologic record of rock
formations. Geologists assume these rocks accumulated
prior to the beginning of life upon the earth.

Closer scrutiny of these ancient rocks reveals they
have undergone extensive physio-chemical
reconstitution, wherein their original mineralogical,
chemical, and physical makeup have changed. New
complex minerals developed from older, simpler
minerals through a process called metamorphism,
caused by great pressure and temperature increases.
Temperatures were upwards in the range of 400 degrees
Centigrade (sufficient to melt lead). Pressures of such
magnitude were maintained over great time periods
sufficient to shorten, stretch out, crumple, complexly
fold and rotate hundreds of cubic miles of solid rock into
extremely complex expressions (such as the one shown in
the photo on the next page). Geologists note that these
rocks were originally clays, silts, sands and limestones
deposited in vast seas. These sediments had to come
from some eroding land mass to have accumulated in
these seas. There are numerous environmental changes
in the depositional sequence recorded in the rocks.
There were also great basaltic lava-like intrusions and
lava flowing out on the ocean floor in the rock sequence.
Imagine if you can, the complex physical and chemical
phenomena that was required to change simple clays,
silts, sands and limy sediments deposited on ocean floors
into the complexly folded, tilted and rotated rock
sequence we see now in the Lead area. This phenomena
took hundreds of millions and billions of years to
develop.

Incidentally, geologists of the post gold-rush days
gave names to the various rock formations that are
prominent in the Lead District — names such as
Homestake, Deadwood, Poorman, Ellison and others.

Sometime between 30 and 60 million years ago,
rocks deep beneath the Northern Black Hills were
subjected to increasing temperatures sufficient to melt
them deep in the subsurface. This heat generated
molten igneous masses that intruded upward, forcibly
shoving apart the rock and making numerous dikes, as
well as forcibly injecting between beds to form extensive
sills and igneous masses like Terry Peak, Bear Butte,
and Mount Roosevelt in South Dakota and the nearby
Bear Lodge Mountains and Devil’s Tower in Wyoming.

Perhaps 2 billion years or so ago, the Homestake
ore body began to form; possibly it was only 50 million
years ago. (This dating problem has not been definitely
resolved.) The genesis or beginning of the ore deposits
involved numerous chemical and physical phenomena.
A process of massive chemical exchange and
redistribution of the elements was involved. A transport
medium was required to move gold, quartz, sulphide
minerals, gases and liquids through solid rock. Gold
ores were localized only in certain folded areas within
certain rock types in the Homestake Formation. (Other
rock types contain no ores.)

Quartz veins are the most prominent features of the
mineralization. They are of all sizes and shapes, and
there are often large numbers of these quartz veins in
the ore bodies. Usually the rock near the quartz veins
will contain arsenopyrite (white cube iron), pyrite (brassy
cube iron) pyrrhotite (bronyz iron) and chlorite (green
tale), and of course, if it is actually ore, gold.

Gold is present in all cases as metallic gold and not
in any chemical combination. The gold is usually very
fine grained, so fine that it is seldom visible to the
unaided eye.
Geology Department —

The highly sophisticated, scientific techniques of today that Homestake’s geologists use include extensive examination of all underground openings, recording of all collected information, plotting of maps, visiting with underground personnel about sampling procedures, geology and actual mining situations, calculating ore reserves; and predicting where new ore may be located. Furthermore, the geologists furnish plans for work to develop the future ore and explore for new ore bodies. The grade value or amount of gold in a block of ore is determined by geologists. This is most important because it must be known whether there is sufficient value in a mining block to make it profitable to mine.

Thus, here at Homestake, mining operations have been dependent upon accurate interpretation of the many geologic complexities that have been a “trademark” of this property. Not only that, but new ideas must also be continually presented, studied, developed and instituted to find new ore bodies.

So it is that the science and proper application of modern-day geology is most important to everyone concerned — the employees; the 22,000 shareholder owners; the gold customers; suppliers; the local, state, and federal governments; and the many others who depend either directly or indirectly upon this operation for their livelihoods.

GEOLOGIC MAPS — Important sources of basic information.

Mapping complex rock folding in a drift.
CORE DRILLING with diamond-faced bits is performed by air-powered drills (opposite), and electric-powered drills (lower left). Resulting rock cores are under study (below).
Surveying

As previously noted, without accurate geological information, there would be no mining. This also holds true for many other necessary engineering functions. One such function is surveying. No mining property of any magnitude can be worked systematically and intelligently without surveys. There is no place for guess work. Underground surveying has for its objective the determination of the position of the various underground workings with relation to themselves and to the surface boundaries and plants. This requires the most accurate of the many types of surveying.

A survey is generally begun on the surface of the earth by what is known as “triangulation”, where measurements are taken between two permanent points, a tie-in observation is made with the star Polaris (the North Star), two more permanent points are established and subsequently followed by surveying from all possible angles. This method has controlled all Homestake surveys since November 1879.

The “triangulation system” is then the basis for the necessary underground surveying. One of the most common methods used here is by hanging two wires with weights on the ends down a shaft to a pre-determined depth. After very delicate and complicated alignments, measurements and surveys are taken underground of those wires, that survey is then connected to the surface “triangulation point survey”. Following this, a transferring of these lines to deeper mine levels as they are opened enables surveyors to accurately place horizontal tunnels (drifts and crosscuts), vertical tunnels between levels (raises) and shafts in the desired locations.

Furthermore, surveys must be regularly made of exploration diamond drilling and development work; measurements must also be taken of actual mining of waste rock and ore wherever it occurs; and accurate maps and records produced from all such endeavors.
Mining the Ore

History —

From the time of discovery in 1876 until about 1900, the ore was mined either by open pit or what is known as “square-set stoping” — a mining system that had been brought from the fabulous Comstock lode in Nevada. It consisted of using 4 large timber posts each 8 feet in length held apart by smaller timber caps and ties. As a block of ore 6-feet by 6-feet by 8-feet was mined out, that block was replaced by a timber square set.

All the ore was drilled by hand. A miner working alone would hold and rotate the drill steel with one hand and use the striking hammer with the other hand (single jack method). Two men working together would find one man holding the steel while the other did the striking (double jack method). Either method was arduous, slow and expensive. The mined ore was then shoveled into cars by hand.

At the turn of the century, mechanical rock drills began to replace hand drilling. The early rock drills were heavy, cumbersome piston machines; the drill steel was fastened to the piston of the drill and hit a blow against the rock with each stroke of the piston.

Shortly after 1900, as the mine deepened, it was apparent that the rock in which the ore body occurred was especially strong and could safely stand unsupported for long periods of time. As a result, a mining method known as “shrinkage stoping” was begun. “Stoping” refers to the actual removal of the ore. This method refers to a system of mining where the broken ore remained in the stope for the miners to stand on as the mining proceeded upwards from one level to the level above. The broken ore took up more room than the solid, so periodically some broken ore was removed to provide proper working space. The process of

Continued on Page 30
LONG, LONG AGO, ABOUT 1903, these miners posed patiently for the photographer. Not only is their clothing, from head to toe, different than today's working apparel, but mine timbers were also much different than those used today. Cordwood fuel became unnecessary with the inauguration of electric power a few years later.
Mining and Milling Terms

There are only two basic industries: mining and agriculture; and these two industries have been responsible for the progress of man from the Stone Age to the Age of Technology.

ADIT A horizontal tunnel driven into the side of a mountain through which a mineral deposit can be explored and developed.

ADSORPTION Adhesion of molecules of a liquid or dissolved substance to a surface of solid bodies, i.e. gold to activated carbon.

ASSAY The testing of a sample of minerals or ore to determine the content of valuable minerals in the sample.

BACK The ceiling of any underground excavation.

BACKFILL Sand portion of the milled ore used to support the walls of a stope and provide a working platform after removal of the ore.

BALL MILL A milling machine used to grind ore into small particles which uses steel balls as the grinding medium.

BEDROCK The solid rock of the earth's crust, generally covered by overburden of soil or water.

BULLION Gold or other precious metal in bars or similar form.

CAGE An elevator-type conveyance which moves people and materials up and down a mine shaft.

CHUTE An opening into a stope through which ore is dropped after it is first mined to waiting mine ore cars for transportation to a shaft.

COLLAR The term applied to the timbering or concrete around the mouth of a shaft; also used to describe the top of a drill hole.

CROSSCUT A lateral or horizontal tunnel made underground that cuts across the ore body (See Drift).

CUT-AND-FILL A stopping method in which the ore is removed in slices or "lifts" after which the excavation is filled with sand backfill before the next slice is mined. The backfill supports the walls of the stope.

DEPLETION The steadily declining amount of ore in a deposit or property resulting from production. Minerals are said to be a "depleting resource" because, once mined, they cannot be replaced.

DEVELOPMENT Bringing a mining property to the production stage.

DRIFT A horizontal underground tunnel in such a direction that it follows or "drifts" with the ore or an ore vein. (See Crosscut).
ELECTROLYTIC PROCESS Pertaining to a refining process in which not quite pure gold is suspended in a cell containing a liquid known as electrolyte. The metal to be refined forms the positive post or "anode" and is deposited on the negative post, called the "cathode," by the electric current fed into the anode.

FOOTWALL The wall or rock on the underside of a stope.

GANGUE The worthless minerals associated with valuable minerals in the ore deposit.

GEOLOGY The science or study of rocks in the earth.

GRIZZLY A grating placed over the top of a chute or ore pass to stop the larger pieces of rock or ore.

HANGING WALL The wall or rock on the upper or top side of an ore deposit.

HOIST A machine which raises and lowers the cage and skips in a shaft.

LEVELS Horizontal passageways or tunnels in the mine leading from shafts. They are established at regular intervals.

MARGINAL ORE Lower grade ore which is close to being uneconomic to mine.

METALLURGY The various methods of preparing gold or other metals for use by separating them from their ores.

MINERAL A substance which may, or may not, be of economic value, that occurs naturally in the earth. It is homogeneous, has certain chemical makeup and usually appears in crystal or grain form.

ORE A mixture of minerals and gangue from which at least one of the minerals can be extracted at a profit.

ORE RESERVES The tonnage of ore of a certain grade which is estimated for the mine or certain sections of it.

OUNCES, TROY Unit of weight used in precious metals industry. 14.583 troy ounces equal 1 pound avoirdupois.

PROSPECT A mining property, the value of which has not been proved by exploration.

PULP A liquid and ore mixture (See Slurry).

RAISE A vertical underground tunnel that has been excavated from the bottom upward.

REFINING The final purification process of a metal or mineral. (See Electrolyte).

ROCKBOLTING The act of consolidating walls and back by means of anchoring and tensioning steel bolts in holes drilled for the purpose.

ROD MILL A rotating cylindrical mill which employs steel rods as a medium for grinding ore into small pieces.

SHAFT An opening cut downward from the surface for transporting personnel, equipment, supplies, ore and waste. It is also used for ventilation and as an auxiliary exit. It is equipped with a surface hoist system which lowers and raises cage in the shaft, as well as "skips" or containers for bringing up ore or waste. A shaft generally has more than one compartment.

SHRINKAGE STOPE A method of stoping which utilizes part of the broken ore as a working platform and as support for the walls.

SKIP A self-dumping type of bucket used in a shaft for hoisting ore or rock.

SLIME Fine fraction of the ground ore.

SLURRY A liquid and ore mixture (See Pulp).

SLUSHER A mechanical drag shovel used to move ore or waste in a stope.

SQUARE SET A set of timbers used for support in underground mining.

STOPE An opening underground in which ore or waste is blasted and broken.

TAILINGS Waste material from the milling process.

VEIN An opening, fissure or crack in rock, containing mineralized material.

WASTE Material that is too low in grade to be of economic value.

WINZE A vertical or inclined opening sunk from a point inside a mine. Similar to a shaft, but the latter starts at surface.
LONGITUDINAL PROJECTION of 9-Ledge D-Limb, showing Open Cut-and-Fill Stoping.
CROSS SECTION of 9-Ledge structure, showing Open Cut-and Fill Stoping.
Mining, continued—
removing all the broken ore, upon completion of the stope, could require several months time. After completely emptied, the stope was refilled with waste rock (not ore) taken from development workings elsewhere in the mine and the Open Cut.

Starting in 1935, the sand portion of the ore (after the gold is removed), has been returned to the mine to backfill mined out stope. This gave a much improved, safer backfill, and is described in detail later on.

As mining advanced to greater depths below the surface, there were changes in rock pressure and in the physical character of the ore bodies. So a method known as "cut-and-fill stoping" was begun in the Fall of 1945, and it gradually replaced the shrinkage method. However in the last several years, a small number of shrinkage stopes have been activated where feasible.

*Shafts and Winzes* —

A shaft is an excavation of limited area compared with its depth, which is made for finding ore and for hoisting ore and rock, moving men and materials between the surface and the mine workings and for ventilating underground mine workings.

At the present time there are two operating shafts, both of which are vertical and are 5,000 feet in depth. These are the Ross and Yates Shafts. The Ross was completed in 1934; the Yates in 1941. A "winze" is a vertical shaft that starts underground and ends underground. Presently there are four such winzes. The No. 3 begins on the 4,100-foot level and bottoms on the 5,000-foot level. The No. 4 operates from the 4,850-foot level to the 6,800-foot level. The No. 6 Winze penetrates from the 4,550-foot level to the 8,000-foot level. Likewise, the No. 7 Winze which is underway at date of this publication, will bottom at the 8,000-foot depth, but

**DRILLING HOLES** for explosives with "jumbo" drilling machine.
begins on the 6,800-foot level. An inclined 45 degree supply raise is in operation between the 4,100 and 4,700-foot levels.

All the ore and waste rock is brought to the surface through the shafts and winzes. About a thousand mine department employees are lowered and hoisted each working day. Explosives and many other kinds of material and equipment are supplied through the shafts and winzes. This includes lumber and timber, mine cars and steel rails, pipe, air-operated shovels, air-powered and battery-operated locomotives, ventilating fans, tools of all sorts, air and water hose, steel ladders and many other items.

In addition to the two operating shafts, the Ross and Yates, other shafts and openings are devoted to ventilation purposes. The Oro Hondo (in Kirk Gulch) and a combination of the Ellison (in Lead) and a drift leading to the Kirk Gulch are air-exhaust passageways through which warm used air is pulled from the mine workings. The B & M Shaft No. 2 (in Lead) and the No. 5 Shaft (in Grizzly Gulch) also bring fresh, cool air into the mine.

The Homestake ore is an exceedingly hard and tough solid rock. It is even more resistant than Mount Rushmore granite, where the faces of Washington, Jefferson, Lincoln and Theodore Roosevelt are carved. A man equipped solely with a pick would make little impression on a face of ore exposed in the depths of the mine. To break such hard rock and prepare it for handling requires numerous special types of tools and equipment, including air compressors and drills, power shovels, power draglines or slushers, air and water hose, and many miles of compressed air and water lines. Large quantities of explosives are used in actually breaking

Continued on Page 33
CONSTRUCTING A TIMBERLINE on a level so that a permanent passageway will be provided. This will enable mining to proceed upward to the level 150 feet above and allow the ore as mined to be dropped into cars for haulage to the shafts. The timberline is also most necessary so that mill tailings can be filled around and above it in order to provide support for the surrounding solid rock walls.
Mining, continued—
down the ore at the working face. In addition, shops, power plants, storehouses and a large variety of other services on the surface are essential auxiliaries to the underground program. The security of the job of each man actually engaged in breaking and milling ore under the complex mining and metallurgical methods of present day operations depends upon a tremendous investment in machinery and technical-staff.

Many Levels in Operation —
Ore mining operations are conducted on 34 levels, from the 1,700-foot to the 6,800-foot, inclusive. The levels above the 1,100, now largely worked out, are spaced 100 feet apart vertically, and below, they are spaced at 150-foot intervals. The mine now has approximately 200 miles of workings on the various levels. These drifts and crosscuts, as such openings are termed, are driven through hard rock to provide access between shafts and ore bodies, and to reveal the location and form of the ore bodies on successive levels.

Development Work —
Development is the work done to open up ore bodies in preparation for actual mining. It consists of driving drifts and crosscuts (horizontal openings 7’ x 7’ in cross section; 7½’ x 7½’ on the lower levels of the mine), boring raises between levels (vertical openings 5’ in diameter), boring diamond drill holes to outline the gold-bearing rock, cutting ditches to carry water to the pumps and other necessary preliminary work before actual mining can be done. The opening of a level and placing it in proper condition before the undertaking of actual mining operations requires many months, and sometimes years, depending on the shape and location of the ore body.

Continued on Page 36

SEALING A TIMBERLINE so that the water which returns mill tailings underground for backfilling stopes will drain only at predetermined openings in the timberline.

“BORE HOLES” between levels serve several purposes: ventilation, exploration and vertical passageways.
GOLD ORE

SLUSHER

6" SAND-CEMENT CAP

SAND BACKFILL

CHIMNEY

10-IN. SQUARE WOOD BLOCKS

ROCK

SAND BACKFILL

CUT-AND-FILL STOPE

SAND BACKFILL

GOB FENCE
MINING WITH TIMBER is necessary in only a small number of stopes, but is carried out as this drawing illustrates.

HEAD-ON VIEW of a slusher hoist pulling a scraper-load of ore to the vertical opening through which the ore will drop to waiting cars on the level below.
Mining, continued—

Methods Used —

After the ore body has been outlined and the necessary development work has been done, the actual ore removal (called "stoping") begins. Stoping — the breaking down and withdrawal of the ore — starts at the bottom of an ore body and proceeds upwards from level to level. Nearly all of the ore between levels is mined by what is known as horizontal cut-and-fill stoping — most is mined without timber, and is called open cut-and-fill stoping — a small percentage is mined with timber, or square sets, and is called timbered cut-and-fill stoping. Shrinkage mining and blast-hole mining are also employed.

In cut-and-fill stoping, the ore body is mined in successive 11-foot slices. In this method of stoping, the sand fill is used as a floor from which the miners begin to drill and blast a new slice or cut of ore eleven feet high. The broken ore is then removed by scraping or slushing into an ore pass through which it is dropped to a chute on the level below where it is drawn and loaded into cars. After a slice of ore has been removed, most of the space is filled with sand, obtained from the tailings of the mill, which provides both support and a floor upon which the next slice is broken.

The miners begin their day's work by first testing the overlying back or roof after the previous blasting, and prying down whatever loose rock may be found there. This is termed "barring down" and is an important safety precaution.

The next step is to "set up" the air drills in proper position and drill a number of holes about 12 feet deep into solid ore. When drilling is completed the ore is blasted. Large areas of the stope are blasted at one time.

Continued on Page 41
MOST IMPORTANT is the examining, testing and barring down of any fragments of ore that remain in a stope after previous blasting.
ROCK BOLTING is carried on extensively throughout the mine. Each long expansion bolt holds several tons of rock in place.
DRILLING BLAST HOLES in a stope with a “jumbo”, an air-powered drilling machine and an air-driven positive-feed chain-drive attached to a guide shell frame.
SCRAPING ORE in a stope to a vertical passageway (above) and drawing that ore through air-powered gates into a car on the level below (right).

BROKEN ORE from a stope above is drawn through a chute into a waiting car. Air-powered chute-gates control the flow of the ore.
Mining, continued—

Square-setting uses heavy timbers to brace and support the roof and walls of the working as stoping of the pillar section advances upwards between the mined-out and filled stopes next to it. This is a relatively costly mining method, but it is necessary in order to complete the mining of the ore bodies with a minimum risk.

Shrinkage mining is done in the same manner as the open cut-and-fill except the broken rock is used as the floor instead of backfilling each slice.

Backfilling With Sand —

When the broken rock is drawn from a stope it is necessary for the resultant chamber-like opening to be filled so the next horizontal cut can be mined without delay. The fill also supports the walls and prevents ground movement due to rock pressure. Filling material is supplied from mill tailings in the form of sand. The sand (mixed with water) is run in from the surface through special rubberlined pipe to the top of the stope to be filled. By adding dry cement to the sand slurry on the top 6-inch surface of each sand-fill pour gives the mine crews a concrete-type floor on which to work.

In both open stopes and in timbered stopes, all openings must be sealed off to keep the sand from running into other parts of the mine workings. One passageway for ore, and one for ladders as a manway, are provided from the mine level to the top of the stope. Water drainage is effected through a series of open slots cut in the sides of the ladder way. These slots are opportunely plugged ahead of the rise of the sand to the opening.
Mining, continued—

Ore Transportation —

Handling the broken ore from the stopes to the shafts, hoisting it to the surface, and transporting it to the mills is a major operation which requires trained personnel and expensive equipment including an intricate underground 18-inch gauge railway system and high-speed, large capacity shaft installations. Five days each week approximately 6,500 tons of ore are hauled to the shafts and hoisted to the surface. In addition a large tonnage of waste rock must be handled, together with a vast amount of materials and supplies necessary in the mining operations. About 100 miles of track are in active use. Approximately 750 automatic side-dump 3-ton ore cars and 510 1½-ton rocker-dump cars are moved either by electric-storage battery or compressed-air locomotives; and 20 8-ton bottom-dump cars moved by electric trolley.
After the ore is drawn from the stope chutes into the cars, it is hauled to the shaft ore-bins into which it is dumped before being drawn off through a loading cartridge of measured capacity (9 to 10 tons) into the ore skips (rectangular buckets). It is then hoisted to the surface where it is crushed to 1/2-inch size and hauled to the mill bins.

**Deepening of the Mine —**

As previously stated in the section on Geology, for every ton of ore mined and subsequently milled, that ton must be replaced, if the operation is to continue. Thus, the search for ore must be a continuing endeavor. The Homestake formation in which the gold-bearing ore has been found in the past has been plunging deeper into the earth. To determine then if there is gold ore present, much geologic study must be undertaken in conjunction with exploratory diamond drilling, testing of samples,
ALL WATER used in the mining procedures and that used to return the tailings from the mill for backfilling of mined stopes must be collected and pumped to the surface, where it re-enters the milling processes.

Mining, continued—

mapping, further study and analyses of all factors and problems — technical and economic.

Greater depths require more winzes (underground shafts), raises between levels, drifts alongside and through the ore with all the hoisting and railroad equipment needed to provide adequate transportation facilities.

Increasing rock pressures and higher and higher rock temperatures occur as the mine is deepened. (These problems among others are discussed in detail on pages 74 and 75.)

EXPLOSIVES ARE NECESSARY in all phases of mining, including shaft-sinking. Ammonium nitrate is the main blasting ingredient.

More and more electric power is needed. Longer compressed-air and fresh-water pipelines must be provided. New pumping systems are emplaced to remove used water. Extension of modern communications systems is a "must": including telephone, short-wave radio and closed-circuit television.

"Down time", the non-productive hours during which personnel, materials and supplies are transported to and from the distant working places, becomes more and more of a problem.

These are just a few of the technical challenges that face the scientists and engineers, but they must be met if deeper and deeper mining is to be!
NEW UNDERGROUND HOIST on the 4,550-foot level is a fascinating product of modern technology. It provides efficient services to the 8,000-foot level, the deepest point in the mine; and as evidenced in these photos, is an electrical-mechanical marvel of the latest scientific achievements in mine hoisting equipment.
MAIN HOISTING UNITS at the Ross and Yates Shafts are among the world's largest of their kind. Each tapered drum (as here on the Yates Hoists) has a steelrope capacity of 5,600 feet in a single layer. Direct-current electric-motors provide several thousand horsepower necessary to hoist 60,000-pound loads up the almost mile-deep shafts at express speeds.
COMING OFF SHIFT after completion of their underground work is a mine crew. Throughout the entire operation it takes well-trained personnel with a wide variety of skills to “get the job done”!
GENERAL CROSS SECTION OF THE MINE
The Milling Process

Metallurgy is the science and art of extracting metals from their ores, refining them and preparing them for use. There are many metallurgical processes; some are mechanical, some are chemical, and some are combinations of both. A process that may be successful in the treatment of one ore may be useless when applied to another, as ores of different metals and from various places are dissimilar. Success in ore treatment requires considerable technical skill based on engineering training, research and experience.

Here at Homestake, the process is divided into two sections; first, the ore is broken down mechanically into such extreme fineness that the minute gold particles are liberated from the enclosing rock; second, these liberated gold particles are then further separated by combined chemical-mechanical processes, with the final chemical process producing pure gold.

After all the mining operations and treatment processes have been completed, less than one-fourth of one ounce of gold is recovered from each ton of ore.

The only other product of commercial value found in the ore is a very small amount of silver which is in combination with the gold. There is only about one twenty-fifth of one ounce of silver to the ton of the ore. It "tags" along with the gold throughout the chemical treatment until separated from the gold in the final refining process. (Note: Thus, we more or less ignore the silver in our following discussion.)

CRUSHING THE ORE involves large machines which reduce the ore prior to milling.

The Crushers —

Immediately after the broken ore is hoisted from the mine, it is "dry" crushed in three stages by three different machines in succession. First, a gyratory crusher breaks blocks of ore up to 30 inches in size into pieces which are less than four inches in size. Next, a standard cone crusher breaks these pieces to one-inch or less. The pieces which are less than one-inch are separated from those larger than one-inch by screening on mechanically vibrated screens with one-inch openings. The ore particles too large to pass through the screens are further crushed in a third machine, a short-head cone crusher. Its product moves to screens which have one-half inch openings, and those pieces that cannot pass through the screen openings are returned to the crusher repeatedly until they are broken small enough to fall through the openings in the screens.

The ore which has been crushed to one-half inch is hauled to ore storage bins in the mill in 30-car trains pulled by electric locomotives.
## Homestake Mills, Past and Present

<table>
<thead>
<tr>
<th>Date</th>
<th>Event Description</th>
<th>Mill Buildings</th>
<th>Total Stamps</th>
<th>Rod Mills</th>
<th>Ball Mills</th>
</tr>
</thead>
<tbody>
<tr>
<td>1878</td>
<td>Produced first ore, May; listed as crushed “outside”</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1878</td>
<td>Started first mill, July; Homestake Mill — 80 stamps</td>
<td>1</td>
<td>80</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1879</td>
<td>Started second mill, Golden Star — 120 stamps</td>
<td>2</td>
<td>200</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1890</td>
<td>Added to Golden Star Mill — 40 stamps</td>
<td>2</td>
<td>240</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1894</td>
<td>Added to Homestake Mill — 20 stamps</td>
<td>2</td>
<td>260</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1895</td>
<td>Added to Golden Star Mill — 40 stamps</td>
<td>2</td>
<td>300</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1897</td>
<td>Added to Homestake Mill — 100 stamps</td>
<td>2</td>
<td>400</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1898</td>
<td>Acquired Highland Mill, renamed Amicus — 140 stamps</td>
<td>3</td>
<td>540</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1899</td>
<td>Acquired Deadwood-Terra Mill, renamed Pocahontas — 160 stamps</td>
<td>4</td>
<td>700</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1900</td>
<td>Acquired Caledonia Mill, renamed Monroe — 100 stamps</td>
<td>5</td>
<td>800</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1901</td>
<td>Acquired Father DeSmet Mill, renamed Mineral Point — 100 stamps</td>
<td>6</td>
<td>900</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1904</td>
<td>Added to Amicus Mill — 100 stamps</td>
<td>6</td>
<td>1000</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1918</td>
<td>Discontinued operations at Mineral Point Mill</td>
<td>5</td>
<td>900</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>1921</td>
<td>Added ball mill in Pocahontas Mill</td>
<td>5</td>
<td>900</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1922</td>
<td>Started South Mill</td>
<td>6</td>
<td>1020</td>
<td>6</td>
<td>1</td>
</tr>
<tr>
<td>1922</td>
<td>Discontinued operations at Homestake Mill</td>
<td>5</td>
<td>820</td>
<td>6</td>
<td>1</td>
</tr>
<tr>
<td>1923</td>
<td>Discontinued operations at Golden Star Mill</td>
<td>4</td>
<td>620</td>
<td>6</td>
<td>1</td>
</tr>
<tr>
<td>1925</td>
<td>Discontinued operations at Monroe Mill</td>
<td>3</td>
<td>520</td>
<td>6</td>
<td>1</td>
</tr>
<tr>
<td>1927</td>
<td>Removed ball mill in Pocahontas Mill</td>
<td>3</td>
<td>520</td>
<td>6</td>
<td>0</td>
</tr>
<tr>
<td>1927</td>
<td>Added 2 rod mills in South Mill</td>
<td>3</td>
<td>520</td>
<td>8</td>
<td>0</td>
</tr>
<tr>
<td>1934</td>
<td>Enlarged South Mill</td>
<td>3</td>
<td>520</td>
<td>10</td>
<td>4</td>
</tr>
<tr>
<td>1934</td>
<td>Discontinued operations at Amicus and Pocahontas Mills</td>
<td>1</td>
<td>180</td>
<td>10</td>
<td>4</td>
</tr>
<tr>
<td>1952</td>
<td>Inaugurated remodeling at South Mill</td>
<td>1</td>
<td>120</td>
<td>7</td>
<td>4</td>
</tr>
<tr>
<td>1953</td>
<td>Completed remodeling at South Mill</td>
<td>1</td>
<td>0</td>
<td>4</td>
<td>4</td>
</tr>
</tbody>
</table>
Grinding —

Since the gold is distributed throughout the ore in very small particles, most of them so small as to be visible only with a microscope, the ore must be finely ground to break the gold grains out of the enclosing rock. About 70 per cent of the ore is ground fine enough to pass through 200-mesh screens, which is finer than the meshes in flour-mill sifting cloths.

The first step in the grinding of the ore takes place when it is delivered by automatically controlled electric vibrating-feeders from the mill ore-storage bins on to belt conveyors. The conveyors discharge the ore to "transportoweighers". These remarkable devices convey the ore on a belt; weigh it as it travels; record the total weight of ore handled; indicate the tons-per-hour being moved; and, make a continuous chart of the rate. In addition to all that, the transportoweighers automatically control the vibrating feeders so as to maintain a pre-set rate of ore to be ground.
From the transport weighers, the ore goes into rod mills accompanied by measured amounts of water. The rod mills are revolving horizontal cylinders 12 feet long by 6 feet in diameter, lined with heavy steel wear-liners and nearly half filled with hard steel rods, each 3-inches in diameter. As the mills rotate 20 times per minute, the rods roll and tumble over one another. The added water "pulps" the ore. As the ore passes through the mill as a pulp, it is ground finer by the tumbling action of the rods. The ore particles are much smaller in size as they flow from the mill as a pulp, having been reduced from one-half inch to less than one-eighth inch in size.

From the rod mills, the ore-and-water pulp flows to ball mills, somewhat similar to the rod mills but 11 feet long and 9 feet in diameter, rotating about seventeen times per minute. As the ore pulp passes through the ball mills it is ground still finer by the tumbling action of the balls. Each of these mills is loaded with about 80,000 pounds of steel balls, one and one-half inches to two-inches in diameter. The ground ore from these mills flows to classifiers, which are inclined trough-like machines with slow-moving rakes in them. These rakes not only agitate the ball mills' product, but also float away those particles of ore that are ground fine enough. The coarser particles of ore settle to the bottom of the classifier and are dragged back by the rakes to the ball mills for regrinding. Thus, none of the ore particles overflow the classifier until they have been ground fine enough so that the gold particles have been broken away from the rock particles and recovery of gold can then be made.

About 750,000 pounds of steel rods, 2,000,000 pounds of steel balls, and nearly fifteen million kilowatt hours of electric power are consumed annually in the grinding of ore.

BALL MILLS do the final grinding of the ore into particles finer than talcum powder.
Recovery of the Gold

The gold is recovered from the ore by two methods: gravity concentration and cyanidation. Gravity concentration depends upon the fact that the gold particles are much heavier than the rock particles and settle out of the pulp much faster. Steel trough-like boxes called launders, with traps built in the bottom, are situated so that the finely ground pulp flows out of the ball mills and through the launders on its way to mechanical separation of the ore particles. Some of the gold particles settle into these traps and are periodically removed from the traps and taken to the Refinery for further treatment to produce high purity gold bars.

The Cyanidation Process —

Cyanidation is a process which depends upon the fact that gold and silver are soluble in cyanide solutions, such as either potassium, calcium or sodium compounds in cyanide. Here at Homestake, a very weak solution of sodium cyanide ranging from one-fiftieth of one percent to one-twentieth of one percent strength are used to dissolve the gold. We have been using the cyanidation process since 1901, and recover over 70 per cent of the gold from each ton of the ore by this method.

Before cyanidation, the particles of finely ground ore are separated by classifying them into “sands” and “fines” (slimes), each for treatment in different plants.

The coarser more granular sands amount to about 59 per cent of the ore and are treated in buildings known as “sand plants”. The finer slime-like portions, which are so fine they are almost clay-like, amount to about 41 per cent of the ore and are treated in a new section called the “carbon-in-pulp plant”.

In order to dissolve gold with sodium cyanide solution, certain conditions both chemical and physical, must be observed. Chemically, it is necessary that oxygen be present in order to dissolve the gold. Lime is added to the sand as it is delivered to the leaching vats. Its function is to neutralize the acidity of the ore as acid destroys cyanide. Physically, it is important to separate the coarser granular sand particles from the extremely fine slime particles, because an excessive amount of the very fine slime in the sand charge would retard the downward percolation of the cyanide solution as it is introduced on top of the sand.

In the sand plants large vats are filled with the granular sand particles. The vats have canvas filter bottoms. There are 35 vats; some contain 750 tons of sand, others 780 tons. After a vat is filled with sand, most of the included water is drained off through the bottom. This draining is then followed by forcing compressed air upward through the sand. (Oxygen is necessary to accomplish the dissolving of the gold.) Cyanide solution is then added to the top of the sand. The solution dissolves the gold as it percolates uniformly downward through the sand. Four periods of drain, air and solution followed by a clear-water wash complete the cyanide treatment. The gold-bearing solutions pass through the canvas filters in the bottom of the vats and flow to further processing equipment.

Recovery of the gold from this cyanide solution is then made by adding a small amount of very fine zinc powder which precipitates the gold as a dark brown powder, and this product is filtered from the solution in
MILLS AND TREATMENT PLANTS are located above ground.
The Cyanidation Process, continued—a filter-press. The powder, known as the “precipitate” is then treated in the Refinery to produce pure gold. The weakened sodium-cyanide solution (with the gold removed) is saved, regenerated and re-used.

The sand, with the gold removed, is then washed out of the vats, collected in reservoirs and returned to the mine as needed to backfill mined-out areas.

For many years, the finer particles of the ore were treated in a separate plant, known as the “Slime Plant” in nearby Deadwood. In August 1973, a new process to treat the “slime” was instituted in and adjoining one of the sand treatment plants. In this process the gold is dissolved by cyanide by conventional methods in large agitation tanks, and then the gold is adsorbed from the solution by particles of granular activated carbon in suspension in the slurry or pulp. The term “adsorption” applies to a surface phenomenon in which gold ions are attracted to the surface of the carbon particles and held there by electrostatic forces. Carbon particles are then screened from the pulp and washed, and the gold stripped from the carbon with hot caustic cyanide solution, and then deposited by electrolysis on steel-wool cathodes. A gold sponge is formed with the steel wool which is then later converted to gold bullion in the Refinery.
GOLD-COVERED steel-wool cathode is being pulled from its electrolytic cell in the Carbon-in Pulp Plant. It will then be refined into gold bars.

AFTER REMOVAL of the gold, the sand is washed out of the vat and returned to the mine for backfilling.
Recovery continued—

**Refining**

Refining is the last of the many steps necessary to produce pure gold and some silver each year from over three billion pounds of tough hard ore that was mined, hoisted, crushed, ground and chemically treated. The Refinery is a small smelting plant containing various types of furnaces, electrolytic and other special equipment.

Here, free gold from the mill launders, precipitates from the sand treatment plants and the steel-wool gold-sponge are processed until pure gold and almost pure silver are the end results. When the three products begin their refining process they are mixed with suitable fluxes and smelted to remove impurities such as iron, zinc, and copper. The resulting gold is referred to as crude bullion. It contains silver and traces of iron, zinc, copper, etc. Further refining takes place when chlorine gas is blown into the molten crude bullion to separate the silver from the gold and flux is added to remove the last traces of impurities. The chlorine reacts with the silver to form silver chloride which is lighter than gold and floats to the surface. It is then removed by skimming. When all of the silver chloride has been removed the gold is poured into small bars weighing 17.14 pounds or 250 troy ounces. Each bar represents the final product of the total operation including mining, hoisting, crushing, grinding, and cyanidation of over 2,170,000 pounds of ore.

Some of the almost-pure bars are then refined to purity by a complex electrolytic process.

REFINERS at the “parting” furnaces ladling off foreign substances, leaving almost pure gold.
POURING an almost pure gold bar. Later it will go through further refining in an electrolytic process, as noted in the photo below. This "sponge" will be then poured into a 99.99 percent pure gold bar.
Recovery continued—

Assaying —

"Assaying" is the metallurgical term for determining the quantity of metal in an ore or alloy. Our Assay Section is an important arm of the geologists, engineers, miners, millmen, and refiners. Without the results of the hundreds of daily tests that are made, the entire operation would literally grind to a halt. In Homestake assaying then, the main purpose is to provide information necessary to proceed with exploration and development, and mining and milling.

For example in the search for new ore in the mine, rock cores from exploratory diamond drilling, after geological review, are sent to the Assay Section, as are rock samples from underground workings that are being developed. In addition, ore samples are regularly taken at each of the active working faces in the mine. Samples from the milling and chemical treatment processes, as well as from the refining itself are also regularly assayed.

Working in conjunction with the Assay Section is the Chemistry laboratory which does work of primarily an inorganic nature such as qualitative and quantitative analysis on various ores. Not only are chemicals made up here for use in the daily plant-control work of the Metallurgical Department, but specialized chemical reagents are also compounded. Analytical information is supplied to company departments pertaining to problems that occur therein. It too is an important arm that renders pertinent information to the entire company operation.

ELECTRIC-ASSAY FURNACES easily melt especially prepared samples which come from many sources, i.e., exploration, development, mining, milling, chemical treatment, refining, etc.

ANALYZATION OF METALS in solution is performed by this atomic absorption spectrophotometer.
YEAR'S ECONOMIC IMPACT

The Business Research Bureau of the School of Business, University of South Dakota, did the first-ever in-depth study to measure the impact of one year's operation of the Homestake Gold Mine on the economies of the Black Hills region and the State of South Dakota. It involved only the year 1973. The study revealed, among many other things, the result of that one year's payroll and the subsequent turn-over of those dollars to grocers, clothiers, car-dealers, etc. etc. (NOTE: The study did not include the payroll of Homestake Forest Products Company.)

Two study examples of many are:
1. The 1973 payroll generated expenditures of at least $93,807,000+ within the State of South Dakota;
2. That same payroll produced state sales taxes (based on 4 per cent) amounting to at least $773,300+.

These examples would show sizeable increases, if 1975 figures were used, because of three wage and salary increases.

The above amounts do not include what the Mine paid in local and state taxes, nor for purchases made by the Mine within South Dakota.

Obviously, then, the impressive annual flow of Mine payroll dollars, plus the sizeable expenditures made by the Company within the State for taxes, supplies and services, and dividends paid to in-state residents are of significant importance to the economic health of South Dakota!
Plant Engineering

In large-scale modern mining and milling operations, it is of utmost importance that efficient electrical and mechanical power be reliably provided; that all plants, machinery, equipment, tools and processes be maintained in perfect working order; and that new, adequate facilities be expertly and economically designed and installed as required by various company departments.

Thus, the Plant Engineering Division, comprised of the Construction and Engineering, Electrical and Mechanical Departments, plays a most important role in not only the day-to-day operations, but also in planning for the future.

Construction

The Construction Department provides work and services in the engineering, design and erection of new surface plant buildings and facilities. They also maintain and repair present plants; operate a heavy-equipment transportation system; supply water to the industry and the communities; and provide protective and housekeeping services throughout the surface operations.

Engineering

This section does all surface surveying, recording, and supervision of Company land and property in the Black Hills operational area. This includes mining properties, residential ground, farm lands, water-right lands and mining claims. The planning and design of new buildings and remodeling and additions to existing facilities all come from this section. Many special maps, graphs, and charts are prepared by section personnel.

Construction

Carpenters build or remodel various installations according to designs as furnished by Engineering. This work includes a variety of skills and jobs that modern-day construction demands.

A nucleus of masons is maintained for mixing, and finishing concrete. Their work also includes construction and maintenance of brickwork and insulation of steam boilers and steam lines; rebuilding of metal-heating and melting furnaces. They also maintain all plaster and stucco surfaces.

Painters do both new and repair painting. This includes the inside and outside of steel, concrete, and frame construction; plant structures and rental property. Prime painting of fabricated steel is usually done by this section. Glass repair, finishing and refinishing of furniture and all sizes and types of sign painting are also carried on.

Transportation

The dispatching and operation of vehicles, one-ton load capacity and over, is a function of the transportation section. Dirt moving, road-and-yard maintenance, including snow removal are also handled. Crane work in the light and medium ranges of weight is another of the various tasks undertaken by this section.
AS A TEAMMATE with the Electrical and Mechanical services, the Construction Department assists in providing a new mine air-exhaust passageway (above), in laying blocks for a plant addition, and in furnishing water for industrial and community needs.
Construction Department, continued—

**Water Supply**

The water section is responsible, with assistance of other sections, for the collection of both potable and unpotable water and distribution of it through surface water lines into and out of storage facilities. This includes the maintenance of many miles of pipe lines and fences outside of the communities. The main lines within the city limits of and connecting Lead, Terraville, Golden Gate, Central City, Blacktail, Pluma, and to the south end of Deadwood are all company owned and maintained. Maintenance and alterations of fire sprinkler systems are also taken care of by this crew.

**Special Services**

The special services section conducts fire watch over the surface plants and furnishes patrol and guard services on a round-the-clock, seven-day-week schedule. In Spearfish Canyon and its tributaries, they, together with Electrical Department personnel furnish patrols who watch for fire, abuse of company-provided free picnic sites and protect the forests, streams and private property in general. Custodians do the cleaning of all offices, company-used apartments, and large change rooms. Laborers are used to fill in shortages in the other departmental sections. They also assist with the unloading and storing of supplies for other departments, plus cleaning up company property, and removing snow from sidewalks, and many other necessary tasks.

**IN BEAUTEOUS SPEARFISH CANYON** the Company owns water rights and most of the mineral claims. Long-standing Homestake policy provides stream protection and free public use.
Electrical

Electricity is intimately associated with Homestake’s beginning, for both the telegraph system and telephone were in limited use in 1879 between offices and timber camps. It was 1888 before the first electric lighting was introduced with 16 lights of approximately 3.6 watts each hanging above the amalgam plates in the Star Mill.

The hoists, mills and auxiliary machines were all steam-powered until 1906 when the first electric motors were substituting for steam engines. By a quarter century later electricity had been applied to all industrial operations.

In the beginning, the first electricity was generated by a hydro-electric plant located at Englewood, a few miles to the south of Lead. At present the Company operates three hydro-electric generating stations with a potential capacity of 10,000 horsepower. These plants maintain a power load through the several seasons in keeping with the water supply, producing about one-third of the required power. Supplemental power is purchased from the local utility company.

Both surface and underground operations use hundreds of electric motors ranging in size from fractional up to 2,000 horsepower for a connected load of over 60,000 horsepower and an average load of 19,000 horsepower. More than 9,500 electric lamps of all types are used, many must burn 24 hours a day. The annual

MOTOR GENERATORS and control equipment at the Yates Shaft which convert electric alternating current to direct current for power source to the hoist motors.

energy consumption of more than 120 million kilowatt hours for light and power is sufficient to supply a number of South Dakota cities.

Some of the largest motors are in use on the hoisting machines operating at two vertical mine shafts,
These shafts extend from the surface of the earth to 5,000 feet. The hoists are operated by direct-current motors from fly-wheel motor-generator sets which convert electric alternating current to direct current. The huge, carefully balanced fly-wheels serve the purpose of equalizing the power demand by storing energy while the hoists are at rest and releasing energy while the hoists are raising ore, men or materials.

Two such hoists are at the Yates Shaft, two at the Ross Shaft and one at the No. 5 air-ventilation shaft. Other hoists, located underground at the Nos. 3, 4, 6 and 7 shafts also require large quantities of electric power. Milling, treating and refining the ore; pumping water from the mine; adequately ventilating the underground workings and fabricating, maintaining and repairing machines and equipment are all ravenous consumers of electricity.

The cages (which lower and hoist men, materials and supplies) and skips (which hoist the ore), run up and down in the mine shafts in much the same fashion as modern express elevators in city skyscrapers. They require elaborate and costly signal controls to assure accurate communication at all times between the cage operators and hoisting engineers. To this end the Company's Electrical Department undertook considerable experimental work in the 1930's, in an effort to simplify the older mechanical signal system which had long been used throughout the mining world. This older system, aside from its great cost, had always left much to be desired in that communication between cage and hoist could be carried out only when the cage was stopped thus lacking the primary requisite of being able to signal at any and all times. This experimental work resulted shortly thereafter in the installation of a better communication system.

By properly applying the science of electronics and using the hoisting cable as a carrier for the signals, it results in a practical communication system between the moving cage and the hoist operator. It is accomplished by transmitting radio waves along the hoisting cable to the hoistroom thence from specially designed radio transmitter-receiver units on the cage and hoist operator's platform.

For general communications throughout the Company, a complete, independent telephone system is maintained and operated. Lines and cables radiate, from a central switchboard with over 200 drops, to all the levels in the mine and to all the surface operations, hydro plants and pumping stations. This is supplemented with a complete FM radio mobile system with instruments in many trucks and other vehicles. The Homestake Forest Products Company also makes use of such a radio system in their logging operations in the northern Black Hills.

A 200-circuit automatic-dial system connects surface plants with offices as well as with the outside world. Closed circuit television is used to monitor the automatic unloading of broken ore as it is hoisted in both underground shafts and in those shafts in which that ore reaches the surface.

The vast electrical network, in addition to the special applications mentioned above, includes transmission and distribution lines, automatic and semi-automatic controls of all kinds, and safety devices, and operating mechanisms. Many of these are unique to the mining industry, and render important aid in the safe use and control of electrical and mechanical equipment. All in all, the electrical equipment in this enterprise represents an investment of many millions of dollars and the steady occupation of 60 employees.
HYDRO-ELECTRIC GENERATORS from three plants (such as the one above) provide a small portion of the growing power requirements. The additional needs are purchased from the local utility company. Dispatching the power (top right), repairing communications equipment (middle), and readying mine-locomotive storage-batteries are but a few of the Electrical Department's responsibilities.
Mechanical

All drilling into solid ore was done by hand from 1878 until 1900 when mechanical rock drills were first introduced. Yet machinery to hoist the mined ore and then mill it has always been an indispensable factor in the life of this property. The first power unit was a slide-unit, single-cylinder steam engine used in the first mill. It was closely followed in 1879 by a similar unit needed to power the first mine hoist.

Thus, mechanical engineering has played an important role throughout Homestake's history, and it continues to have four main functions: design, installation, operation and maintenance. These are the basic tasks for which the 170 Mechanical Department employees are responsible. For example, the magnitude of these tasks includes operating and maintaining innumerable pieces of mechanical equipment which have a total of more than 40,000 installed horsepower. More than 6,500 gallons of water per minute are handled by pumps in the mine and the pumps that deliver potable water to the plants and communities.

The operation and maintenance of the main hoisting units at the Yates and Ross Shafts are most important responsibilities. These hoists, classed among the world's largest, are fully equipped with proven safety devices and controls, and can hoist their 60,000 pound loads up the mile-deep shafts at express speeds.

VERSATILE MILLING MACHINE, operated with precision, cuts a set of gear teeth from solid steel.

Compressing more than 25,000 cubic feet of air per minute is accomplished in two main air-compressor plants. This air is then cooled and piped underground for distribution through hundreds of miles of airline to operate such widely scattered equipment as power-chute gates, safety gates, rock drills, air tuggers, power shovels, water pumps and locomotives. It is also used underground in blowpipes, explosives' loaders, raise-boring machines, and other devices.

Pulling approximately 900,000 cubic feet of used air per minute from the mine, day and night, requires large exhaust fans. In the deep, hot parts of the mine portable 30-ton and 60-ton spot coolers mounted on rails are used to maintain working conditions. Each 60-ton spot cooler is capable of air conditioning 30 average homes.
Mechanical, continued—

Most maintenance and repair is done in various well-equipped shops, with large pieces of equipment serviced in place. Some of the shops and their annual responsibilities are:

Slusher Repair: maintains 146 slushers (scrapers), 52 power shovels (front-end loaders), and 380 tuggers (small hoists).

Drill Sharpening Shop: grinds 250,000 carbide rock bits, 104,000 feet of reconditioned drill steel; handles 93,000 feet of new drill steel; reconditions 1,200 picks and 10,000 pinch bars.

Rope Shop: fabricates more than 15,000 special wire rope slings; dispenses more than 750,000 feet of wire rope; installs, inspects, and maintains more than 20 miles of main hoisting rope.

Railroad Car Shop: fabricates new underground man cars and other special cars; maintains the more than 2,000 cars of various kinds used in the mine and on the surface.

Auto Repair Shop: maintains over 150 autos, trucks, tractors, cranes, and other vehicles; and furnishes surface transportation for men and materials.

Locomotive Shop: maintains 53 electric locomotives, 4 electric trolleys and 17 air locomotives.

Cage and Skip Repair: builds and maintains 12 ore and rock skips, 5 small and 7 large men-and-material cages.

SHARPENING TUNGSTEN-CARBIDE drill bits requires special grinding equipment.

HUGE SHEARS cut steel plates up to ½-inch in thickness to required sizes.
TOUGH STEEL is made into precision parts in the Machine Shop. Everyday jobs include turning, boring, milling, grinding, planing and shaping.

Mechanical, continued—

Machine Shop: provides machine shop maintenance and repair to other crews; builds many special items of machinery and maintains 2 raise bore-machines, 4 drift "jumbo" drills, 22 stope "jumbo" drills; and a large amount of miscellaneous small equipment.

Blacksmith Shop: fabricates and-or salvages special mine equipment and supplies. Some yearly examples — 1,500 five and ten-foot steel ladders and brackets, 1,500 eyepins, 3,000 feather pins, 18,000 cable hitch-keys, 400 pairs railroad switch points and "frogs", 400 safety screens for raises.

Outside Maintenance Crew: installs and maintains all hoists, compressor pumps, fans, boilers, heating equipment, mill equipment, air conditioning equipment and plumbing facilities.

Hoist Operating Crew: operates the hoists to lower and raise men, material and equipment; and remove the ore and waste rock from the mine.

Crusher Crew: installs and maintains all skiploaders, crushers, screens and conveyors.

REPAIRING POWER SHOVELS is one of many jobs regularly performed by the Mechanical Department. Most such front-end loaders operate on rails. This is a crawler type.
Records and Supplies

Accounting —

All Homestake departments keep complex and voluminous records regarding production, economic information, technical and scientific projections, and much more. All of this recorded information is most necessary, for those charged with the responsibility of guiding any business venture (or parts thereof) must have accurate, complete, up-to-the-minute records readily available for constant study and control.

In addition to departmental records, “overall” records are also kept and made readily available for company auditors, independent auditors, and various state and federal government agencies. The one department that is responsible for these “overall” business records is the Accounting Department. This staff of professionally trained and highly skilled personnel receive invaluable assistance from amazing computers and their related auxiliary machines.

Supplying —

There is an old saying that “a military force travels on its stomach and fights on its provision of weapons and ammunition.” Likewise a large industry, such as this gold mine, needs many readily available items so that uninterrupted operation can be assured. These items range from massive machines of all kinds to the smallest of staples.

Thus, this operation relies on the Purchasing and Supply Department to purchase, receive, store and/or deliver the numerous vitally needed tools, machines, parts, equipment, and miscellaneous supplies so that this organization can continue to be an important contributor to South Dakota’s economic and social well-being.

UP-TO-THE-MINUTE methods, techniques and equipment (such as the above computers) are necessary not only in accounting procedures, but also in scientific and engineering endeavors.

JUST ONE ITEM of several thousands regularly used in the mining, milling and services operations is CEMENT. Thousands of dollars worth are purchased each year from the South Dakota State Cement Plant.
Employee and Community Relations

In the field of employee and community relations, Homestake has been a pioneer. For example, company-provided pension plans have been in effect since 1917; free medical services and employee-participating health and accident insurance plans since 1910.

Medical Services —

Homestake has maintained a Medical Department since 1879. Free medical care is furnished locally to certain regularly employed persons, their spouses, pensioners who retired directly from active employment, widowed spouses of deceased employees or pensioners, unmarried children 17 and under, and unmarried children age 18 to 23 who maintain residence with the employee or pensioner while attending a full-time accredited educational institution. This care consists of both clinical and hospital services rendered in the Lead-Deadwood communities and clinical services provided in Spearfish. No charges are made for out-patient clinical services rendered, or in-patient hospital services performed by the full-time staff of physicians, nurses, technicians, aides, etc.

Insurance Plans —

In 1910, the Company instituted an insurance fund which provides for certain payments in the event an employee becomes ill, is injured in an off-the-job accident, or dies from any cause. Both the Company and employees contribute to this plan.

In 1955, another insurance plan was added. The Company pays the complete cost of a Life Insurance and Accidental Death and Dismemberment policy which is provided every full-time employee.

In 1964, a Group Long-Term Disability insurance plan was instituted. This provides income to employees that are totally disabled because of illness, or on, or off-the-job injury. Employees and the Company both contribute to this plan.

In 1965, a Major Medical insurance plan was offered the employees and their dependents. The plan provides that a large percentage of certain covered medical expenses incurred at hospitals other than the hospital under contract by Homestake be paid by the insurance. The insurance premium costs are borne by Homestake.

Pension Plan —

Homestake recognized the need for retirement long before Social Security, and has had retirement plans ever since 1917. Since then, more than 900 employees have received pensions with all costs borne solely by Homestake. A new plan was instituted in 1949, and provided that all Homestake's contributions be placed in an irrevocable trust fund, so that retired employees would be guaranteed a pension even if the Company ceased operations. The plan was further changed in 1962 and further improvements have been made since that date.

Homestake Veterans Association —

This Association was formed in 1906. The organization is fraternal in character with membership based on a minimum of 21 years employment. There are now over 700 members. There is just reason to be proud of the organization and its purpose, for few industrial organizations have as large a percentage of long-term employees.
Safety —

A formal Safety Department was established in 1916 with a full-time director. Today there are six staff members, which indicates the importance placed on the employees' well-being.

The safety program now consists of four divisions: EDUCATION of personnel in mining procedures and safety applications with classes for new employees, also movies and lectures; continual INSPECTIONS of working areas, and monthly meetings to inform management; general COMMUNICATIONS to departments on safety data and accident control; PRESENTATIONS of awards and bonuses, and record keeping in all of these programs.

Sizeable numbers of employees are trained in mine rescue operations and participate in monthly drills. The Department staff works closely with the Mining Enforcement and Safety Administration, a Federal Government agency; and also with the South Dakota State Mine Inspector in separate training and inspections of the surface and underground workings.

The leading national publication devoted to safety concerning off-the-job activities of the entire family, is mailed to employees' homes at regular intervals.

Reduced frequency and severity of accidents over a period of years can be attributed, not only to improved technology, but also to improved safety attitudes. Because of this record, Company departments have continually received commendations from the National Safety Council that recognize their frequency and severity rates are considerably below the average for the U.S. mining industry as a whole.

Educational Programs —

An extensive four-year higher education scholarship program annually includes sons and daughters of active or retired employees, who may attend any college or university of their choice. A total of thirteen other scholarships are awarded annually to students at South Dakota's two engineering colleges. Twelve additional scholarships and awards are made to other South Dakota College students.

Assistance is also rendered the South Dakota Foundation of Private Colleges.

Community Programs —

The Company encourages, assists and participates in community enterprises, and supports regional and state organizations. Considerable assistance has been rendered to recreational clubs in softball, baseball, golfing, skiing, skating, hunting and fishing. A rustic building in Spearfish Canyon is Company maintained. Its facilities are free to organizations, such as fraternal, religious, educational, etc.

Free picnic areas along Spearfish Creek are provided and maintained for public use, and free fishing along this stream and free hunting on company timber lands are permitted.
Problems Peculiar to Gold Mining

Every business has its own peculiar problems. This is true for farmers, ranchers, manufacturers, storekeepers, and gold miners alike. Here at Homestake, there are both technical and economic problems that are entirely different from those encountered elsewhere. For example, one of the many technical problems is the continual search for ore.

Exploration —

As the mill hungrily grinds almost 4,400 tons of ore each day, the known reserves of ore diminish accordingly. To stay in business, they must be replaced. So, probing and searching for new ore goes on through constant exploration and deep-level development. Such exploration and deep-level development activities require a distinctly separate transportation system, with underground hoists and shafts that reach deeper and deeper, new tunnels and levels, more power, more water, more pumps — years of work! All this is preliminary to any actual mining of ore.

Rock Pressures —

Besides temperature increases, underground rock pressures also increase with depth. Some mines throughout the world have “rock bursts.” The rock literally “bursts” because of the extreme pressure. While we have not yet encountered “rock bursts,” the increasing rock pressures require more rock bolting, chain-link fencing, steel mats, and timbering to support these tremendous pressures.

Ventilation —

Although most people realize that scientists have established that the earth’s center is a molten mass, most of them are surprised to discover that the rocks in the earth’s crust get progressively warmer with depth. The rocks just below the surface of the earth at the mine site have a temperature of 44 degrees F. This temperature gradually increases until at 6,800 feet below the surface it is 120 degrees F., and over 130 degrees F. at 8,000 feet. Thus the air at that depth is also 130 degrees F. Not only that, the air is quite moisture laden. This occurs because much water is used throughout the mining operations and much of it evaporates into the air, thus increasing the air’s moisture content. Needless to say, the high, humid temperatures would make any kind of work extremely difficult, if not impossible.

It is therefore necessary to remove this hot, humid air and replace it with cool, dryer air. Homestake has always provided well-ventilated workings in the upper mine levels, and for more than a decade has been working diligently to properly ventilate the deeper levels. Several millions of dollars have already been thus spent and more such large expenditures continue to be regularly made.

The past ventilation program included sinking a 6,200-foot air-intake shaft; enlargement and replacement of older air-exhaust shafts and drifts; installation of 30-ton and 60-ton portable air-refrigeration units; addition of more auxiliary ventilating fans, vent tubes, etc. Also planned for future ventilation needs are more of the same. As it is today, 1976, almost 900,000 cubic feet of warm, used air is pulled from the mine every minute of the day and night; and an equivalent amount of fresh, cool air enters the workings through other openings.
Mining Costs —

Even if other cost items such as labor, taxes, materials, supplies, etc., remained constant, overall mining costs increase as mining goes deeper. These particular cost increases include the delivery of materials and supplies where needed; more time to get to and from the working places; more water pumping expense; more ventilation requirements; more rock-pressure support; more overhead for supervision and safety; and more underground shafts and levels with their necessary hoisting and haulage equipment.

GOLD SITUATION

On March 17, 1968 the two-tier gold system was established by agreement between Central Banks of the United States, Italy, England, Switzerland, Germany, Belgium and The Netherlands. Until that date, Homestake had sold its gold to only the U.S. Treasury Department as set by law. The Treasury Department then ceased buying gold from producers or selling to users, so the Company immediately sought customers who were legally entitled to manufacture and-or use gold. The price of gold immediately became governed by the unpredictable and fluctuating world market quotations. These market quotes have indeed been volatile, just as have market prices for livestock and other agricultural products.

Incidentally, on January 1, 1975 it became legal for American citizens to own pure gold, which right had been removed in January, 1934.

Mining and its related activities, by their very nature, have an impact on the environment. Minerals cannot be taken from beneath the earth’s surface and processed into usable items without affecting the immediate surroundings in one way or another.

In pioneer days throughout the U.S., it was customary to discharge raw sewage into rivers and streams. It was also accepted as the logical, reasonable and legal way not only for mining operations to dispose of waste products, but also for all industries and individuals to do likewise. Thus, this relatively minor pollution was accepted by society. So, both the raw sewage from the Lead-Deadwood area and that portion of Homestake’s mill tailings not returned to the mine for backfill were discharged into Whitewood Creek drainage.

What may have been considered reasonable practices for many decades are rightly no longer acceptable. For a considerable number of frustrating years, the Lead-Deadwood Sanitary District and Homestake cooperated on investigations of the sewage and tailings problems with several engineering studies made by reputable firms and subsequently reviewed at many public hearings. Almost all of the studies determined that the most economically feasible solution for all concerned was to jointly treat both the raw sewage and the mill tailings together.

In August, 1975, the South Dakota Department of Environmental Protection directed Homestake to independently solve the mill tailings problem. So engineering was immediately implemented, with construction of impoundment facilities programmed to start by mid-1976 on nearby Homestake-owned ground to the south of Lead. However, Homestake is continuing to cooperate with the Sanitary District and the communities with the raw sewage problems.
Homestake Forest Products Company

This wholly owned subsidiary with sawmilling headquarters at Spearfish, South Dakota sells lumber and timber products to the gold operation for use in mining and related activities. It also produces all types of finished lumber for commercial outlets, and ships pulpwood chips to manufacturers of paper products.

It was most fortunate that the Homestake ore body was discovered in an area surrounded by timber, thus providing a dependable supply of this indispensable material. The reports of Captain Reynolds in 1859 and of General Custer in 1874 described in part the extensive forested areas of Black Hills ponderosa pine. From its very beginning the lumbering operation has passed through many interesting phases. For a number of years it provided not only all necessary timber and lumber products, but also practically all fuel for heat and power, and thus represented a large percentage of the total mine operating costs.

In the beginning, the trees were selected for cutting according to sizes most suitable for hewing out mine timbers. After the trees were felled and the logs hand hewn on two sides to desired timber width and thickness, the remaining bark was peeled and the logs cut to length. Oversize logs were sometimes run through the saw mill and cut into lumber and square timber. Fuel cordwood was cut until 1907 when a gradual change was made to coal, followed in part by the introduction of hydro-electric power.

Old-time Lumbering —

One hundred years ago throughout America, people in general regarded the forests — like all other natural resources — as inexhaustible. As timber was plentiful, it was lavishly used without much thought, if any, given to the possibility of future yields. Man well knew that he could not preserve trees, but he was most negligent in going along with nature and protecting forests or growing new trees.

With the Black Hills gold developments in full swing in the 1880’s, timber was needed in great quantities for use in mines and mills, for fuel, for cabins, for businesses in the mining camps of Custer, Hill City, Lead, Deadwood, Keystone, Rockerville, Sheridan and others. So it was that cutting was indiscriminate and widespread. However, within a number of years it was apparent that some system was needed that would bring about protection from fires and wasteful methods of lumbering, as well as applying intelligent direction and control of the forests with their reproduction in mind.

Conservation Enters —

So it was that a movement to establish a Federal forest reserve to include all of the unappropriated public forest land in the Black Hills became successful. It culminated in the Black Hills Forest Reserve being set aside in 1897. On September 19, 1898 the reserve was put under administration and the Black Hills National Forest was born.

It enjoys the distinction of being the first in the United States where regulated cutting was done. The first sale of stumpage from any national forest, widely known as Case No. 1, was made that same year to Homestake, about 4 miles southwest of the present community of Nemo. Subsequent cutting was done under the supervision of trained foresters on the sustained yield basis, i.e., annual cut not allowed to exceed current growth in the forest. The Homestake Gold Mine and the subsidiary woods products company
both manage their own timberlands on the sustained yield basis. High cutting standards are maintained regardless of whether logging is on government, private or company land.

The danger of forest fires is acute during the dry season and full cooperation with governmental and private agencies is maintained, both in fire prevention and suppression. Likewise, the menace of insect infestation in the forests is actively combatted. Between 1895 and 1908 beetle infestation swept the Black Hills, destroying approximately 1.5 billion feet of timber. The beetle has resumed its deadly work three times since World War II. The company individually and cooperatively regularly wages vigorous campaigns against the beetle. However, at the time of publishing this booklet the infected trees were at near epidemic proportions, particularly in the northern Black Hills.

The Evolution of Timber Haulage —

Log and finished-product transportation began in the pioneer days of ox teams and horses, then narrow gauge railroads, early half-tracks, and finally arrived in the gasoline and diesel era. It is a long cry from the primitive oxen outfits skidding small logs through the woods to the modern tractors which operate throughout the year, regardless of grade, road or climatic conditions — moving tree-length logs from the woods to the landings. Hand in hand with the 10-ton tractors go the power winch and the arches or yarders, followed by the modern trailers.

Small crawler tractors drag the tree-length logs (maximum length 80 feet) from the woods into the open, with minimum damage to standing timber. A large crawler-type tractor equipped with a winch or revolving cable drum on the back and an arch coupled onto the draw bar, picks up the ends of several trees, previously gathered by the smaller woods crawler tractor and skids them to the woods landing. Powerful cranes then load the tree-length logs onto the multi-wheeled truck trailers, which transport their load direct to the sawmill, a distance of many miles from where the trees were felled in the woods.

POWERFUL HOISTING EQUIPMENT not only easily loads tree-length logs on the trailer, but also readily unloads the trailer after it returns to the woods having ridden “piggy-back” on the diesel powered truck.
The Sawmill —

The sawmill, and its allied operations, was remodelled beginning in 1974 and today provides a much larger volume of finished wood products for America's growing needs. These modern industrial improvements included a new planing mill and a new pollution-free boiler system which replaced the old smoky sawdust burner so common to lumber mills.

Sawmills have long known how to derive the maximum amount of lumber from a log. However, many years ago, up to 50 per cent of some logs went unused. Today these "waste" pieces at Homestake Forest Products Company's mill are processed into chips to be used in making paper products. Other unusable waste, such as bark, goes to the smoke-free boiler system for heating purposes.

The Essential Forest —

No question but that forests are vital not only to industry, such as mining, but also to each and every American personally. Experts say that each person uses the equivalent of a 100-foot tree annually. Buildings, paper products and thousands of other wood-fiber products come from the forests. Their esthetic value to mankind is immeasurable. They are a haven for wildlife, a protector of watersheds and an important manufacturer of life-giving oxygen. Furthermore, forest-related industries provide 1.7 million jobs.

Forests are not "automatic". More than ever, they require management, planning and conservation. Homestake Forest Products Company is indeed cognizant of the need to use and manage the forest wisely. This stable enterprise of over 150 people, readily recognizes that timber resource benefits are widespread, and with intelligent management these benefits will be available for many tomorrows.
Diversification

Uranium —

Homestake’s first step toward diversification began in 1953 when several uranium deposits were acquired on the northwest edge of the Wyoming Black Hills near Devil’s Tower. That same year, control was acquired of several promising uranium properties in the Big Indian Wash District, southeast of Moab, Utah. The first Wyoming deposits were mined by the open-cut method. One, near Carlisle, was finished within a year; the other ore body near New Haven lasted somewhat longer. In 1954, the Utah prospects were firmed up when all the capital stock of Little Beaver Mining Company and the LaSal Mining and Development Companies was acquired. The third venture in this district, the North Alice Mine, was acquired under a lease and option agreement.

Ore production in the Little Beaver and LaSal mines began in 1955. The Little Beaver was mined out by late 1957, and the LaSal ceased operations in the Autumn of 1964. Though neither of these properties were large, both were quite successful. The North Alice continued producing until December, 1971.

In 1956, negotiations were initiated that led to acquisition of rights to share in profits from mining and milling uranium from certain uranium deposits in the Ambrosia Lake area in New Mexico where the largest known reserves of ore in the United States had been found. Two partnerships, Homestake-New Mexico Partners and Homestake-Sapin Partners, were formed. Homestake, as general partner, financed the enterprises, directed development and operation of the mines; and designed, constructed and operated two mills.

During this same period, continued exploratory drilling on Wyoming uranium property near New Haven, revealed a substantial ore body. A shaft was sunk in late 1957 and the mine which began producing in 1958 was known as the Hauber, from the ranch on which it was situated. Ore from the Hauber mine was processed under a toll agreement with a custom mill in Edgemont, South Dakota. The quota was filled in December, 1966, when existing agreements with the custom mill terminated and the mine was closed.

In February, 1958, the first uranium ore was put through the Homestake-New Mexico Partners Mill. Full production was reached at the Homestake-Sapin Partners Mill that November. Both partnerships’ mines and mills operated separately until late 1961 when Sabre-Pinon Corporation (the partner in Homestake-Sapin Partners) acquired the interests of all but one of the participants (exclusive of Homestake) in Homestake-New Mexico Partners. Homestake and Sabre-Pinon (today known as United Nuclear Corporation) together purchased the interest of the remaining participants in Homestake-New Mexico Partners. What evolved subsequently was a new contract with the U.S. Atomic Energy Commission and integration of the two mills in June, 1962. The AEC’s stretch-out program accepted by the partnership in March, 1963, set production requirements for U₃O₈ (uranium oxide) through 1970.

In 1969, each partner at the invitation of the Atomic Energy Commission presented a proposal to be relieved of its obligation to deliver uranium U₃O₈ concentrate during calendar year 1970. The proposals were accepted.

Homestake has since contracted to sell its share of the uranium released by the AEC to the commercial market.
UNITED NUCLEAR-HOMESTAKE PARTNERS URANIUM MILL, about eight highway miles from Grants, New Mexico, has been processing ore and producing U3O8 (uranium oxide) since June 1958.
Exploration —

Following its successful move into uranium, Homestake took positive steps toward still further diversification.

Entering the 60's, the Company became involved in exploration in several western states as well as Australia, Canada, Chile, Libya, Peru, the Philippines and other islands in the Southwest Pacific. Two projects that were developed during this time but have since been sold included Port Costa Clay Products Company in California, and the Saskatchewan Canadian Potash property.

Exploration and development are remaining at high levels in the mid-1970's. As one example, the Company has an 85 per cent interest in lands with uranium potential known as the Pitch properties in western Colorado, and have been conducting studies to see if a producing mine is warranted. In South Dakota, west of Lead, Homestake and Taiga Gold, Inc., have formed a partnership and have been reopening the former Bald Mountain gold properties to determine the feasibility of bringing them into production.

Physical testing of an indicated ore horizon is usually done by drilling vertical, non-core drill holes that measure about four inches in diameter. These holes are drilled so they completely penetrate the favorable stratigraphic horizon. Samples are collected by the drillers at five-foot intervals. By examining these samples, geologists can create a cross-sectional geologic map showing the various rock types penetrated.

This typical drill-rig in the photo (right) was doing contract drilling for Homestake in southeastern Utah some years ago.
Lead - Zinc —

Homestake and American Metal Climax have developed jointly-owned lead-zinc ore bodies in the Buick area of southeast Missouri. The decision to proceed was based on exploration begun by Amax in 1959 and Homestake in 1961 which indicated ore reserves of sufficient magnitude and quality to justify bringing the ore bodies into production. Construction of the mine's concentrating Mill Plant began in 1965. Two eighteen-foot inside diameter shafts were subsequently sunk to the ore body. The service shaft is 1,350-feet deep and is used to transport men and equipment. The production shaft is 1,390-feet deep and is used to hoist crushed ore. The mine-mill plant began continuous operation in January, 1970. In addition to the mine-concentration plant complex, a lead smelter, the first to be built in the U.S. in 40 years was constructed. It went into operation in January, 1969. Known as Amax-Homestake Lead Tollers, the smelter plant is jointly owned by subsidiaries of Homestake and Amax, and has an annual capacity of 100,000 product tons.

This property is one of several such lead-zinc properties operated by neighboring companies on the western slope of the St. Francois portion of the Ozark Mountains, all located to a large extent in the Clark National Forest.

TWO IMPOSING STRUCTURES, one of which is in this photo at the right, are the concrete headframes that cover the vertical shafts at the Missouri lead-zinc mine and mill site.
THE MISSOURI LEAD SMELTER COMPLEX, located about 2½ miles from the mine site, is comprised of a sintering plant; sulphuric acid plant; blast furnaces; refinery and casting plant.
Silver - Lead —

Two other projects that were under study starting in the early '60's included a lead-silver prospect in Colorado and a copper-lead-zinc property in Peru.

A U.S. Geological Survey report indicated possible silver-lead ore occurrence in a vein structure located on the northwest edge of Creede, in the southwest Colorado mountains. So in the early 1960's, the property was leased from Bulldog Mountain, Incorporated who had started mineral exploration of the vein structures.

Early results from Homestake's diamond drilling were unsatisfactory, so it was decided to drive a tunnel into the mountain for further exploration and evaluation. In June, 1964, a tunnel was started at an elevation of 9,700 feet above sea level. Exploration on this level showed encouraging mineralization of silver sulfides, native silver and lead sulfides. However, the commercial value of the deposit had not been determined at this point, because the vertical extent of the ore zone was still unknown. Thus, a new tunnel 340 feet below the 9,700 Level was begun in August, 1966. Subsequent work on this level indicated that it was likely there was enough commercial ore to warrant building a small mill.

After extensive further studying of the ore, laboratory analysis, and pilot plant testing, it was decided to build such a mill. In July, 1969, a 300-ton per-day mill went into sustained operation. Though small, this property has been an excellent producer up to date.

THE BULLDOG MOUNTAIN silver mine and mill in Colorado overlooks the lush, beautiful valley formed by the Rio Grande River.
Copper - Lead - Zinc —

In 1963, Homestake joined with nine other partners in the Eastern Andes Exploration Syndicate to explore for minerals in the Andes Mountains of South America, Peru. South America is well-known as a land of high relief and rugged mountains, and the "prospects" were rather inaccessible. Thus, this required horses and burros to carry both people and supplies for many hours over torturous high-altitude trails. Subsequent exploration work was successful and an ore body of mixed copper, lead and zinc (with some silver) was found near the Peruvian town of Madrigal.

After long and complex negotiations, Homestake was chosen to place the property into production. Thus a limited partnership called Compania Minera del Madrigal (abbreviated CMDM) was set up, and a wholly owned subsidiary of Homestake was formed, named Compania Madrigal, to act as general managing partner.

By 1967, it was apparent the new ore body might contain one million tons of mineable ore and that the venture should be changed over from an exploration organization to a development and operating one.

In 1969, a complex contract between the partnership and the Peruvian government was signed, but a few months after it was signed, the elected government of Peru was overthrown and replaced by a military junta. After a period of uncertainty, it was determined that the new government would honor the contract, but intended to change the mining law drastically. At this point, Homestake was forced to stop sending money out of the U.S. by the Foreign Direct Investment Control Act passed during the Johnson Administration, and so had to stop advancing funds to the project. After long negotiations, CMDM secured a loan of $6,500,000 from a Japanese trading company and five-year contract for the sale of copper, lead and zinc sulphide concentrates to a Japanese smelting and refining company.

Mine development and mill construction began in 1970 and continued into early 1972. The mill was to be a 500-metric ton per-day flotation mill producing separate copper, lead and zinc sulphide concentrates. Development and construction presented many problems as the vein is located in a very remote and rugged part of the Andes at elevations approximating 13,000 feet above sea level.

By February of 1972, a 550 short-tons per-day flotation-mill had been constructed, and the mine equipped and developed. In addition, considerable housing, a diesel-electric plant, offices and maintenance facilities had also been built and equipped. Since April, 1972, the mine and mill have operated steadily at, or above, the designed tonnage rate.

The mill produces three different flotation concentrates — one of copper sulphides, one of lead sulphides and one of zinc sulphides. These are trucked separately from the mill to the railroad head at Sumbay (63 miles away) everyday. Here they are loaded onto gondola-type railroad cars, and shipped to the Pacific Coast port of Matarani. After shipments accumulate for about two months, they are then loaded and freighted to Japan for smelting and refining into pure metal, and subsequent resale.
HIGH IN PERU, this 550 short-tons per-day mill produces concentrates of sulphides of copper, lead and zinc.
Copper

In April, 1973, Homestake inaugurated the Homestake-Keweenaw project in Northern Michigan. This joint venture, which Homestake manages, is comprised of Homestake Copper Company (a wholly owned subsidiary of Homestake Mining Company with 60 per cent interest) and American Copper and Nickel Company (a wholly owned subsidiary of International Nickel Company, Inc.) with 40 per cent interest. The first phase of the project was to dewater the underground workings of the Centennial Mine. Dewatering was accomplished by using two skips equipped with hinged doors in the bottom called "clap" valves. Each skip brought up approximately 1,400 gallons each trip. A total of 53,000,000 gallons were bailed from the working areas in a three-month period.

As the water was removed, the shaft and underground workings were rehabilitated. Then extension of the shaft was begun. Initial plans call for sinking some 1,400 feet to the 45th level. At the end of 1975, the 44th level had been reached.

The pilot plant has been built at the mine site for purposes of determining the best means of concentrating the ores which may be developed.

THIS PILOT PLANT, placed in operation in mid-1975, will produce 6,000 tons of copper concentrates annually containing about 53 per cent copper.
Gold... the International Measure of Value

Dr. Donald H. McLaughlin gives his personal views in response to frequently-asked questions about gold. Dr. McLaughlin was formerly President and Chairman of Homestake Mining Company.

Dr. McLaughlin, gold has been a fascinating subject to people for centuries. How has its role changed in recent times?

Men have had gold and used it for millennia, but it was not until the exploration of the Americas that enough was found to serve its many uses properly. In the past century, gold has been available in adequate quantities both for the arts and for money when the need arose for a medium of exchange. There has been enough at nearly all times, but it still remained sufficiently scarce to be regarded as precious. Under the gold standard, it provided a firm base for the monetary system of the entire western world but in the course of the disasters that started in 1914, its function was gradually restricted as one nation after another resorted to inflation when the burden of war and excessive debts had to be met.

What is the basic role of gold today in the international monetary system?

Today, unfortunately, authoritarian money — fiat money — prevails throughout the world. Currencies are no longer redeemable in gold — or anything else for that matter — and must be accepted at least within national boundaries as legal tender. Nevertheless, gold still constitutes a substantial element of the reserves held by treasuries, central banks and international agencies such as the IMF. Gold is still recognized as the final means of settlement of international balances but the reluctance with which bankers part with it, when claims have to be met, reveals which element of reserves they regard as the best money. Gresham's Law seems to be still valid. (Bad money continues to drive good money out of circulation!)

Gold has always been thought of as an important index of a nation's wealth. Do you think this is true today?

Gold is an important index of the soundness of a nation's money. The degree to which money measures a nation's wealth is a more complicated question.

Gold has been a traditional hedge against currency inflation. If this is true, do devaluations increase the demand for gold?

Worried people do indeed turn to gold for protection against depreciation of a currency. When the discipline of the gold standard is respected and currencies are convertible into gold the money supply cannot be expanded indefinitely. If great deficits arise from overwhelming events such as wars for survival, the right to redeem currencies in gold is inevitably suspended or even abandoned completely as far as a specific form of currency is concerned and inflation results as the paper money supply grows in response to mounting claims. In such times, people would turn to gold if they were
allowed to. When this right — this protection — is denied, the money managers can meet deficits without restraint by creating more and more unredeemable paper money, thus bringing about a selective and most unfair confiscation of wealth through inflation. Confidence in gold is far more enduring than respect for fiat currencies. And when currencies are not convertible into gold, their official valuation in such terms becomes meaningless.

Do you see any fundamental change in the future role of gold?

Gold will surely persist as the basic monetary commodity of the world. The worrisome problem that now faces us is the restoration of a stable monetary system based on gold without going through a drastic liquidation of debt through hyperinflation or default, or possibly through both painful procedures.

What are the major factors affecting the price of gold? How is the price determined today?

To one who accepts gold as the basic monetary commodity of the world, the expression price of gold doesn’t make sense. If gold is a standard of measurement, prices should be stated in units of gold. But we are unfortunately less pure in our usage and keep referring to the price of gold in currencies of fluctuating value which these days means declining value. A “price” for gold in current dollars reflects a complex composite of demand arising from non-monetary uses for gold, from its service as a means of storing wealth and from its traditional acceptance as the world’s common monetary commodity. The demand is real and persistent, for it is based on the unique qualities of the metal — its resistance to corrosion, its beauty — as well as the expectation that its acceptance as money will persist. All in all, the demand, involved as it is with both material and psychological elements, endows gold with an inherent worth that is recognized by all men — except perhaps the chrysohobes in Washington. It is very real and enduring enough to persist through times of both prosperity and disaster. The worth of gold is really remarkably stable. It is the currencies that change in value or price, as confidence in them deteriorates as it does when they are irredeemable and subject to abuse. The so-called price, of course, does change as demand for gold in jewelry, for electronics and other uses is influenced by the state of the economy and by fears of loss through inflation as well as by uneasiness created by money managers who make threats to dispose of the gold in reserves. All these and many other factors — economic and emotional, but all real — influence the daily demand that is reflected in the prices quoted in centers such as Zurich, Paris, London and New York. Of course, the supply of gold is another factor influencing the market price. The output of the mines is fairly steady but with more than three quarters of it dependent on South Africa, policy decisions there with regard to sales by governmental agencies must also be taken into account. But, basically the value of gold is fairly steady and it is the behaviour of the currencies that is largely responsible for the changes in price expressed in such depreciating units.

In 1975, the holding of gold by private individuals again became legal. What effect do you think this will have on the gold market?
Removal of restrictions on ownership of gold by American citizens will, of course, enlarge the market demand for gold. If deficits and their financing through increasing the money supply are ended, and confidence regained in the business and banking world, the demand for gold by individuals should subside. If you do not expect that these desirable ends will be attained, you can look for a higher demand for gold with the right to own it restored.

Many people think of gold as a precious metal dug out of the ground only to be buried again in underground vaults. What are some of the important practical uses of gold today?

Most of the gold mined today goes into active uses apart from monetary stocks. So the old cliche that gold is dug from the mines only to be buried at Fort Knox makes no sense at all. The consumption of gold for non-monetary uses in the U.S.A. is close to four times the production of the domestic mines. The artistic uses still make the strongest demand, accounting for over 50 per cent of the domestic consumption. Recently, it has declined rather drastically, which probably reflects the depressed state of the economy. The relatively high price for gold may also tempt manufacturers of jewelry to resort to lower gold content in their wares — a practice not unlike that of monarchs in troubled times in the past when they debased their coinage. There is however, a growing demand for gold wherever reliability of electrical contacts and circuits is essential, where durability in corrosive environment (such as in human mouths) is required, where reflection of radiation at the hot end of the light spectrum is needed, and for other purposes where the unique properties of the metal can be effectively employed.

What industries are the largest users of gold?

The largest uses are for artistic, dental and electronic purposes.

Are there new uses promising to become important?

More and more research is being done on the properties of gold and uses for the metal are sure to develop. For example, the high reflectivity of gold for light at the red end of the spectrum makes it most useful for shielding against radiant heat and for reflectors of infra-red rays. In these days when conservation of energy is becoming so important, think what might be saved in air conditioning by employing very thin films of gold to reflect heat — or to concentrate the sun's ultra red rays, where the heat could be turned into mechanical power. As research progresses, gold is bound to find many applications in a world of increasingly sophisticated technology. Fortunately, gold can be dispersed in amazingly thin coatings or layers which makes many uses possible without requiring great quantities of metal.

Is the U.S. self-sufficient in gold?

No. We now import about 6 times as much as we produce.

Many people think of gold as coming from the mines as the large nuggets of gold rush days.
Is it true? How much gold do you actually get from a ton of ore?

Nuggets of gold are found in gravels and sands called placer deposits. The gold in them was derived from the erosion of solid rock containing the original deposits of gold in quartz veins and stringers or disseminated with various sulphides. Conspicuous gold now and then is found in very rich veins but such occurrences are rare. The major source of gold today is in the relatively thin beds of conglomerate — ancient gravel layers — that form the famous reefs of the Witwatersrand in South Africa. The gold in the reefs, however, has been reworked in the billions of years since it was deposited in these beds and today most of it is in fine particles not easily seen with the naked eye. At the Homestake Mine visible gold in the ore is rather uncommon. Most of it is in particles too fine to be detected even with a hand lens. A ton of ore has to be broken and crushed to a fine sand or pulp and treated to recover a quarter to a fifth of an ounce of gold. In some shallow deposits that can be mined in open pits, ore of much lower grade can be economically worked. The grade of ore sufficient for profitable operations, of course, depends not only on quantity of gold in it, but also on the cost of mining and treatment. Costs also vary with many factors, including size, shape and depth of the deposit, amenability to treatment, and a lot of other factors.

It has been said that all the gold mined between the time Columbus discovered America and 1967 would weigh about 70,000 tons. Is there a practical limit to the gold that can be mined; are there untapped resources in the world?

Gold is a heavy element. It’s specific gravity is 19.3, so that a cubic foot of gold weighs about 1200 pounds, (0.6 ton). All the gold mined since America was discovered — if 70,000 tons is acceptable as a reasonable figure — could be put in a cube 50 feet on a side. The gold now in the monetary reserves could be put in a block less than half this size. The yearly output of the Homestake Mine would only make a little cube of 2.6 feet. The total production from Homestake, however, some 32 million ounces, would fill a cube of 12 feet. New gold deposits will undoubtedly be discovered which will postpone the time of shortages as present reserves of ores are depleted. There is nothing known, however, of a magnitude that could replace the reefs in South Africa, and the chances of finding even another Sierra Nevada gold region, which led to the California gold rush more than a century ago, are rather slim. But prospecting will continue — and of course, will be stimulated when lower grade ores can be mined profitably. Prospectors and miners are always optimistic that they will find something new, and perhaps there may be some pleasant surprises ahead.

Since ancient times, gold has been regarded as the most precious metal in the arts and the commerce of the world. Do you think this will ever change?

Gold with its unique properties and many functions is surely going to hold its place in the arts and commerce of the world, as well as provide the enduring form of money that commands confidence at all times. And above all, gold is beautiful and precious. It is sure to retain its status as the noblest of metals.
GOLD IN SPACE . . .

in Industry . . .
in Medicine . . .
in the Arts.

As Dr. McLaughlin stated in the preceding article, gold is now playing an increasingly more important role in mankind's life than ever before; for it has also become a remarkable ingredient in modern history. This rapid industrial demand for gold has come because it is strong, extremely malleable and ductile, resistant to corrosion, impervious to all strong alkaline solutions and most acids; and has excellent conductivity and a high melting point. Experts predict that by the 1980's industrial uses will absorb all gold produced annually in the world.

In the aerospace industries gold alloys are used to braze the fuel injection manifold assemblies of jet engines where oxidation and corrosion cannot be tolerated. In high speed aircraft their laminated glass wind-screens contain a thin layer of gold, one-fifth of a millionth of an inch thick! One troy ounce is sufficient for a transparent sheet 100 feet
square, believe it or not! Furthermore, one troy ounce can be drawn into a continuous wire invisible to human sight, 35 miles long!

Dr. McLaughlin also pointed out that one of gold’s outstanding properties is its high reflectivity of light at the red side of the spectrum. Reflectivity is defined as the ratio of the intensity of light thrown back to that of the total incident light. It varies with the material in the reflector and the wavelength of the incident light. Thus, a completely reflecting surface would have a reflectivity of 100 per cent. The reflectivity of gold rises rapidly at about the center of the visual range which accounts for its attractive yellow color. The high reflectivity of gold extends into the far infrared where it exceeds 98 per cent. This quality makes it outstanding for shielding against infrared radiant heat. So an astronaut walks in space with perfect safety tethered to his space craft by a cord plated with gold to reflect that heat. A gold coating only 0.000004 inch thick helps protect men and equipment from the heat generated by rocket engines. The gold-coated heat shields of satellites and space craft reflecting almost all the sun’s heat are a great asset in tracking operations because of the strong reflection.

The Richfield Oil Building in Los Angeles, erected in 1929, had many thin gold-coated panels on its outer walls. By reflecting the sun it saved on air-conditioning costs and its untarnishability also cut cleaning costs. Gold remains untarnished for thousands of years. Gold recovered from the tombs of Egyptian Pharaohs or holds of sunken treasure ships is found to be as bright and shiny as new. This non-corrosive property is most important in the telephone industry where gold is used for repeaters in communication cables planted on the bottoms of the oceans. It also plates the transmitter electrode in telephones.

The computer industry relies heavily on gold. In fact the extensive electronics industry uses many printed circuits that are either alloyed gold or plated gold.

Gold has an outstanding record in both dentistry and medicine. In dentistry its use is very long standing. The first gold fillings, in the form of gold leaf were being implanted by the year 1450. For almost one-half century intra-muscular injections of soluble gold salts have been given in the treatment of rheumatoid arthritis. Injections of colloidal suspension of radio-active gold are used in the treatment of certain types of cancer. The fact that it is chemically inert has led to gold’s use in spare-part eye surgery.

Space herein does not permit listing the many, many other ways that are being developed for gold usage. However, gold has aroused much interest among chemists, metallurgists, physicists and scientists in general. They are regularly finding new uses for gold through programs of basic research, applied research and development for all possible areas of application. It is not beyond the realm of possibility that dramatic new uses for gold will turn out to be things that cannot even be visualized now.

<table>
<thead>
<tr>
<th>1 TROY OUNCE PURE GOLD WOULD BUY:</th>
<th>In Japan</th>
<th>In U.S.</th>
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<tr>
<td>1871</td>
<td>Yen 20.67</td>
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<td>1930</td>
<td>Yen 41.37</td>
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<td>1938</td>
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<td>Yen 12,441.39</td>
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<td>1967</td>
<td>Yen 12,441.39</td>
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<td>1968, March - Gold backing of dollar removed by U.S.</td>
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<td>Yen 53,653.20</td>
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Black Hills Gold Jewelry

Distinctive! Unique! Beautiful! Striking! Charming! All of these adjectives are rightfully used to describe the many pieces of famous jewelry that have been manufactured for many, many years in these Black Hills!

The basic design was handed down from the early Black Hills gold-rush days, when, legend says, a local early day jeweler developed and fashioned the grape-and-leaf design.

In addition to a number of widespread manufacturers of jewelry, industrial and space-age instruments, etc., we of Homestake furnish some gold to two Black Hills Gold Jewelry fabricators, one located in Deadwood and one in Rapid City.

These girls, both from those Black Hills gold jewelry manufacturing families, proudly display just a few of their distinctive gold items while holding a Homestake gold bar!

EIGHTEEN THOUSAND TONS of hard, tough ore had to be mined, crushed, ground and chemically treated to yield these nine gold bars (right) which are 99.99 percent pure. Their total weight is 3,600 troy ounces (over 246 1/2 pounds, avoirdupois).
monument
This impressive steel structure — THE YATES SHAFT HEADFRAME — rises boldly from a man-made mountain-top plateau, to reach over one hundred and fifty feet skyward.

Not only is this distinctive landmark a terminus for a vertical highway plunging 5,000 feet into the earth, but it also houses the powerful crushers which smash massive pieces of hard-won ore into small pebbles, ready for milling.

**to men**

Viewed from the deep gulches and pine-covered hills, this proud skyscraper stands as a monument to the grizzled prospectors of yesteryear, to the first practical mining men who had to base their decisions on the scant evidence of ore in a few scattered prospect holes, to the hardy miners who soon came, to all those who followed, and to the employees of today!

Indeed it has been our good fortune to have had, and to continue to have, an excellent work force of loyal, dedicated people. The teamwork between officers, operating staff and workers has been the key to our playing a century-old important part in the industrial growth and life of South Dakota and the Nation!

And, we also sincerely appreciate the support given us by our shareholders and our customers, whose contributions to American industry and the Free Enterprise System are most important!