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September 29, 1960

MEMORANDUM FOR: Mr. J. F. Frost

LYON DRILLING COMPANY

Mrs. Lyon called yesterday afternoon, apparently at the suggestion of Mr. Shea of The Anaconda Company. She stated that she is the owner of the Lyon Drilling Company, which has completed over 300,000 feet of core drilling at Butte for The Anaconda Company. She considers her organization capable of bidding on any project involving core drilling, and would appreciate being placed on our mailing list when such projects are being placed for bid.

She can be reached at either of two addresses. They are:

Lyon Drilling Company
Route 2, Box 99
Peoria, Arizona

or

Lyon Drilling Company
Box 722
Butte, Montana.

W. P. HEWITT

WPH:si

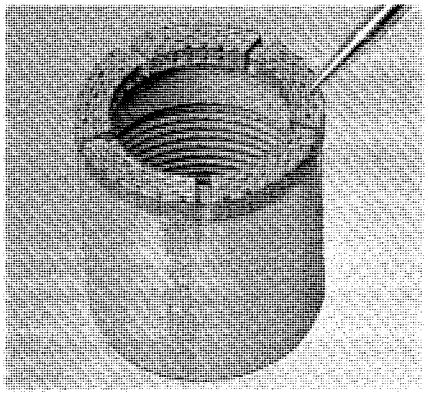
Longyear®

TOPICS

NUMBER 7

NEWS ABOUT PRODUCTS AND SERVICES FOR EXPLORATION

W. P. H. MAR - 1960



Diamonds in the Circle-Set bit are arranged in circular ridges indicated by pencil. Grooving action of diamonds set in such ridges helps create relatively large cuttings. The grit facing applied to this bit helps reduce the effects of abrasive rock.

Drillers Praise Performance Of Circle-Set Bits*

Exceptional performance of Longyear Circle-Set diamond bits are being reported by many users who have tried them.

A southern granite producer who tested them found that "Circle-Set bits performed wonderfully here."

A report from France said, "The brilliant results obtained up to now with the Circle-Set diamond bits let us have high hopes about the possibilities of this new product."

A midwestern construction company reported "excellent results with the Circle-Set bits we are trying."

The unique Circle-Set design (patented*) has diamonds set in concentric rings. Because it creates relatively large cuttings, and can get rid of them, this bit frequently penetrates faster with less pressure, and has longer bit life. Its crown shape helps minimize vibration in the string of tools.

The design is highly successful in many types of formations. First cost is low and salvage value is high.

**Patented in United States (U.S. Patent Nos. 2,662,738 and 2,729,427) and in Canada (Patent No. 538,118).*

Fully Equipped Rig Can Reach Remote Sites and Set Up Rapidly

♦ ♦ ♦

Reconnaissance Drilling Indicates Potential Source Of Paper Clay in Minnesota

Minnesota and Wisconsin paper mills soon may be able to get paper clay from Minnesota instead of shipping it in from far-away Georgia.

Longyear's preliminary investigation of clay property for Donovan and Ryan, St. Paul, indicates a sizable source of "ore" in Southern Minnesota. Samples tested by two laboratories indicate that the material contains white kaolin, suitable for paper clay.

In its investigation Longyear determined logical sites for reconnaissance drilling on the property, carried out this drilling, and submitted core samples to two testing laboratories. The results of all data,

Continued on Page 4

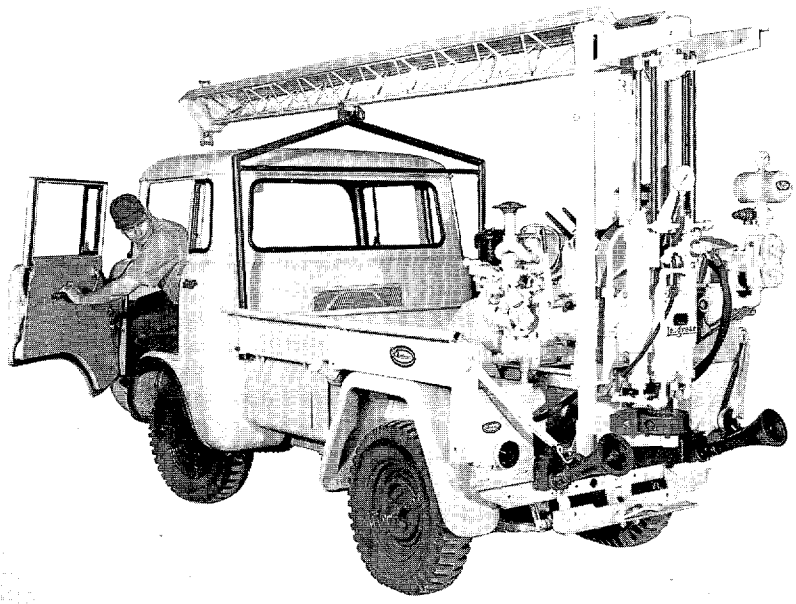
Of all types of industrial equipment, few have demands made on them as tough as those made on diamond core drills. These drills are often used in rough, mountainous country, have to be moved into areas where no roads or trails exist, and may be used in the open year around.

Whatever the conditions, few drills of its size will reach drill sites faster or drill as efficiently as the Longyear Jeep-Mounted "24" recently shipped to Greece. The cab-over-engine jeep has a four-wheel drive for getting into and out of areas that are hard to penetrate.

The "24" drill is equipped with an air-cooled gasoline engine (14 hp at 2200 rpm), hydraulic swivel head, drum hoist, and three speed transmission. The rugged truss-type steel mast for 10-foot pulls is raised by a hydraulic jack.

The cab is totally enclosed for

Continued on Page 4



With the mast down, this jeep-mounted "24" is ready for the move on to the next drill site.

AIR PHOTO INTERPRETATION HELPS LAY OUT 45 MILE ROAD THROUGH ALASKAN WILDERNESS

Longyear Maps Soil & Vegetation; Analyzes Road Problems

Between Willow Station and Talkeetna Station, Alaska, lies 45 miles of open, unsettled territory dotted and criss-crossed by lakes, streams, bogs and muskegs.

Last year the U. S. Bureau of Roads laid out plans for a road between these two points. The proposed route makes 26 stream crossings and frequently cuts across bogs and muskegs.

To anticipate—and avoid—any potentially serious problems in construction and maintenance of this road, the Bureau of Roads recognized the advantages of soils mapping by aerial photo interpretation. Longyear Photo Interpretation specialists subsequently produced maps from aerial photos of the 140-square-mile area (45 x 3¼), mapped and described soils and vegetation, and made nine recommendations for changes in the proposed route. *Savings in time and money on assignments of this kind are often one-fourth to a half of conventional methods.*

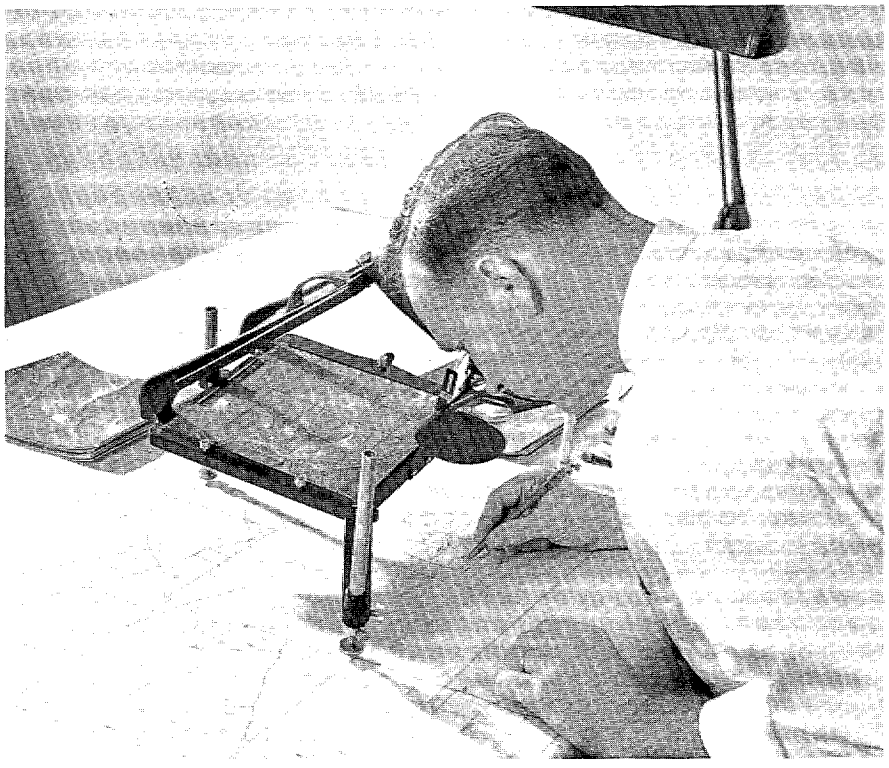
Engineering Report

The engineering report by Longyear answered questions on timber-clearance, subsoil conditions, kind and availability of aggregate, frost heave, perma-frost, seepage, bedrock, possible landslides, and other potential problems.

Using aerial photography by Mark Hurd Aerial Surveys, Inc., the prime contractor, the Longyear Photo Interpretation team produced one set of maps showing soils features and another set showing timber, brush, and other vegetational cover. The soil and vegetational features were discerned from overlapping aerial photos by stereoscopic study and portrayed on maps drawn to a scale of 1 inch equals 1000 feet. During the mapping, field checks were carried out to determine the reliability of terrain details as derived from photo-analysis.

Analysis of the maps by Longyear revealed facts on the general geology, bedrock, soil, and description and location of good aggregates which will be needed for road building. Permafrost was found to be absent. In spite of the large stream system, the area was described as not well drained and containing a number of lakes and muskegs. The study showed that landslides were not to be anticipated along the proposed route. Among 14 categories of vegetational cover shown on the maps, none presented difficult clearing problems.

Field checks by the photo interpretation teams are made to verify the accuracy of details obtained from air photos. Here soil is being examined in the area being analyzed for the road.



Transferring of details from air photos to the base map is accomplished with this optical instrument. This follows study of the overlapping photos with stereoscopic equipment to discern geological, soil and vegetational features.

Route Changes Proposed

After studying the area, Longyear engineers recommended nine changes in the route. Some of these shifted the road from bogs or muskeg onto well drained gravel terraces close by. One would permit easier bridging of a lake and avoid a possible seepage zone. Another would eliminate a stream crossing and shorten the section to be built in a bog. The length of highway to be built through muskeg at one location would be shortened by changing its direction slightly.

The complete report, including maps, was submitted to the Bureau of Roads in Juneau for further study.

Other applications of Longyear Photo Interpretation include (1) mineral exploration, (2) location of industrial sites, dams and bridges, (3) irrigation and conservation programs, (4) forestry studies and (5) routes for pipelines and railroads.

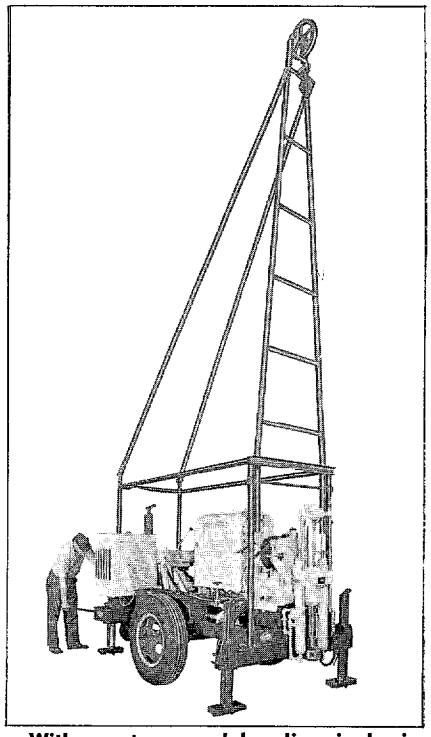
Trailer Rig for South America Has Diesel Powered Drill, Pump

A compact, trailer-mounted drill rig equipped with water-cooled diesel engines has been shipped to South America for a customer's Wire Line drilling program. The rig is perfectly balanced, making it easy to move in any terrain.

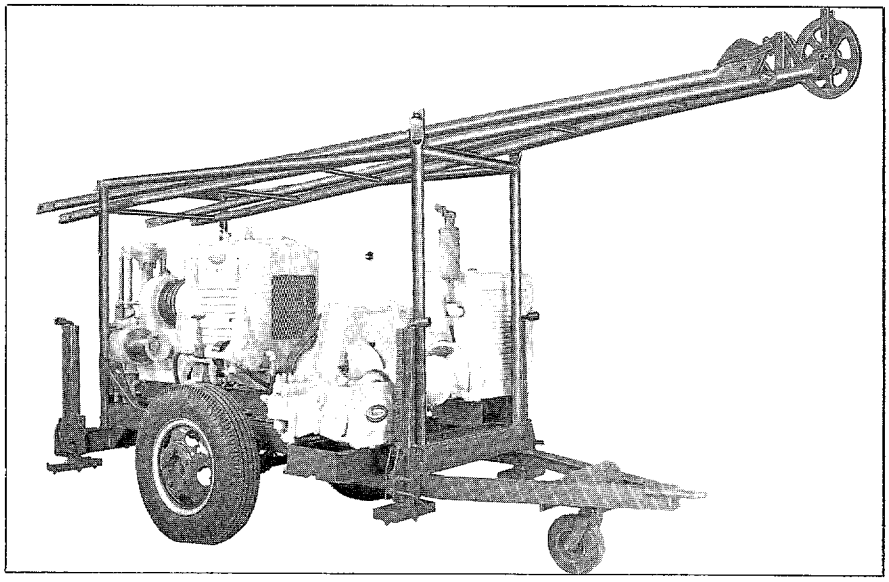
The Longyear Junior Straitline drill has a hydraulic swivel head, drum hoist, side-mounted cathead, and 4-speed transmission. The diesel engine is equipped with electric starting. This medium depth drill has capacity for 1350 feet of EW rod, 750 feet of NW rod.

An important part of the rig is its diesel-powered, 5-speed pump, a Longyear 535-RQ. By shifting gears of this variable-volume pumping unit, the operator can control output volume from 4.5 to 35 gpm. Therefore, he can employ closed-circuit pumping (not using a bypass) to increase bit life and core recovery. The pump engine also has electric starting.

The rig is also equipped with a Wire Line Hoist (for retrieving the core-bearing inner tube of the Wire Line Core Barrel), steel mast, and four rack-and-pinion leveling jacks.



With mast up and leveling jacks in position, the rig is ready for action. The mast has a second, smaller sheave wheel for the Wire Line cable, used to retrieve the core-bearing inner tube of the Wire Line Core Barrel.



The variable-volume 535-RQ pump shown on the right enables the drill runner to control pump output easily as pressure and volume requirements change. The Wire Line Hoist is shown in the center.

Drilling Indicates Source of Paper Clay in Minnesota

Continued from Page 1

including a surface map of drill hole locations, drilling logs, cross-section maps of overburden and clay-bearing material, and the laboratory results, were submitted in a report to Donovan, Inc., the managing partner of the joint venture. Longyear also submitted a tentative mining plan and an estimate of mining costs to help the client decide whether further exploration and development are justified.

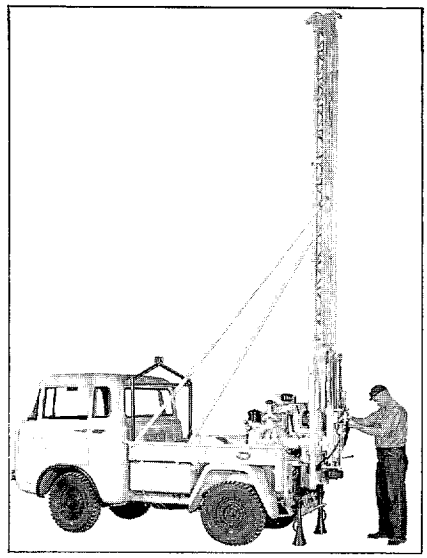
♦ ♦ ♦

Rig Can Reach Sites And Set Up Rapidly

Continued from Page 1

comfort of the drill crew. A Longyear "314" pump is mounted beside the Longyear "24" drill, leaving room for tools and other equipment in the truck and yet providing access to the pump.

Drill capacity is 750 feet with EW rods, 675 feet with AW. The Longyear "314" pump has a capacity of 14 gpm at pressures up to 300 psi.



A few minutes after reaching its destination, the Longyear "24" is ready to drill. Its heavy duty components and reserve power have made it popular the world over.

Longyear®

Printed in U.S.A. 11-19-59

E. J. LONGYEAR COMPANY
Minneapolis 2, Minnesota

CANADIAN LONGYEAR, LIMITED
North Bay, Ontario

LONGYEAR et Cie.
Paris, France

LONGYEAR N.V.
The Hague, Holland

Legend

Landform, estimated thickness and average composition.

Knobs, kettles and ridges. This landform has greatest relief in the area. Largely unsorted glacial till; 3% boulders, 9% cobbles, 44% gravel, 36% sand, 7% silt, some clay. Many tens and probably several hundreds of feet thick.

Irregular and subdued knobs, kettles, ridges and hummocks. Second in relief to HKR. Similar to HKR in composition and thickness (possibly fewer boulders and more silt).

Upland terraces, essentially smooth. Interbedded sand and gravel. Rare boulders, 3% cobbles, 27% gravel, 68% sand, some silt, minor clay. Up to 40 feet thick.

Lowland terraces, immediately above present flood and stream meander belt, some stream channel dissection, locally recently abandoned flood plain but not yet uplifted to form terrace-edge scarps. Interbedded sand and gravel. Rare boulders, 1% cobbles, 30% gravel, 68% sand, some silt, rare clay. Up to 5 or 10 feet thick.

Level-surfaced areas with kettles and kettle-like depressions and some minor ridges and troughs. Largely unsorted till similar in composition and thickness to HKR, except for local, thin, surficial deposits similar to LU.

Level-surfaced areas with some minor ridges and troughs. Similar to LRK in composition and thickness.

Level-surfaced areas with numerous kettles and kettle-like depressions. Similar to LRK in composition and thickness.

Areas with numerous sub-parallel to irregular low ridges. Similar to LRK but locally covered with an unusual thickness (several feet or more) of loess.

WATER FEATURES:

Lakes, open water, without swamp or floating vegetation.

Rivers and creeks. Most minor streams are perennial but some are undoubtedly intermittent; no differentiation practicable. Beaver dam and pond on lower left.

Muskegs. Much open water with swamp grasses and floating vegetation; in many cases could be called choked or swampy lakes.

Bogs, very little open water; water-saturated and thickly matted with moss, grasses and low brush; traversable on foot only with difficulty.

Esker-like ridges occurring on the Hilly group, the SR unit, or in proximity to them.

SCARPS:

Correlated terrace—edge scarps. Number 1 is topographically highest and occurs in northern part of the area. They decrease successively in elevation to the lowest, number 5, at the southern end of the area.

Uncorrelated scarps. Usually of lesser height than the above.

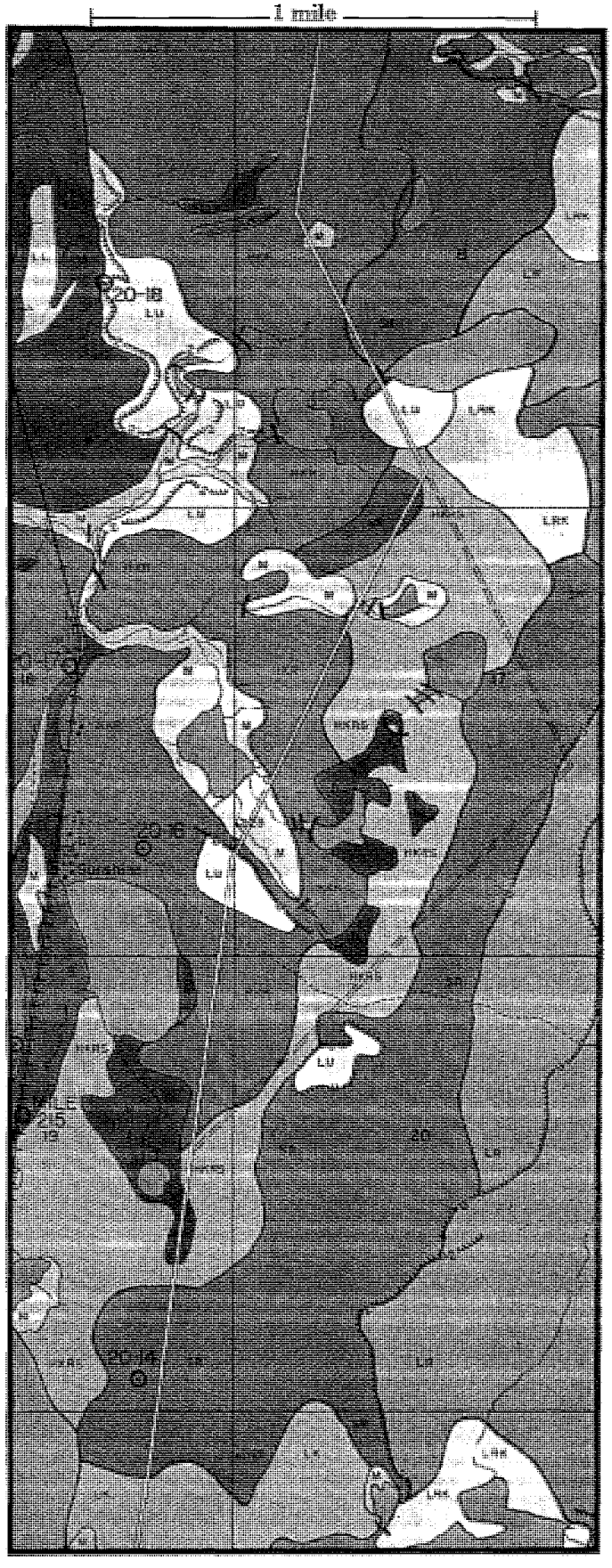
Road

Proposed road

Bridges

Irrigation ditch

Gravel pit and borrow pit



Railroad | Mile marker | Bench marks | Bldg. | Trail

This is a portion of one of the eight soils maps made by Longyear for the U. S. Bureau of Roads. The dotted line shows one of nine changes recommended in the route. This change would shift that portion of the highway to a better drained, more favorable location.

F. V. R.

MAY 2 1 1957

READ & ROUTE
WRL ✓
NW
JET ✓
JFP
AWN

RECEIVED

May 8, 1957

MAY 11 1957

WESTERN MINING DEPT.

F. V. R.

MAY 1 1 1957

Mr. John Lord
American Smelting and Refining Company
800 Continental Building
Salt Lake City 1, Utah

DIAMOND DRILLING PROBLEMS

Dear Mr. Lord:

Attached are copies of two letters addressed to Mr. L. R. Brownfield, pertaining to difficult drilling problems which have been encountered in work now being done in Northern Ontario. I thought that this information, which originates from experts in this field, might be of value to you and those with whom I worked for centuries.

One of the above-mentioned letters is from Mr. Robert Carter, Western Mining Engineer, on Drilling Operations for Sprague & Henwood, Inc. and the other is from Mr. T. J. Milewski, Manager, Contract Drill Building, Joy Manufacturing Company.

Very truly yours,

J. E. HOWT

W. R. L.
MAY 20 1957

cc: Publicard - A/M
Kohlberg
Kohlscheed A/M (all with attachments)
Pictorley "
JJCollins "
TFCiandaia "
SCenter "
JFKent

SPRAGUE & HENWOOD, INC.
P.O. Box 645
Grand Junction, Colo.

April 12, 1957

Mr. L. P. Entwistle
c/o Northern Peru Mining Corporation
Casilla 219
Lima, Peru

Dear Sir:

A copy of your letter dated March 27, 1957, addressed to Mr. L. W. Hart, American Smelting & Refining Company, concerning your drilling problems on Cochavara Drilling has been forwarded to this office by Mr. James A Ross of Sprague & Henwood, Inc. for reply.

You have inquired concerning the possibility of using a mud drilling fluid instead of water and from the information you have given in your letter we believe that a controlled mud drilling fluid would be of great benefit to you.

At present we are using such fluids on a drilling project for Bear Creek Mining Company at Eureka, Utah, where drilling conditions are somewhat similar to those you have described. We are using controlled mud fluids on other projects also and in every instance they have aided in overcoming many drilling problems. The benefits we have experienced are; greatly improved core recoveries, better hole conditions which has resulted in considerably less non-drilling time, and considerably less trouble with caving formation conditions. Drilling time in which hole progress is made has increased greatly because of less lost time from stuck tools, less reaming and casing, and less cementing time. In fact hole completion time using mud has been considerably less then when using water as the drilling fluid. As stated above increased core recoveries have given our customer much more information from holes drilled than previously was obtained using water and as we all realize this is the purpose for which holes are drilled.

In our operations we are using comparable equipment to that which you have in mind as indicated in your letter.

Our practice is to collar our holes with a 5 5/8" size tri-cone roller bit. This size is carried only so far as necessary to place a conductor pipe through loose surface materials or if the hole is collared in bedrock then for 3 or 4 feet. The collar conductor pipe is fitted with a "T" so that the drilling fluid may be returned to the mud pits or mud tanks.

The mud pits or mud tanks are usually of 500 gallon capacity or larger and often we use 2 pits. The larger capacity pits are better for settling cuttings from the drilling fluid. With more settling of cuttings we have less wear in our pumps.

We then continue the hole using a 4 1/4" size tri-cone roller bit, sometimes the 4 3/4" size may be used and occasionally at depth we reduce to a size of 3 7/8". We find that the 4 1/4" size is usually the best for penetration rate and bit life. We have found that using a smaller size than 4 1/4" reduces bit life because apparently the bearings in the smaller size roller bits are not sufficiently strong to give proper bit life.

The 4 1/4" size is carried to the depth at which a core is desired.

In this non-core drilling we have been using standard diamond drilling equipment. We normally use an "N" size rod. Sometimes we have used "BW" size rods and occasionally we have used "NW" rods. At other times where possible we use a "PK" size rod. The "PK" rod is the largest and heaviest and in roller bit service gives the best performance. It is accepted that with the heavier rod and more weight you obtain better penetration rates, better bit life, and straighter holes.

However, in our normal operation we use an "N" size rod. We have found it most advantageous to use drill collars above the bits or if drill collars are not available we run at least 30 feet and sometimes 50 or 60 feet of "PK" rods behind the bit before reducing to "N" rods. The remainder of the drill tools will be "N" rod size. It is of great advantage to have as much weight as possible near the bit and it is for this purpose that heavy drill collars are used when available. In a 4 1/4" size hole we will run 3 1/2" drill collars where possible behind the bit. We may run 2 or three of these collars. As stated above, instead of drill collars, we often will use PK rods.

In non-core drilling we will use either a mud pump or a Bean 435 pump. The capacity of the Bean 435 is 35 gallons per minute and the capacity of the mud pump is approximately 65 gallons per minute. The greater volume of fluid is helpful and better progress can be made with the larger capacity pump; however, we do use the smaller capacity pump very often because this is the standard pump which we use for core drilling and we find that for core drilling the 35 gpm pump is much more suitable than the mud pump. We believe that you would have very little success using a smaller capacity pump than a 35 gpm unit and we would suggest that if you have a larger capacity pump available that it be used for the non-core drilling.

After the hole is drilled to the depth at which core drilling is required, we then continue core drilling using either a large series 2 3/4" x 3 7/8" core barrel or an NX size core barrel. Where the large series core barrel is used we will continue the drilling without casing the hole if hole conditions will permit such practice and where we have been using drilling fluids we find that often we can continue without casing. If we continue core drilling NX size, we may case the hole off with NX casing and continue using an NX size core barrel and using drilling fluids.

We usually use a standard NX double tube core barrel for core drilling when using mud drilling fluids. We have used the NXM barrel for difficult core recovery conditions, but we find that we can use the NX

double tube core barrel with fairly heavy drilling muds and obtain very good results. At times we have used a mud barrel in which the core barrel is designed to carry very heavy drilling fluids and in a mud barrel the core cut is less in size than in a standard core barrel; that is in the NXmud type barrel a BX core will be recovered whereas with an NX standard barrel we recover a standard NX core.

The drilling mud used will vary from 35 second viscosity mud to a 50 second viscosity mud and usually the viscosity will be in the range of 45 seconds. The required mud viscosity will be determined by the hole conditions as will other properties of the drilling mud. It should be mentioned that the function of the drilling fluid is to carry cuttings from the hole, to prevent caving conditions in the hole, and in some cases to prevent washing of the core so that the percentage of core recovery may be increased.

To determine the proper drilling mud for any particular job and set of conditions we believe the services of a drilling mud engineer would be most helpful. There are so many factors involved which must be considered to determine the proper composition of the drilling fluid that the services of a mud engineer are almost essential to obtain the proper fluid for any particular set of conditions.

Our company recognized this need and we now have in our employ a mud engineer who determines the proper drilling mud for any particular job. We have numerous jobs scattered throughout a wide area and we find that each particular job requires a particular drilling fluid.

The determination of the proper drilling fluid for any particular job is made by this mud engineer. We have found that once the proper drilling fluid has been developed by the mud engineer then this fluid can be maintained by the field drilling personnel and periodic checks by the mud engineer are made to determine if a change in drilling fluid might be advantageous or if the proper drilling fluid is being maintained.

The major problem in mud drilling is lost circulation in the hole. When circulation is lost then it does create a problem. In our operations we try to restore circulation using special materials. We often find that we cannot restore circulation and when this is the condition we then continue drilling even though the cost of the drilling is greatly increased by the loss of the drilling fluid. At other times we may case the hole to eliminate the lost circulation but often when we do this we find that after casing and reducing the hole size, we drill only a few feet and lose circulation again.

The only problem we have in using standard diamond drilling equipment is when we have lost circulation problems. We find that when using the standard double tube core barrels we do not have enough clearance between the inner and outer barrel to permit the use of effective lost circulation materials. When the problem is serious we then use a mud type barrel which will permit the use of lost circulation materials and very often circulation can be restored by the use of these materials. However we find frequently, particularly in the Eureka, Utah

area, that in very large cavities it is impossible to restore circulation no matter what materials are used and in such instances we continue drilling even though we have no circulation return and we continue using a drilling mud.

To sum up the above, we believe that you can use the machines and equipment you now have available provided that the drill rods used are size 8 or larger and the pump to be used for non-core is of a 35 gpm capacity or larger.

We would recommend the use of size N or NW rods wherever possible but BX size holes can be drilled with B or BW size rods and satisfactory results obtained. We have drilled AX size holes using a thin drilling mud but we avoid reducing to this size wherever possible because the tools do not permit the use of the most suitable drilling fluid.

We would recommend that when you start any program involving the use of mud drilling fluids that you obtain the services of a mud engineer to develop the proper mud for your particular job. It might be mentioned that we have found that mud engineers who are experts in petroleum drilling often are not familiar with the problems of drilling small size holes in hard rock such as we experience in the mining industry. The mud engineer should be made aware of the problems involved in hard rock drilling and should attempt to develop a drilling fluid suitable for use with diamond drilling equipment. We have found in several instances that there is a tendency on mud engineers from the petroleum industry to suggest changes in the equipment to suit the drilling mud. This was one of the reasons why our company decided to employ a company mud engineer so that we might develop drilling fluids suitable for use with equipment such as used in hard rock drilling in the mining industry. The equipment which we in the mining industry use has been developed over many years and has been found to be the most suitable equipment for drilling hard rock formations for the least cost. It is therefore most important that any drilling fluid should be developed to use as much of this type of equipment as possible. If a change in drilling equipment is required, it will then very probably increase your costs so that the use of drilling fluid might not be advantageous.

In your letter you have stated that you want to drill the leached capping up to depths of 700 feet with some kind of bit other than diamond. We do not know if you have considered using compressed air but we do a lot of drilling using compressed air instead of water or drilling fluids and we have found that when you can drill the formations with a tri-cone roller bit and you do not have excessive ground moisture conditions that the use of air may sometimes be most advantageous. If we do the drilling with air, we normally then case off the zone which has been drilled with air and continue drilling using a mud drilling fluid.

This letter is rather lengthy but I hope that I have given you some useful information and that I have described our operations so that you might adapt some part of them to your particular operation.

If there is any further information which you may desire, we are most willing to help you in any way possible.

I trust that you find the above of interest.

Very truly yours,

SPRAGUE & HENWOOD, INC.

(Sgd) Robert R. Carver
Western Manager

RRC:jmt

cc: J. A. Ross
L. R. Hart
Scranton

Copied N.Y.Mining Dept. 5/8/57

Joy Manufacturing Company
900 Woodland Avenue

Michigan City, Indiana

April 10, 1957

AIR MAIL

Mr. L. P. Entwistle
Chief Geologist
Northern Peru Mining Corporation
Lima, Peru

Gentlemen:

We have been asked by your Mr. L. H. Hart of your New York office to write and give you our recommendations concerning mud and rock bit drilling on the Cochavara property as set forth in your letter of March 27th.

We note that you are contemplating on using a Hughes Type "G" core bit 4 3/4" OD by 2 1/4" ID with drilling mud or using a Hughes 3 7/8" non-coring bit to depths of 700 feet in a leached capping.

If you are not particularly interested in the cores from the leached capping, then we would recommend the use of 4 1/4" Hughes Tri-Cone rock bits. If however, you require cores then the "G" Hughes core bit should be used. It should be noted however, that in using the "G" bit a larger hole must be drilled, and this taxes the capacity of the drill and the pump.

The reason we have stipulated 4 1/4" Hughes Tri-Cone rock bits is because that particular bit has large bearings and stands up better than the 3 7/8" and also gives more room in the hole for easier setting of the NX casing.

We are assuming that the rock to be drilled can be cut economically with the "G" bit or Tri-Cone bits. If however, the rock is too hard and siliceous and requires considerable pressure on the bit for economical operation, then the drills that you now have would not be suitable for such drilling. Heavier pressures would require a larger drill, drill pipe and drill collars.

The Boyles #5-12 pump that you now have is of the small Simplex type and capable of handling only a light mixture of mud. It would appear to us that for efficient operation, a Duplex mud pump of the Wheatley 3 1/2 x 5 size should be used.

We would recommend the use of a 10 ft. drill collar about 3 1/2" in diameter weighing approximately 800 lbs. to which would be attached the

the Tri-Cone rock bit or "G" core barrel and bushed on the other end to the N drill rods. For a sturdy drill string, 100 ft. of PK drill rods could be used behind the drill collar or "G" core barrel and then bushed to N rods.

The Type 40-C Sprague & Henwood drill is not large enough for rock bit drilling or coring a 4 3/4" diameter hole with the "G" bit to depths of 700 ft. The rotating speed is too fast for rock bit drilling.

The Sprague & Henwood #138 with screwfeed swivelhead is large enough for this work, but it should be equipped with an N2 Hydraulic Oil Swivelhead for variable speeds and pressures. Screwfeed Swivelheads are not practical for rock bit drilling. The Joy 22-HD drill with N2 Hydraulic Swivelhead which you now have will be suitable for this rock bit drilling, as we use the same type of drill for rock bit drilling with mud on many of our contract jobs.

It would not be advisable to use larger than NX casing, as the above drills could not drill holes to depths of 700 ft. using 5 5/8" or 6 1/4" rock bits and setting 4" ID pipe.

It is not practical to use drilling mud with an NX single tube core barrel as there is not enough room between the core and the ID of the barrel for proper passage of the mud fluid. Better results could be obtained by using a double tube core barrel with a light mixture of mud, which we often use on our contract jobs.

As previously stated, the success of rock bit drilling or using the "G" bit is entirely dependent on the nature and hardness of the rock to be drilled. For an economical experiment, we would first recommend the use of the 4 1/4" Tri-Cone rock bits. If the rock cannot be cut economically with the Tri-Cone bit, then there would be no advantage in trying the "G" core bit and barrel, which we understand are quite expensive.

If we can be of any further help to you in connection with this particular matter, please do not hesitate to write us.

Yours very truly,

JOY MANUFACTURING COMPANY
(sgd) W. J. Pilaraki, Mgr. Contract Drill Division

WJP/et

cc: Mr. L.H. Hart
American Smelting & Refining Co.
New York, N. Y.

Copied N.Y. Mine Dept. 5/8/57

RECEIVED
APR 11 1957
WESTERN MINING DEPT.

AIRMAIL

New York, April 9, 1957

F. V. R.
APR 30 1957

MEMORANDUM FOR -

Messrs. LHHart
SIBowditch (2)
SRCarter
TPClendenin
JJCollins (2)
PIConley
GADirom

Messrs. LPEntwistle
DFKent
WRLandwehr
WSMcCullough
KERichard
KWhiting
LKWilson

J.F.F.
APR 30 1957

PACKSACK DIAMOND DRILLING

The attached memorandum by Messrs. R. B. Sprague and H. W. Pfeffer is a good summary of their experience in using the Packsack drill. This outfit evidently is useful under certain conditions for sampling near surface deposits. Since I believe the drill might be adapted to many exploration projects, particularly for preliminary sampling, I am distributing it to those in charge of our exploration offices.

C. P. POLLOCK

(all w/att.)

READ & RETURN			RLR		
WRL			NW		
			SLT	✓	ALT
RJL			JFF	✓	
SIB			AWN		

READ AND RETURN		
FVR	✓	
[illegible]		
[illegible]		
RJL		

W. R. L.
APR 11 1957

March 28th, 1957.

MEMORANDUM

Packsack Diamond Drilling

INTRODUCTION

The data in this memorandum are based on experience of Asarco Exploration Company personnel in the Lac de Renzy Area during the summer of 1956. Part way through the summer season, it was decided that a number of questions could best be answered by short diamond drill holes, and in view of the difficult terrain, the Packsack diamond drill was chosen for the purpose. Several groups of completely inexperienced men were employed at different times to run the drill. The men who had used the chain saw which has an identical motor, naturally showed up to considerable advantage. The geological personnel who instructed the drillers, had no previous experience with the Packsack Drill and no more than the ordinary knowledge of drilling that the geologist obtains by working around diamond drills. We did have the benefit of being able to observe a number of experienced men working with the equipment on adjacent properties.

We intend to try the Packsack Drill in sampling massive sulphide outcrops in areas of permafrost during the coming season, and we will prepare a memorandum on special problems that we may encounter.

SUMMARY

The packsack diamond drill was found to be a very handy tool under certain conditions. Its best use is where short holes up to 100 feet are required and where access to the drill site is not easy.

All the equipment can be carried by packboard wherever a man can walk. The machine is easy to operate by a two-man crew and a short training period is sufficient.

Holes drilled are 1-1/4" in diameter and the core is 3/4" diameter. Recovery is as good as for a standard "E" core machine. A good crew will drill from 20 to 50 feet in a shift. Water requirements are only one gallon per foot drilled under favourable conditions. The weight of all equipment depending on the quantity of casing, relay pumps, etc. will be from 300 to 700 pounds.

EQUIPMENT

The equipment used is marketed by Packsack Diamond Drills Limited, 1385 Hammond Street, North Bay, Ontario. The drill is powered by a Mall chain saw motor and it uses a transmission head built by Packsack Diamond Drills Limited.

The equipment, ready to operate and with sufficient rods to drill to a depth of 50 feet, is quoted at $850 f.o.b. North Bay. The shipping weight is approximately 300 lbs. However, this should be supplemented by a relay pump and a spare drill motor plus the attached list of spare parts, to maintain one drill working continually. The total cost in our case for this equipment, was $1,964.64, and the additional weight was probably in the range of 200 lbs.

The pump used with this is a Briggs and Stratton 5-S.

Everything is in units small enough to be readily transported on a pack frame but the equipment required to drill to a depth of 100 feet is too heavy to be carried by packboard in just two trips. Drill rods are the heaviest item and new aluminum alloy rods will be tried this year. A 5-foot rod of aluminum alloy weighs only 3 lbs. as against 9 lbs. for the standard steel rods. The manufacturer suggests that aluminum rods and steel rods be used alternately. This should reduce the weight for transportation and should also allow for drilling deeper holes as the weight of the string of drill rods which must be pulled by hand is one of the main limiting factors.

The size of the bit, core barrel and drill rods, is XRT giving a 3/4 inch core as compared with the 15/16" core when using EX sizes. The type and arrangement of the string of rods is identical to those used on larger stationary diamond drills. The rods are turned by the small chain saw motor and pressure to the drill string is applied by means of a "jo-bar" (this is a bar that is used as a lever by the drill helper to regulate the advance in drilling). The drill rod string is pulled by hand without any special type of equipment.

FUEL CONSUMPTION

The gasoline consumption for both the drill and the small pump is approximately 3 gallons per 8 hour shift. Oil is mixed with the gasoline which is used in the Mall motor. Unleaded gasoline is preferred but regular gas may be used. The larger pump which is used to bring water from some distance burns considerably more gasoline, however, it will commonly only be required for a few minutes to fill up some kind of relay tank near the small drill. Very light weight plastic pipe or fire hose is used with the large pump.

WATER REQUIREMENTS

Water requirements can be as low as one gallon per foot of hole drilled. Where water does not return the consumption is necessarily higher. A larger volume of water is needed for drilling-in casing. The small pump has a rated

lifting capacity of about 10 feet over a distance of 200 feet. Experience shows, however, that it is much better to keep this pump at approximately the same elevation as the collar of the hole and the nearer to the hole the better. Particular attention should be paid to keeping the pump intake above the sand and mud and to keep it from being obstructed in any way. We found from experience that this intake could be clogged simply by handling the screen after having handled rod grease. We used the Hale Type NP pump with a No. 6-S Briggs and Stratton motor, for long distance pumping. With a head of 100 feet, this has a capacity of 15 gallons per minute, which is, of course, much greater than is needed for the drilling. To conserve fuel, a sump of some kind was constructed at about the elevation of the collar of the hole, and the small pump was used from this sump.

BITS AND DIAMOND COST

A total of 1613.5 feet was drilled during the summer. The overall cost of bits, shells and casing shoes averaged $1.90 per foot of which 56¢ was direct diamond cost. Footage per bit varied to extremes from a high of about 80 feet to a low of 5 feet. The performance of different lots of bits from the same company and from different companies also varied greatly. A fair average for purposes of calculation of bit performance is about 20 feet per bit. Diamond recovery was around 60%.

REPAIR COSTS

The cost of all repairs including complete overhaul at the end of the season was less than $250. One machine although it was used more than the other, did not require nearly as much repair. It appears that the second machine had been damaged due to the carelessness of an operator probably by using gasoline without adding oil.

DRILLING PROCEDURE

Drilling Crews

We found the best system was to have a crew of two men who are interchangeable as drill runner and helper. Men who had used a chain saw could be trained in approximately 2 half days with an occasional later check-up. The three main points that had to be emphasized to the drillers were (1) keeping the chain of the jo-bar in line with the drill bar so as to maintain an even pressure and to avoid distortion of the rods, (2) being certain that water was entering the hole, and most important of all, (3) that core was placed in the trays correctly.

Drilling

Drill holes collared in outcrop are much the easiest. In this case, a hole is first drilled for the eye-bolt of the chain used in the jo-bar. The drill hole is collared six inches from this hole. The drill hole is started with the drill in a vertical position, and with the bit held against a foot, the rods are gradually inclined to the desired angle. Where the hole has been started by casing through overburden, it is often easiest to attach the jo-bar chain to a tree stump. In some cases, a hole for the plug may be drilled in a large boulder.

Casing may be put down with the Packsack drill. A depth of 15 or even 20 feet is about the limit of the power of the machine, especially if the overburden is sticky with clay. Sometimes we succeeded in drilling through a large boulder and then through more overburden before reaching bedrock, but at other times the boulder penetrated, would rotate and lock the casing in place. When drilling-in casing, easing the machine up and down and flushing with full water volume is a must.

LENGTH OF DRILL RUN

In good ground, it was often possible to join two or three 5-foot core barrels together and to make runs of up to fifteen feet before pulling. This is a great help in speeding up the job. It is also a good idea to have three or four two-foot core barrels and plenty of 2-foot rods to lengthen the string as the rods should not be pulled off the bottom when adding either rods or barrels.

RATE OF ADVANCE

With the machine operating well and with good rock conditions we were completing holes to a depth of 112 feet in two shifts. We paid a bonus of $0.80 per foot for any footage drilled over an average of 20 feet per working day in a two-week period. Under this system, the average footage drilled was 30 feet per day.

BLOCKING CORE

One of the most difficult features to learn in the use of the Packsack Drill is the proper blocking of core. There are no core springs in the barrel used in this type of drill and the core must be blocked by drilling dry for approximately 30 seconds. At first it was difficult to persuade the men to drill for 30 seconds without water as they had been warned of the consequences of dry drilling, but after a watch with a sweep second hand was employed, the results improved. With practice one could determine whether the core had been blocked or not by lifting the machines and the string of rods about 6 inches off bottom, and feeling whether it returned easily to bottom or whether it slid over

core which had slipped from the barrel. When core remains in the hole, it is recovered by fishing with a barrel to which a special core spring has been attached. Speed is increased if a separate barrel with the core catcher attached is kept ready for this purpose. We intend to try strings of aluminum rods for fishing as well, as one should be able to use them without breaking them down to 10-foot lengths when inserting or withdrawing from the hole.

CORE RECOVERY

In our experience, core recovery compared favorably with that achieved by a stationary diamond drill. Blocking and grinding are easily detected by the man who holds the drill in his hands.

INCLINED VERSUS VERTICAL HOLES

Experience showed that even moderately inclined holes are preferable to vertical holes. In vertical holes the rods tend to "whip".

/s/H. W. Pfeffer and R. B. Sprague

/rl

NY-4/9/57-cc: LHHart
SIBowditch (2)
SRCarter
TPClendenin
JJCollins (2)
PIConley
GADirom
LPEntwistle
DFKent
WRLandwehr
WSMcCullough
KERichard
KWhiting
LKWilson

READ AND RETURN

AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona

RECEIVED
AUG 30 1956
WESTERN MINING DEPT.

August 28, 1956

Mr. L. H. Hart, Chief Geologist
New York Office

F. V. R.
SEP 1 1956

ROTARY DRILLING IN EXPLORATION

Dear Sir:

Reference is made to your file memorandum of July 24, in which you give some interesting information on Anaconda's current program of sampling porphyry copper mineralization in Butte by rotary drilling.

Due to the lower cost and more particularly the high speed attained by Anaconda, we possibly should be considering this method in some of the exploration which we may have before us here in the southwest. A number of questions come to mind, and I am wondering if you could obtain the answers for us or put us in touch with someone in Anaconda's program who would be acquainted with these details:

1. I presume air-circulation is used, but is there ever occasion to revert to mud-circulation temporarily to prevent caving?

2. What air pressures and volumes are involved? What is the cross-section size of the drill column?

3. What bit pressures are necessary?

4. Anaconda's holes averaged 400' in depth. Could the holes have been drilled deeper with similar cost and speed?

5. Was any water contained in the rock drilled, either as moisture or as pronounced inflow? Is water in the rock a limiting factor either in advance of the hole or in obtaining accurate samples?

6. Do samples tend to be overweight due to a sand-blasting effect on the walls of the hole? (It would seem to me that this action could produce serious salting in those common instances where sulphides are associated either with the harder or with the softer zones.)

7. How are the samples collected? Would there possibly be different methods of collecting the samples for completely dry, moist or wet material?

Yours very truly,

KENYON RICHARD

W. R. L.
AUG 30 195

KR/ds
cc: WRLandwehr

SL-43.1

Fm 229 5m 10 55 90

COPY

American Smelting and Refining Company
Northwestern Mining Department
Wallace, Idaho

RECEIVED
DEC 12 1955
WESTERN MINING DEPT.

December 8, 1955

WRL | RJL | SJB | RL | NW | SCT | JFF | AWN

Mr. G. A. Dirom, Resident Engineer
American Smelting and Refining Company
425 Birks Building
718 Granville Street
Vancouver, B. C.

Dear Mr. Dirom:

I have a copy of Mr. Hall's letter to you of December 8 regarding the use of compressed air rather than water to clear diamond drill holes. This is the first indication I have had that any correspondence was being exchanged between your office and company personnel in other offices on this subject.

Please send me a copy of all letters on matters of this nature which you write.

Yours very truly,

ORIGINAL SIGNED
J. C. KIEFFER

JCK:GM

cc: AOHall
FVRichard

F. V. R.
DEC 12 1955

W. R. L.
DEC 12 1955

November 17, 1955

Mr. J hn G. Knaebel
Anaconda Copper Mining Company
Bluewater, New Mexico

Dear Jack:

Last December I received a letter from Ken Richard of our Tucson office, stating that you were trying out the Longyear Wireline Core Barrel in drilling an NX hole to obtain a BX core. If possible, I would like to get data on the results, particularly the type of material drilled, the depth of hole, core recovery, rate of drilling, and how this compares with similar results obtained with conventional methods.

I would like the information for friends of mine in the Philippines who are mining a porphyry-type copper deposit, and who are considering Longyear equipment for their exploration purposes.

With best regards to both you and Joy, I am

Very truly yours,

W. R. Landwehr

WRL:si

Mining Hydrology Problems in the Birmingham Red Iron Ore District

by Thomas A. Simpson

D.D. file

January 11, 1955

REMARKS ON LONGYEAR FORMULA

1. The apportioning of the weight to be given core and sludge in determining the average metal content assumes that the metal content is not uniform.

2. If the metal content is not uniform then the weight given the core and sludge recovered should be in proportion to the respective amounts recovered, provided the sum of the two is equal to the amount of material representing the theoretical volume of the hole.

3. If the amount of sludge recovered varies from the theoretical amount, an error is introduced - due to (1).

4. The Longyear formula disregards any variation in sludge recovery from the theoretical and, therefore, is in error due to (3).

5. The Longyear formula minimizes salting. Theoretically salting can only take place by the extraction of material from the walls produced by the bit. The material plucked may be above or below the average grade in metal content. In either case the effect of salting upon the sludge will be greater than upon the recovered core because of the difference in the area of the contributing surfaces. The core is salted by a surface determined by its circumference. The sludge is salted by two surfaces, that determined by the circumference of the core, and that determined by the circumference of the hole. As the latter is the greater, the degree of salting of the sludge is proportionately the greater. In addition, the sludge is further salted by caving from the wall of the entire hole.

6. As the degree of salting of the sludge is greater than that of the core, the greater the percentage of core recovery the greater the weight that should be given it in determining the average metal content.

7. The practice of apportioning the weight to be given core and sludge according to the amounts recovered disregards the salting of the sludge as described in (5).

W. R. LANDWEHR

D.D. file
[illegible]

January 11, 1955

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W. R. LANDWEHR

AMERICAN SMELTING AND REFINING COMPANY
MINING DEPARTMENT
120 BROADWAY, NEW YORK 5

RECEIVED
DEC 17 1954
WESTERN MINING DEPT.

C. P. POLLOCK
EXPLORATION MANAGER

December 15, 1954.

Air Mail

Mr. W. R. Landwehr,
American Smelting and Refining Company,
600 Pacific National Life Building,
Salt Lake City, Utah.

Dear Sir:

The descriptions of Longyear's wireline core barrel by Mr. Kenyon Richard and Mr. Byron S. Hardie, enclosed with your letter of December 9th, are very interesting. Longyear may have something here of practical value. I agree with you that you should ask these people to submit bids on the Red Hills or some other project to see how their costs compare with conventional methods.

Yours very truly,

C. P. Pollock

cc FVRichard A/M
TASnedden A/M
KenyonRichard A/M

W. R. L.
DEC 17 1954

READ AND RETURN

FVR	✓	
STB		
DWJ		
RJL		

WESTERN MINING DEPARTMENT
Salt Lake City, Utah

December 9, 1954

AIR MAIL

Mr. C. P. Pollock, Exploration Manager
American Smelting and Refining Company
120 Broadway
New York 5, New York

LONGYEAR WIRELINE
Core Barrel

Dear Sir:

Herewith is a copy of Mr. Richard's letter of December 8, transmitting a copy of Mr. Hardie's memorandum of November 1 on the results obtained at Chino by the use of the Longyear Wireline Corebarrel.

If possible, we should try this method of drilling on one of our projects, such as Red Hills, to determine whether or not the increased core recovery can be consistently obtained.

Very truly yours,

W. R. Landwehr

WRL:si
cc:KERichard

5

T-1.3.1

RECEIVED DEC 9 1954

AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona

December 8, 1954

WESTERN MINING DEPT.

Mr. W. R. Landwehr, Chief Geologist
Western Mining Department
American Smelting and Refining Company
Salt Lake City Office

S. I. B.

R. J. L.

W. R. L.
DEC 9 1954

READ AND RETURN

FVR	✓	
SIB	✓	✓
LWL	✓	
RJL	✓	
	✓	WPH-12/9/54

SLT ✓ NJ

LONGYEAR WIRELINE
Core Barrel

Dear Sir:

Attached is copy of a File Memorandum with two pages of pictures on the Longyear Wireline Corebarrel by Mr. Hardie.

Since Mr. Hardie wrote his Memorandum, I have talked with Messrs. Maillot and Hope of Phelps-Dodge and with A. F. Pickard, Field Superintendent, who developed the Wireline Corebarrel for Longyear.

Maillot and Hope more-or-less confirmed Luelf's figures inasmuch as they said core recovery and speed were excellent. However, the total footage drilled has been about 10,000' instead of Luelf's 43,600'.

Pickard stated that the Wireline equipment is no better than conventional equipment for depths less than 300'.

From conversations with drill contractors and others it is apparent that one of the particular advantages of this equipment is that due to their large diameter, the rods tend to support the hole walls, and disturbance of the walls by the frequent "round trips" of conventional rods and barrels is largely eliminated.

The chief disadvantage is the small core size. However, it seems to me that in the case of drilling disseminated mineralization where a continuous sample is desired, an AX core of plus-95% recovery would be a more accurate sample than NX with, say, 75% core recovery. Longyear is now making 4 experimental Wireline outfits which will drill an NX hole and obtain a BX core. These 4 outfits will be used by Anaconda in the Grants area, New Mexico. This size, or even larger, would probably be an improvement over the present AX Wireline core for porphyry copper sampling.

Another disadvantage is that the Wireline equipment is not well adapted to mud-circulation. I understand that clearances are not adequate and that the threads of the rods wear rapidly if mud instead of water is used during drilling.

Although the Wireline set-up uses the same swivel barrel that is used with standard drill rods, core recovery is much improved over the latter. This is accounted for by two factors: (1) With standard equipment the average driller will force the drill as long as he can make progress after a "block" has occurred. He does this in order to avoid the labor of pulling the rods. Due to the water

T-1.3.1
Dec. 8, 1954

Mr. W. R. Landwehr

shut-off arrangement and to the ease of removing the core, the Wireline equipment greatly reduces this psychological hurdle. (2) The Wireline bit has a stair-step design which, it is claimed, may tend to lock the bit in the bottom of the hole and prevent the side-whip which sometimes causes core breakage with ordinary bits.

If this Wireline equipment can consistently obtain plus-95% core recovery, it merits consideration as an improvement over churn drilling in the measurement as well as in the preliminary exploration of deposits of disseminated mineralization in which a continuously accurate sample is of first importance.

Yours very truly,

Kenyon Richard

KENYON RICHARD

KR:ar

Attachment: Mr. Hardie's Memo with 2 pages of pictures.
2 Longyear circulars.

cc: WRLandwehr - 1 extra with attachment.

AMERICAN SMELTING AND REFINING COMPANY
Vanadium New Mexico

November 1, 1954

FILE MEMORANDUM

DIAMOND DRILLING
Longyear Wireline Corebarrel
at
Chino Pit, Santa Rita, New Mex.

Last week I talked with Ray L. Luelf, E. J. Longyear Company representative, about the new wireline corebarrel that his Company placed on the market in January of this year. Mr. Luelf had just demonstrated the use of the corebarrel and accessory equipment recently purchased by Kennecott Copper Corporation and now in use at the Chino Pit. The principal advantage of the wireline corebarrel is the removal of the innertube with core through the drill casing without raising the corebarrel. This unique operation is performed with the use of a Longyear patented locking head on the innertube and a lifting device that is lowered through the drill casing with a wire line.

The only corebarrel size available at this time recovers an AX size core (1 1/6 inch diam.) from a BX hole. BX size drill casing is used instead of BX rods to allow the AX innertube to pass through the casing. Longyear makes the special BX bit that drills AX core. The corebarrel and innertube are standard except for the locking head and barrel seat. According to Mr. Luelf, Longyear is currently developing an NX wireline core barrel that will recover a BX core. The use of a ball-bearing swivel type head on the innertube and a water shut-off valve aid in core recovery.

Mr. Luelf gave me the following figures on Longyear's 50,000 foot drilling contract with Phelps Dodge at Bisbee, Arizona using the wireline corebarrel:

Drill footage	Core Rec. %	Ave. footage per drill shift	Depth of holes - ft.
43,600	98.7	43.7	1400 to 1800

This drilling has been without casing or cementing as no sludge is recovered. Previous drilling results in comparable ground with standard equipment are stated by Mr. Luelf to be from four to six feet per drill shift with 20% core recovery using casing and cement to aid in sludge recovery.

The attached pictures show the equipment in use at Kennecott's Chino Pit. Two of the wireline innertubes are used at the drill to cut down on time lost removing core. A Longyear wireline hoist driven by a 7½ h. p. gasoline motor hoists the innertube with core through the BX drill casing at about 130 ft./min. The empty innertube with locking head is lowered to the bottom of the hole by dropping it through the water-filled casing. The innertube descends in the vertical hole at about 180 ft./min. and has sufficient inertia to lock it within the corebarrel at the bottom of the hole. When a dry hole is drilled, a special device allows a

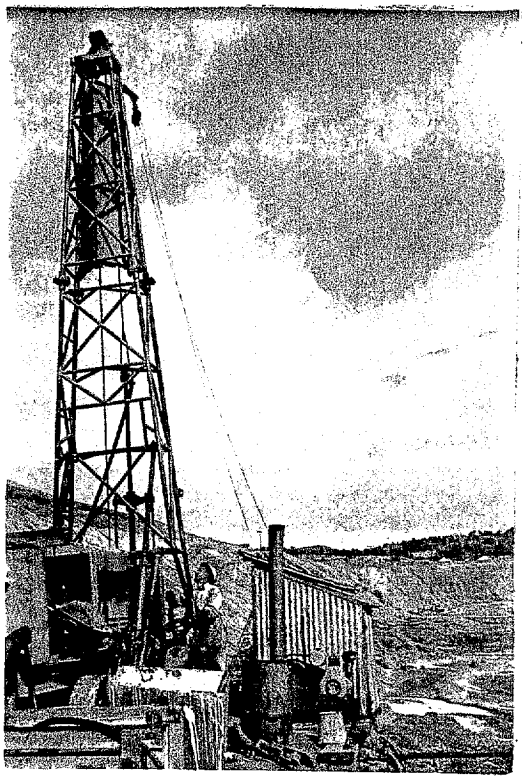
File Memorandum

free fall of the innertube through the drill casing at a safe rate of speed. The innertube will descend into a locked position by gravity in holes as flat as 40 degrees below the horizontal.

The core picture is from Diamond Drill Hole 1258 on the west edge of the Chino Pit. This is the first hole in which the new wireline core barrel has been used at Santa Rita. The core recovery to a depth of 420 feet is about 88% in altered granodiorite dikes and diorite, decomposed limestone and magnetite-pyrite-chalcopyrite mineralization. At a depth of 420 feet, the core was composed of about 30% magnetite with pyrite and some chalcopyrite in limestone and diorite gouge. In this material a recovery of 100% was observed by Mr. Desvaux and me. Some of this core disintegrated when lifted from the core tray. Drilling costs are reported to have been less than half on this hole compared to an adjacent hole being drilled in similar ground with standard equipment. Increased bit footage and drilling speed are expected when a special drill head to handle the BX drill casing replaces the standard drill head being used on the U. G. Straightline Longyear drill. This will allow removal of the innertube without breaking the rods or casing and swinging the head away from the hole as is now being done. This operation involves lifting the bit slightly off the bottom of the hole, allowing cuttings to drop under the bit. No casing has been used in the hole being drilled with the wireline corebarrel since no sludge is recovered. Also the walls of the hole are strengthened by aquajell. The drill rods are pulled only when a worn-out bit must be replaced, reducing disturbance of the walls to a minimum.

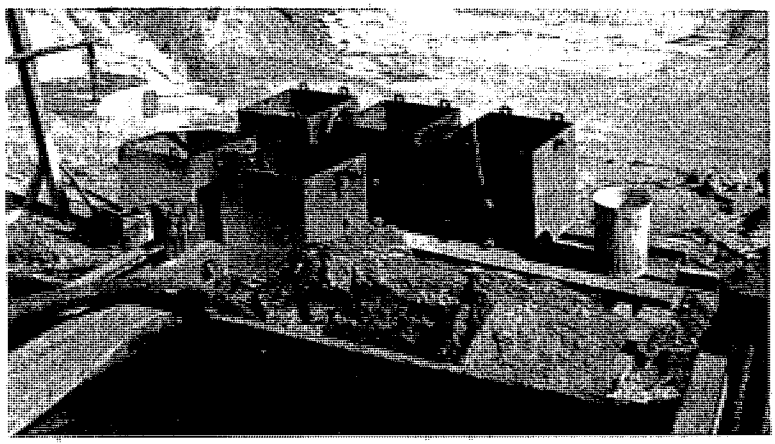
BSH:ar

Byron S. Hardie

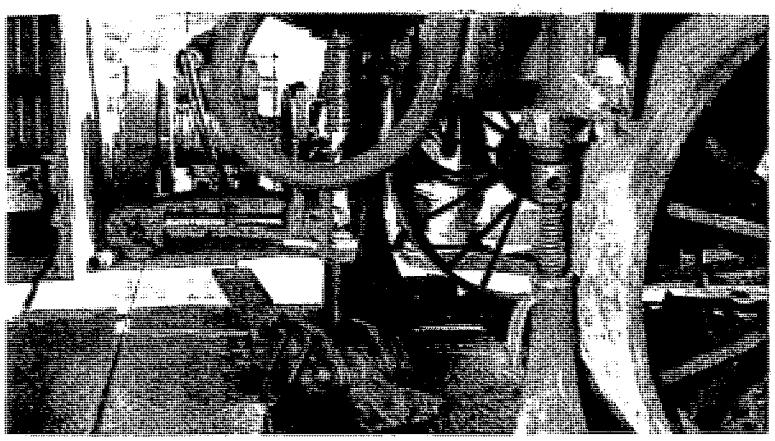


Longyear U.G. Straitline Diamond Drill and wireline hoist on D.D.H. 1258, Chino pit, Santa Rita, New Mexico

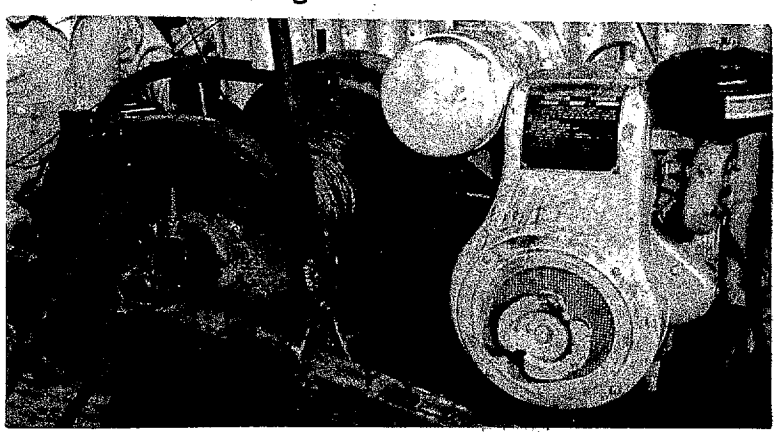
West end of Chino pit showing location of D.D.H. 1258



Sludge boxes not yet used on Hole 1258 at 420 ft. depth



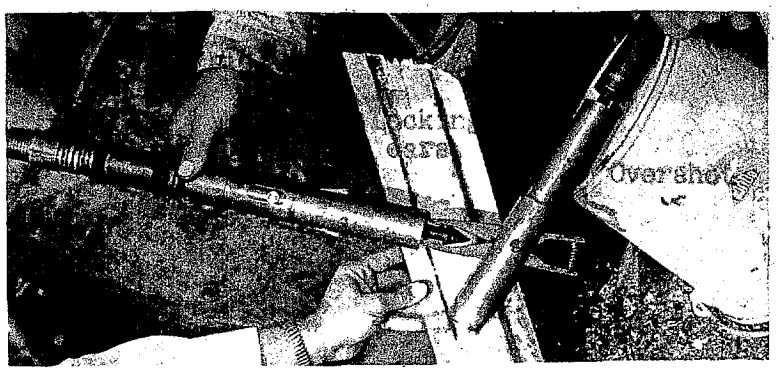
Wire line lifting innertube from bottom of hole. Wireline hoist in background.



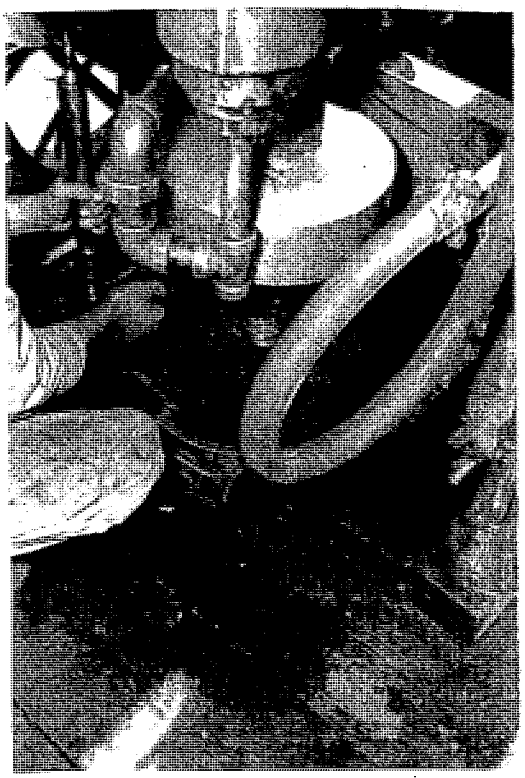
Wireline hoist with 7½ h.p. gasoline

Overshot and jars in position to lower through BX drill casing to recover innertube with core.

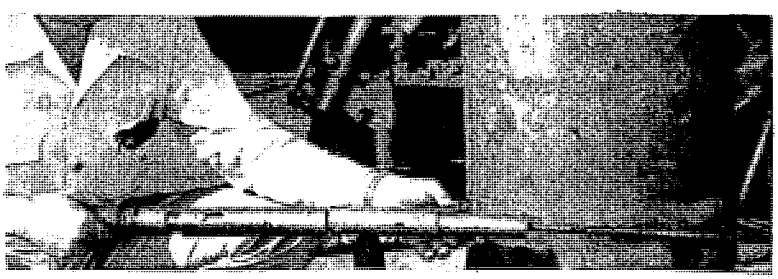
Locking head and ballbearing swivel type ax innertube. Various water shutoff valves are shown. Changing the valve can allow varying water pressure to be used before valve operates.



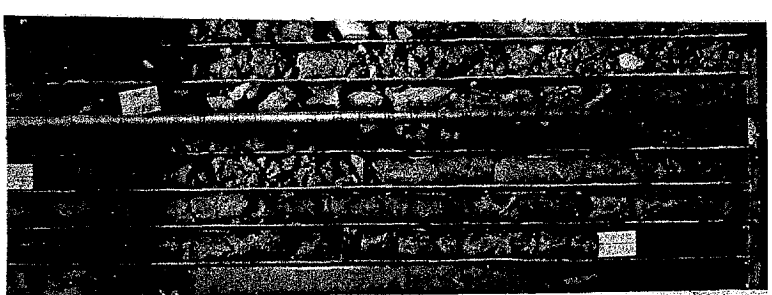
Overshot in out-of-line position to illustrate position before lifting. Locking ears are seen in locked position extended from locking head.



Innertube and locking head about to be released for a free fall through the drill casing to the corebarrel at the bottom of hole.



Locking head and overshot are in lifting position with locking head extended to retract locking ears. Jars on right are seen in extended position. Fingers of left hand are about to depress ears on overshot to release the locking head.



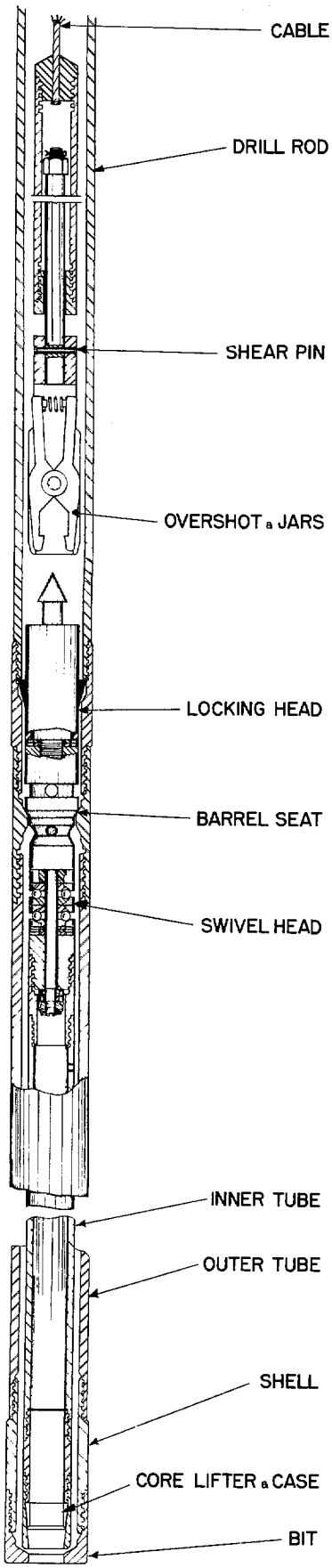
Magnetite, diorite, limestone drill core (AX) showing close to 100% core recovery.

E. J. LONGYEAR CO.
MILLS BUILDING
EL PASO, TEXAS

Longyear

FEB 19 1954

WIRE LINE CORE BARREL



PATENTS PENDING

THE RECENT introduction by the E. J. Longyear Company, Minneapolis, Minnesota, of Wire Line Core Barrel equipment, has provided the diamond core drilling industry with a new tool and technique which promises to revolutionize exploratory drilling. This small diameter wire line equipment has been under continuous development and tests since 1947. A number of BX size holes have been successfully completed and in depths ranging from 500 to 3200 feet. Currently, a hole is being drilled in the eastern part of the United States which is expected to reach a depth of 5000 feet. Core recovered with this equipment is approximately 1-1/16″ in diameter.

The principle of the Wire Line Core Barrel has been used by the petroleum industry in large diameter holes for many years, but has never before been successfully applied to small diameter diamond core drill holes.

The significant features of the Wire Line Core Barrel, for which patents have been applied, are as follows:

(1) The string of drill rods is hoisted from and lowered into the drill hole only at such times as it is required to replace the diamond core bit.

(2) At the end of each core run, the inner tube, together with the core lifter assembly and the core, is extracted from the hole through the inside of the drill rods by means of a wire line cable reel. With skilled operators, the extraction of the core-laden inner tube, and lowering of the empty inner tube in a 1,500-foot hole requires about 15 to 20 minutes, as compared to at least 60 minutes round trip time using conventional diamond core drill rods and core barrel. Round trip time with the wire line equipment in a 3,000-foot hole has been accomplished in 32 to 38 minutes' elapsed time, as compared to 3 to 4 hours' time required with conventional equipment.

(3) The core barrel is equipped with a ball-bearing, swivel type head and optional, if desired, with a water shut-off valve. This latter feature is of particular importance because the application of a water shut-off valve largely eliminates the human element in detecting a core block. The instant a core block occurs in the bit or inner tube, the water shut-off valve action prevents the circulation of fluid, alerts the operator, and forces him to "pull" before core grinding starts. This results in vastly improved core recovery, decreased diamond loss, and longer bit life.

Longyear

WIRE LINE CORE BARREL

PATENTS PENDING

In the Longyear Wire Line Core Barrel, the E. J. Longyear Company offers to the mining industry one of the most valuable contributions to the technique of mineral exploration in the history of diamond core drilling. This tool is the result of years of research and field testing. It has now been proven on deep hole drilling and has demonstrated its ability to lower costs and improve core recovery.

With the Longyear Wire Line Core Barrel, drilling can proceed without withdrawing the string of drill rods from the drill hole until it is required to replace the diamond core bit.

The Wire Line Core Barrel described in this bulletin is designed for operation in small diameter holes with the use of clear water for circulation.

Bulletin No. 201

THE Longyear WIRE LINE CORE BARREL consists of:

1. An outer barrel assembly which is attached to a string of wire line drill rods. This barrel has, at its lower end, the wire line reaming shell and diamond core bit.

2. A retrievable inner barrel (core retaining) assembly with a core lifter at the lower end, a swivel type ball bearing head at the upper end of the inner tube, and a locking head and spear at the upper end of the inner barrel assembly.

3. An overshot and a wire line cable which are used to retrieve the inner barrel.

4. A wire line hoisting unit.

5. A string of wire line drill rods and couplings.

WATER SHUT-OFF VALVE

The Longyear Wire Line Core Barrel can be furnished with a water shut-off valve. With this important feature, the human element in detecting a "block" is largely eliminated. In a closed circuit between the pump and the bit, the instant a "block" occurs in the inner tube the valve restricts circulation and alerts the operator by increased pump pressure and discharge of water through a relief valve.

OPERATION

Drilling commences and proceeds in a customary manner (Fig. 1). At the end of each core run, the string of drill rods and the outer barrel assembly remain in the hole (Fig. 2), while the inner (core retaining) barrel is pulled up from the hole (Fig. 3). A "standby" inner barrel assembly can then be immediately dropped into the hole, and drilling resumed while the core is being removed from the previously pulled assembly.

The string of drill rods is normally hoisted from and lowered into the hole only when it is required to replace the diamond bit.

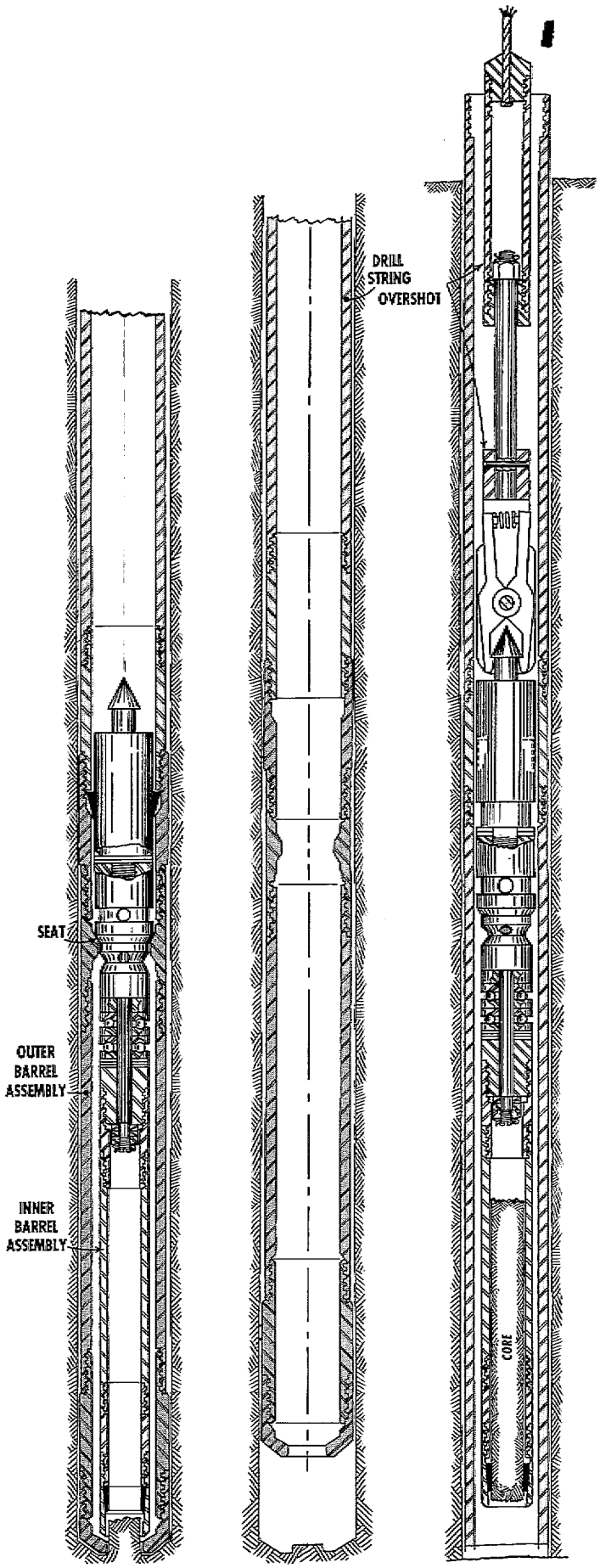


FIG. 1 FIG. 2 FIG. 3

ADVANTAGES **There are many advantages resulting from the proper application and use of the Longyear Wire Line Core Barrel:**

A Round-trip time for the retrievable inner barrel is only a fraction of the time for a string of drill rods.

B Lower round-trip time results in reduced "down time", increased net drilling time, more round-trips per shift, higher footages per shift.

C Less caving in the hole—less core blocking.

D Longer core runs—higher core recovery.

E Longer bit life.

F Less fatigue for the operator.

G Less wear on the drill motor and hoist.

***SUM TOTAL*—lower costs per foot of hole drilled.**

SPECIFICATIONS

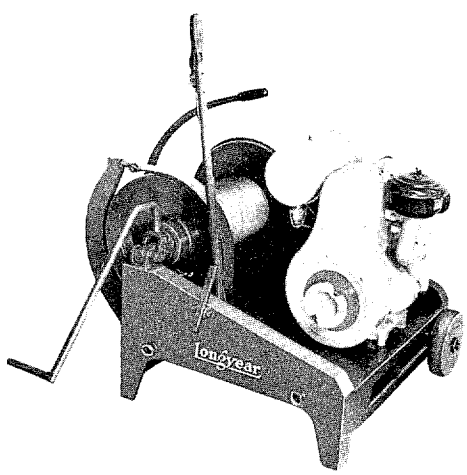
At the present time the Longyear Wire Line Core Barrel is offered for sale in the listed sizes. Other sizes are being field-tested.

WIRE LINE CORE BARREL:	
Type	Swivel
Hole diameter	BX, 2-3/8″ approx.
Core diameter	1-1/8″ approx.
Length of barrel, nominal	10′ (20′ optional)
Weight of complete core barrel assembly (10′)	93 lbs.
Weight of inner tube assembly (10′)	31 lbs.
OPERATING EQUIPMENT	
WIRE LINE DRILL RODS AND COUPLINGS:	
Length, nominal	10′
O.D., Rod and couplings	2-3/16″
I.D., Rod	1-13/16″
I.D., Coupling	1-11/16″
Weight of rod and coupling (10′)	40 lbs.
OVERSHOT ASSEMBLY:	
Weight	20 lbs.
DIAMOND CORE BIT:	
Type	Box
Set O.D. nominal	BX, 2-11/32″
Set I.D. nominal	1-1/8″
DIAMOND REAMING SHELL:	
Set O.D. nominal	BX, 2-23/64″

WIRE LINE CABLE:	
Construction	Preformed, galvanized
Diameter	3/16″
Weight per 100 feet	6.2 lbs.
SHEAVE ASSEMBLY:	
Sheave diameter	6″
Weight	14 lbs.
WIRE LINE HOIST:	
Line Speed (Bare drum at 2600 engine r.p.m.)	230 f.p.m.
Weight complete (less wire line cable)	490 lbs.
Drum diameter	5″
Drum length	15″
Drum flange diameter	16″
Engine—Air-cooled (Gasoline)	7 HP @ 2600 r.p.m.

SUBS:

Available to connect wire line drill rod to A, B, or N standard drill rod couplings.



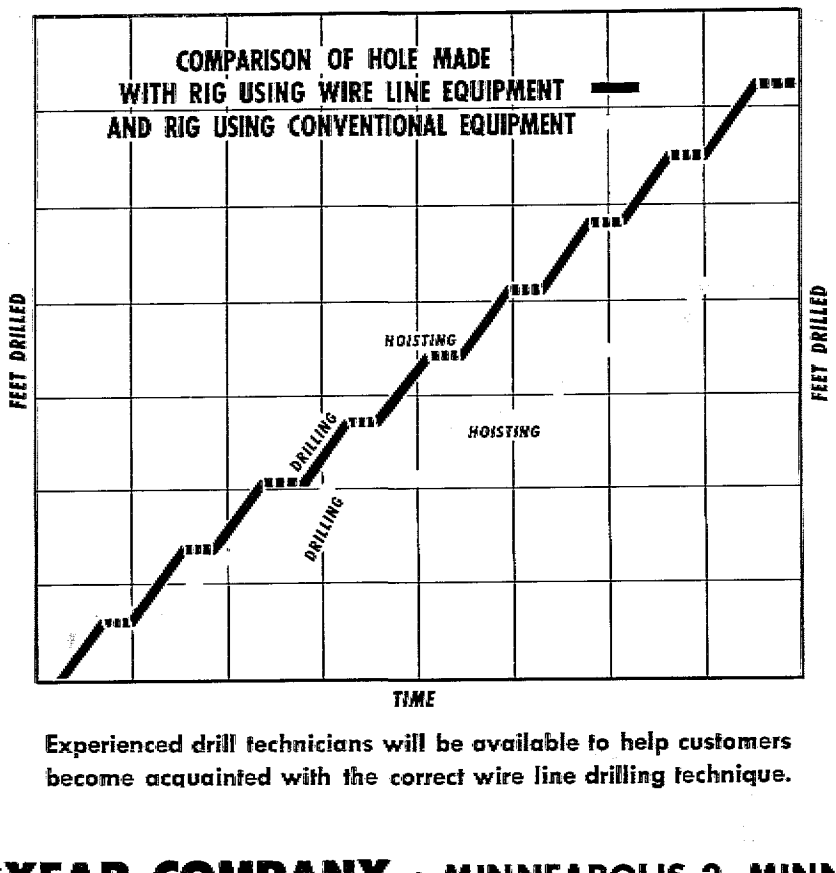
WIRE LINE HOIST

Longyear engineers and sales representatives will help in determining the practicality and economy of using wire line equipment on your particular job.

Among the factors which must be considered in the application are the following:

1. Types of formations to be drilled.
2. Depth of hole.
3. Average length of core run.
4. Average life of bit.
5. Rate of penetration.

The following hypothetical case graphically illustrates the performance of the wire line equipment in comparison with conventional equipment:



Experienced drill technicians will be available to help customers become acquainted with the correct wire line drilling technique.

E. J. LONGYEAR COMPANY • **MINNEAPOLIS 2, MINNESOTA, U. S. A.**
NEW YORK 17, NEW YORK
SALT LAKE CITY 4, UTAH

CANADIAN LONGYEAR, LIMITED • **NORTH BAY, ONTARIO, CANADA**
MONCTON, NEW BRUNSWICK

LONGYEAR ET CIE • **PARIS, FRANCE**

REPRESENTATIVES IN PRINCIPAL MINING CENTERS OF THE WORLD

DIAMOND CORE DRILLS
•
CONTRACT CORE DRILLING

MINING ENGINEERING AND GEOLOGICAL CONSULTANTS

W. R. L.

February 23, 1950

Mr. H. A. Kursell, Consulting Engineer
American Smelting and Refining Company
120 Broadway
New York 5, New York

TOQUEPALA DIAMOND DRILLING
A PROPOSED METHOD FOR
WEIGHTING CORE AND SLUDGE

Dear Sir:

At Toquepala last year Kenyon Richard and I discussed various methods that might be employed to improve upon the more or less standard Longyear formula for deriving the combined assay value of a core-sludge sample.

Subsequently Mr. R. C. Johnson called attention to an article in the October, 1949 issue of "Mining Engineering," entitled, "A new Method of Weighting Core and Cuttings in Diamond Drilling," wherein the author, Josiah Royce, points out that in drilling iron ore in the Vermillion Range of Minnesota the Longyear formula could under some conditions produce erroneous results. The author proposed a new method wherein the assumption is made that the core is a perfect sample if 100% recovery is made, and in such cases no weight should be given to the sludge in the final analysis of the sample. A curve was drawn which departed from the Longyear curve (a straight line) in the higher range of core recoveries and gave increasing weight to the core assay as the recovery approached 100%. No consideration was given to possible variations in sludge recovery.

The method proposed in the following is one in which both sludge and core recoveries are taken into account. The theory is based essentially on the assumption that in the hypothetical case of perfect recovery in both core and sludge, the sludge is less reliable than the core sample; that is, the sludge is subject to at least some contamination or dilution regardless of the 100% calculated recovery. Since recent drilling at Toquepala has shown that core recoveries ranging from 70% to 100% may be expected, no alterations have been made to the Longyear formula in the lower ranges of recovery.

The objective here is to provide greater emphasis on the core assay as the recovery approaches 100%, as in the method mentioned above; however, the proportion of ore minerals to gangue is considerably less in porphyry copper ore than in iron ore. That is, a relatively small loss of core in the case of the copper ore might consist mainly of ore minerals, which could increase the assay of the sludge as much as 50%. To assign the core assay a high proportion of the weight in such instances might produce a combined assay that was considerably below the true value.

In designing the method described below, provision was made to eliminate to a large extent the possible occurrence of such an error; on the BX chart the 100% sludge recovery curve departs gradually from the Longyear line at a point near 80% core recovery. A large proportion of the weight is not given the core until core recoveries reach the 90% to 100% range. In contrast, the curve drawn for the iron ore samples departs from the Longyear line at about 37% core recovery (EX) and rises steeply, being almost a straight line from 60% to 100% core recovery.

The accompanying graphs (one for each bit size in use, NX, BX and AX) show evenly spaced curves between the direct proportion line and the Longyear line (tangent to the latter). These curves represent sludge recoveries from 40% to 100%. For sludge recoveries over 100%, the excess is subtracted from 100 to obtain the percentage used; that is, for a recovery of 115% the recovery used would be 85%. Thus, in any case, as sludge recoveries depart from 100%, the influence of the sludge assay is reduced accordingly. Likewise, as the core recovery drops below 100%, less emphasis is placed on its assay in the combined result.

To determine the relative weights to be given the core and sludge, the per cent recovery of each is obtained by means of a specific gravity measurement and the dry weights of the two samples. With these data the recoveries are determined by use of the graphical method originated by Walter Barlow and described by R. E. Mieritz in the report of June, 1949 on "Diamond Drilling and Sampling at Silver Bell, Arizona." The core recovery is scaled on the horizontal axis. The point at which a vertical line through the value for the core recovery for any sample intersects the corresponding sludge recovery line determines the weight to be given the core (core factor), scaled on the vertical axis. This result is subtracted from 100 to obtain the weight assigned to the sludge (sludge factor) in the combined assay.

Example No. 1

		% Rec.	Assay
	(Core	95	1.0% Cu
Size AX	(Sludge	90	1.3% Cu

Red circle - point of intersection of core and sludge recoveries on AX chart.

Green circle - percentage weight to be given core assay (72.0) (core factor)

100 - 72.0 = 28.0 - percentage wt. given sludge assay (sludge factor)

$$\frac{\text{Core}}{(1.00 \times 72.0\%)} + \frac{\text{Sludge}}{(1.3 \times 28.0\%)} = \frac{\text{Combined Assay}}{1.084\%\ \text{Cu}}$$

As a comparison, the Longyear formula produces the following with the same recoveries and assays:

$$\frac{\text{Core}}{(1.00 \times 39\%)} + \frac{\text{Sludge}}{(1.3 \times 61\%)} = \frac{\text{Combined Assay}}{1.183\%\ \text{Cu}},$$

or .10% more copper in the combined assay. As may be seen from the chart, where core recovery is 100%, the weight given the core in the Longyear formula is 41% in the combined assay, regardless of sludge recovery.

Example No. 2

		% Rec.	Assay
	(Core	90	1.20% Cu
Size BX	(Sludge	120	0.95% Cu

Red circle - point of intersection of core and sludge recoveries on BX chart.

Green circle - percentage wt. to be given core assay in combined assay, (69%). (Core factor)

100 - 69 = 31 - percentage wt. given sludge (sludge factor)

Core		Sludge		Combined Assay
(1.20 x 69%)	+	(.95 x 31)	=	1.122% Cu

Longyear Formula				
(1.20 x 45%)	+	(.95 x 55)	=	1.062% Cu

Before this method is adopted, a study of available data should be made. This may best be done by preparing a graph showing core and sludge recoveries and assays as four individual lines for the sulphide zone in each hole. From such a chart, information may be gained as to the behavior of the sludge assay in runs with near perfect core recovery. This method of analysis offers a means of appraising relative reliabilities in various combinations of recovery. For example, such a graph prepared from the results of one hole at Silver Bell showed that the difference between core and sludge assays for the same sample was greater in regions of low core recovery. The sludge ran persistently higher than the cores; as the core recovery increased, the two assay curves tended to converge. This analysis indicated that the higher value of the sludge was principally due to selective grinding or washing of the cores, rather than "salting" from the unprotected walls of the hole.

In conclusion it is recommended that if it proves advisable from the operating as well as the sampling standpoint to continue drilling for high core recoveries, rather than placing the major emphasis on the sludge sample, as was Cerro de Pasco's practice, the final value should be derived by the new method described in the foregoing, where the core in the high recovery instances has a greater influence than the sludge in the combined assay.

Very truly yours,

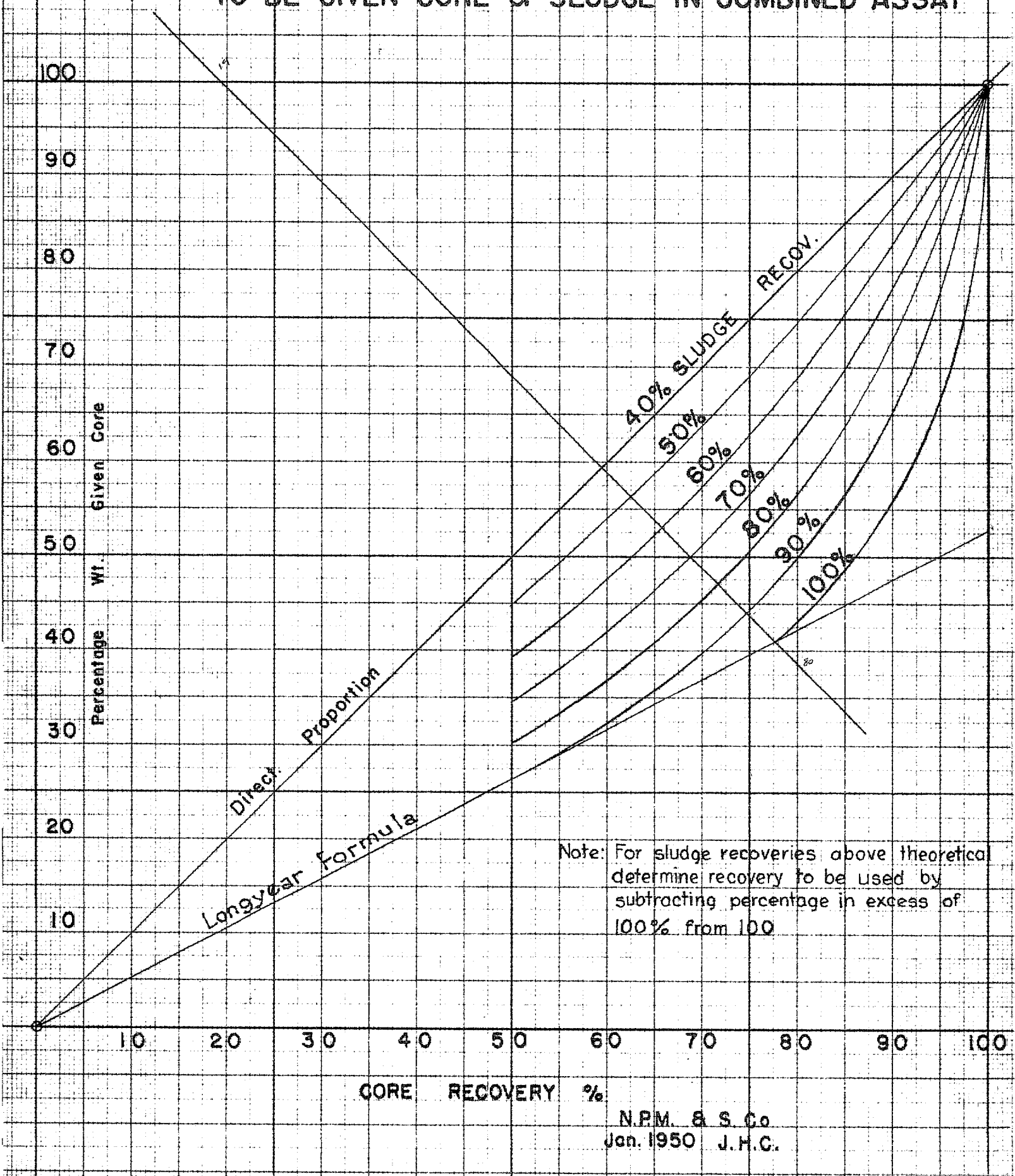
J. H. Courtright

J. H. Courtright

JHC:si
cc:R.C.Johnson - Lima Office (2)
L. E. Kitch - Quellaveco (2)
K.E.Richard - (1)
8 extra copies

Note: The positions of the lines representing the Longyear formula on the attached graphs correspond approximately to data given on page 548 of Field and Mining Geology, 1947, by Forrester. Measurements of core and reaming shell diameters should be made in the field to determine the magnitude of error involved in the use of standard data on core and hole sizes.

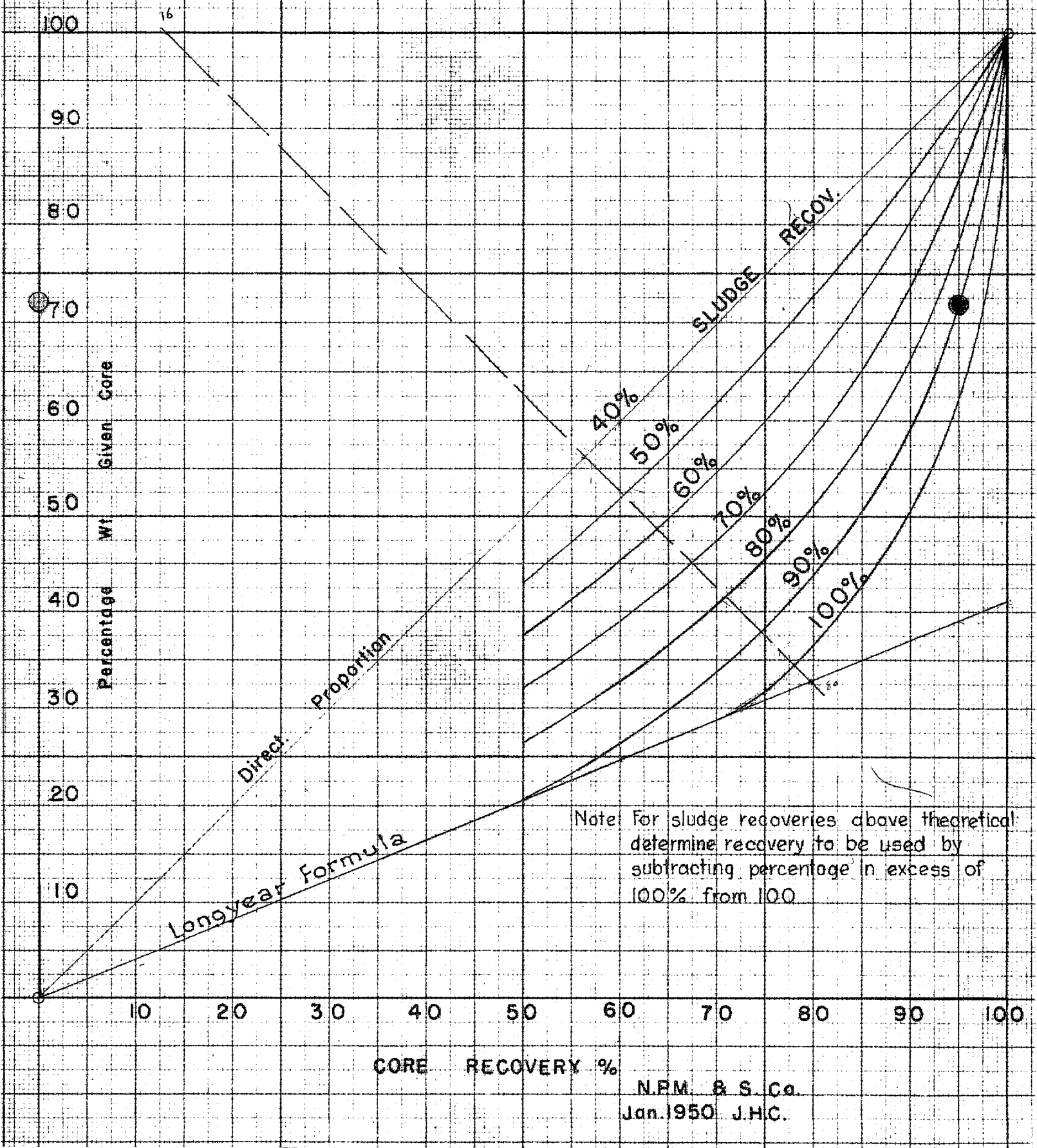
NX- DIAMOND DRILL SAMPLES
GRAPH FOR DETERMINATION OF WEIGHT
TO BE GIVEN CORE & SLUDGE IN COMBINED ASSAY



Note: For sludge recoveries above theoretical determine recovery to be used by subtracting percentage in excess of 100% from 100

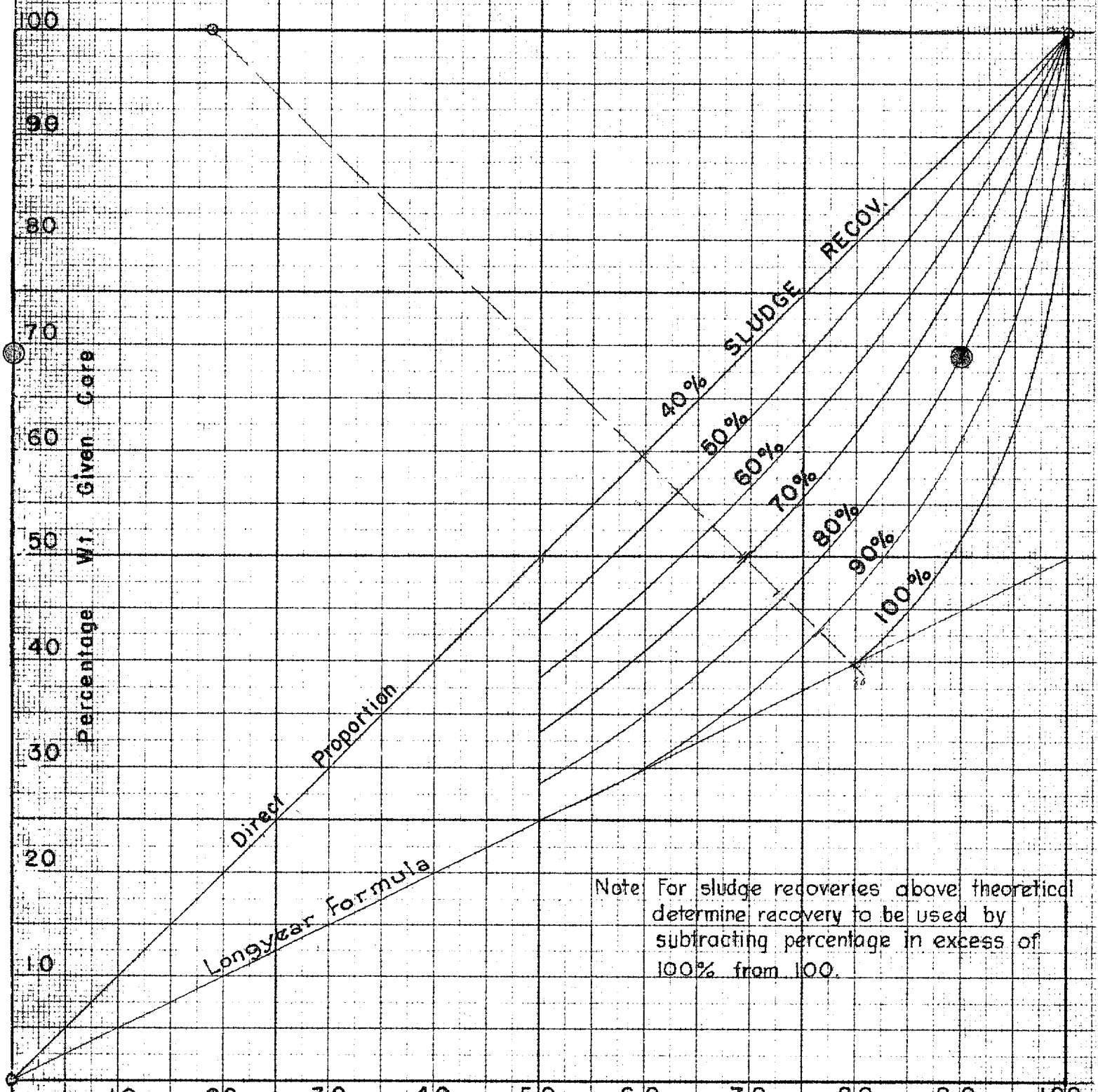
N.P.M. & S. Co
Jan. 1950 J.H.C.

AX- DIAMOND DRILL SAMPLES
GRAPH FOR DETERMINATION OF WEIGHT
TO BE GIVEN CORE & SLUDGE IN COMBINED ASSAY



N.P.M. & S. Co.
Jan. 1950 J.H.C.

BX- DIAMOND DRILL SAMPLES
GRAPH FOR DETERMINATION OF WEIGHT
TO BE GIVEN CORE & SLUDGE IN COMBINED ASSAY



Note: For sludge recoveries above theoretical determine recovery to be used by subtracting percentage in excess of 100% from 100.

N.P.M. & S. Co.
Jan. 1950 J.H.C.

J. F. J. Forms used by Webber
in billing merchandise for M. A. Hanna Co.

Please return
WRL

MANGANESE ORE COMPANY

D.D.H. No._____

_____Claim No._____

Surface 0_____

Pre Rpld.

200

Form M17 RPC 10676

_____193___

_____

_____

Dear Sir: I have to report the following progress on_____

Section _____Town _____Range _____

_____County, State of_____

INFORMATION, ETC.	DRILL HOLES					
NUMBER						
PREVIOUSLY REPORTED						
TOTAL DEPTH TO DATE						

REMARKS:

[redacted]

DRILL HOLE No._____

Location_____ Sec._____ T_____ R_____ State_____

Elevation_____ Angle of hole_____ Direction of hole_____

Hole started_____ Hole completed_____ Casing — Pulled / Left

Scale — 1 inch = 50 Feet

Hole drilled by_____ Material classified by_____

Material	Depth	Angle of hole	Angle of strata	Inches of core	Sludge						Core						Combined Analysis					
					Wt. lbs.	Percentage					Wt. lbs.	Percentage					Wt. lbs.	Percentage				

April 18, 1949

Mr. James A. Ross, President
Sprague & Henwood, Inc.
P. O. Box 446
Scranton 2, Pa.

Dear Mr. Ross:

I was glad to hear from you.

It is true that the Silver Bell work will soon be finished. At Ground Hog, however, we plan to keep drilling pretty continuously unless economic conditions get too bad. I expect that we will keep one surface and one underground drill going there.

At the present time we have no other definite plans, although we have several things "cooking" and hope that something will develop. I have sent your letter around to those of our organization who might have to do with drilling work and (as I have done in the past), I have pointed out to all our men the desirability of keeping our drilling work going at as even a rate as possible, for our mutual benefit.

I do not know when I will get to New York again, but will certainly try to see you when I do.

With best personal regards,

Yours very truly,

ORIGINAL SIGNED BY
D. J. POPE

D. J. POPE

DJP:bm
Bl. ccs:
W.H.Loerpabel
F.V.Richard
W.R.Landwehr
J.F.Johnson
L.H.Hart

W. R. L.
APR 19 1949

T-1.1

Mr. W. R. Landwehr

File Diamond Drilling

AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona

December 29, 1948

JAN 5 1949

MEMORANDUM TO MR. A. E. RING:

Bingham Canyon, Utah
Kennecott Copper Corporation
DIAMOND DRILL PRACTICE

On December 22, 1948, an inspection was made of diamond drill operations at Bingham Canyon, Utah. Drilling there is under the direct supervision of Mr. Russel Anderson, geologist.

In 1945 the company, having completed over 150,000 feet of churn drilling in the sampling of the Bingham Canyon porphyry copper deposit, decided to adopt diamond drilling as a means of testing the ore lying beneath the pit bottom -- too deep for open pit mining. This decision was apparently based on the assumption that diamond drilling would provide a sample (1) at least equal in reliability to the churn drill samples, and (2) at a much lower cost. (In 1944 a company engineer stated that churn drilling and under reaming to 1800 feet cost $20.00 per foot.)

To date, 8 vertical holes averaging 1100 feet in depth have been completed. The rock encountered is a fine grained somewhat friable monzonite. Chalcopyrite, the chief ore mineral, is present essentially as very minute grains and thin veinlets disseminated through the rock matrix.

Drilling

The drilling, contracted by Boyle Brothers, is accomplished with a gasoline powered U 6 Strait Line Longyear hydraulic machine operating two 8 hour shifts per day.

Holes are collared and drilled NC size (3-9/16") for the first 20 feet, then continued through the standard sizes, NX, BX and AX, the latter being the minimum size used. Soft friable zones frequently encountered have a tendency to slough and "sand up" the hole. When this occurs, the hole is cemented; if the caving continues, the hole is cased. As a rule, about 60 feet is the maximum length of hole existing above the bit, unprotected by cement or casing.

The average rate of advance is 12 feet per drill shift. Water is used at the rate of 400 gallons per hour of drilling.

Cement (120 minute Calseal) is pumped to the bottom of the hole through the rods, then "grouted" with 400 lbs. pressure produced by a Royal Bean #20 pump and applied by water through the rods at the top of the cement column. The drillers report this method to be more effective than the usual method in supporting the walls of the hole.

W. R. L.
JAN 6

A 10 foot rigid type core barrel is in use at present. Mr. Parks, foreman, stated that non-rotating type barrels and face discharge bits had been used without noticeable improvement in core recovery.

The ground tends to cause short blocks; two and three foot pulls are frequently made. Sludge runs are normally held to 9 feet or under.

Sampling

Sludge is settled in a 12 foot long, 3 baffle, metal, 200 gallon tank designed to provide an 8% upgrade on the semicircular bottom from intake to overflow end. Filter tests of the overflow determined the slime loss to be negligible, according to Mr. Anderson. The sludge is dried at the drill in an oven heated by a coal fire. The sampler is relied upon to see that the sludge is not overheated. A rough measurement of the volume of wet sludge (number of 3-gallon buckets) is used to approximate recovery at the drill. Recoveries over 100% indicate that cement or casing is required.

The average sludge recovery for 8000 feet of drilling is reported to be 95%. This unusually high percentage is somewhat misleading, I believe, due to the fact that the drilling is in wet, caving ground (holes make as much as one g.p.m.) and recoveries often run over 100%. This dilution which is ignored in the calculation of average recovery tends to balance off low recoveries obtained elsewhere in the hole.

Core recovery for the 8000 feet is reported to be an average of 44% on a linear basis.

Core - Sludge Assays

All core recovered (with the exception of specimens taken at 25 foot intervals for the files) is ground for assay. In calculating the combined assay, the actual weight of the sludge is used rather than the theoretical weight; however, in cases of over 100% recovery, the theoretical weight is used. The core and the corresponding sludge assay are rarely equal; variations as great as 80% are reported. However, over the full length of the hole the two quite often average up rather closely. Results from 3 holes were as follows:

Footage drilled	Av. core assay	Av. sludge assay
1250 ft.	.924 % Cu.	.934 % Cu.
1100	.77	.85
1150	.789	.789

Mr. Anderson stated that in some cases sludges ran high in the upper half of the hole and low in the lower half, producing an average assay equivalent to the average core assay. These results were due, he believed, to variations in the nature of the copper occurrence: in the upper portion the sulphides were disseminated mainly in the monzonite matrix, in the lower portion the sulphides were present more often in

quartz masses or veins and were therefore more likely to be recovered in the core, while the intervening low grade or waste material would be ground out and enter the sludge.

The average specific gravity of the ore, 2.465, determined in past mining and milling operations, is used in calculating core and sludge recoveries.

Costs

Contract prices per foot were not available; however, it was learned that the maximum (NX over 1000 feet) is $5.50 per foot, and that the average for all sizes and depths is less than $5.00 per foot. Cementing ($4.75 per hour), including the cement ($6.00 per 100 lb. bag) amounts to about $1.25 per foot of hole drilled. Reaming ($2.00 per foot BX, $1.75 AX) averages about $.50 per foot of hole drilled. Assuming $4.50 as the base average per foot drilled, the total average direct cost would be $6.25 per foot. This does not include such items as roads, moving drill, water supply, sampling, laboratory, assaying, engineering and supervision. A figure for these was not available.

J. H. Courtright

J. H. COURTRIGHT

JHC:srs

cc: DJPope
WRLandwehr ✓
LHHart

Walt,
I found this in Hart's old file. Probably one copy should be filed under drilling, Bingham and one under Bingham - as you want.

S. F. R.
JUL 1 1953

Boyles Bros. DRILLING COMPANY INCORPORATED

DIAMOND DRILLING CONTRACTORS AND MANUFACTURERS
Phone 6-8555 1321 South Main
SALT LAKE CITY 4, UTAH

READ AND RETURN

RSP		
WRL	✓	
KW		
FVR	✓	

AUGUST 6, 1948

F. V. R.
OCT 2 1953

W. R. L.
OCT 2 1953

AMERICAN SMELTING & REFINING COMPANY
PACIFIC NATIONAL LIFE BUILDING
SALT LAKE CITY, UTAH

ATTENTION: L. M. HART

GENTLEMEN:

IN ACCORDANCE WITH OUR RECENT TELEPHONE DISCUSSION CONCERNING THE DEEP HOLE DRILLING AT THE BINGHAM PIT AND YOUR REQUEST THAT ADDITIONAL INFORMATION BE ADDED TO THAT ALREADY FURNISHED IN OUR LETTER OF AUGUST 4 TO MR. J. FRED JOHNSON, WE HAVE DECIDED TO REPEAT THE ENTIRE SUBJECT AND ELABORATE ON THE POINTS IN QUESTION.

1. AQUAGEL IS USED TO KEEP CASING FREE AND TO CLEAN HOLES OF SAND AND OTHER RUNNING MATERIALS, BUT NOT FOR DRILLING PURPOSES, SINCE RECOVERY OF SLUDGE FROM THE AQUAGEL SOLUTION WOULD BE EXTREMELY DIFFICULT.

2. THE ONLY CEMENTING MATERIALS USED ARE CALSEAL 120 AND LUMNITE. WE USE ONE SACK TO FIVE OR SIX GALLONS OF WATER AND ADD TO THE MIXTURE FIVE OR SIX DOUBLE HANDS FULL OF LUMNITE CEMENT TO IMPROVE THE DRILLING CHARACTERISTICS OF THE CALSEAL. LUMNITE SERVES NO OTHER PURPOSE. ALL CEMENTING IS DONE BY THE PRESSURE GROUTING METHOD.

3. ALL HOLES ARE APPROXIMATELY 1,200 FEET DEEP AND ARE DRILLED SIZE NX UP TO 200 FEET, BX TO ABOUT 600 FEET, AND ARE COMPLETED SIZE AX.

4. CORE RECOVERY VARIES GREATLY, FROM 20% TO 80%, DEPENDING UPON THE CONDITION OF THE GROUND. TO DATE CORE RECOVERY HAS AVERAGED 41.41 %.

5. RETURN WATER CONTAINING SLUDGE IS RUN THROUGH TWO BAFFLE BOXES AND THE SETTLINGS DRIED IN OVENS. SAMPLES ARE TAKEN EACH FIVE FEET OR ON THE PULL; IF THE PULL IS LESS THAN FOUR FEET TWO PULL SAMPLES ARE ADDED TO MAKE ONE SLUDGE SAMPLE. CORE AND SLUDGE ARE RUN SEPARATELY FOR ASSAY PURPOSES, AND BOTH CORES AND SLUDGE ARE PULVERIZED. THE ACCEPTED STANDARD METHOD IS USED TO DETERMINE THE

RELATIONSHIP BETWEEN CORE AND SLUDGE. IF GREASE IS USED IN DRILLING ALL SAMPLES ARE WASHED CAREFULLY BEFORE ASSAY.

6. A COMPOSITE SAMPLE IS TAKEN FOR EACH 50 FEET OF HOLE DRILLED AS AN ADDITIONAL CHECK OF INDIVIDUAL ASSAYS.

7. WHEN DRILLING THROUGH QUARTZITE AND OTHER FORMATIONS WHICH HAVE A SUGARY CONDITION, IT HAS BEEN FOUND THAT SLUDGE VALUES ARE EXTREMELY HIGH IN SOME INSTANCES DUE TO THE MINERALIZATION BEING WASHED OUT OF THE ROCK, HOWEVER, THAT CONDITION IS NOT CONSISTENT AND PROBABLY ONLY 50% OF THE TIME DOES THIS HAPPEN. IN OTHER MORE SOLID FORMATIONS ASSAY VALUES BETWEEN CORE AND SLUDGE ARE VERY CLOSE, PARTICULARLY SO WHEN THE FORMATIONS ARE SOLID AND THE MINERAL DOES NOT HAVE A TENDENCY TO WASH OUT OF THE CORES. WE ARE INFORMED THAT TO DATE NO SET PATTERN HAS BEEN ARRIVED AT FOR THE ORE BODY, BUT THE RESULTS ARE CONSIDERED VERY SATISFACTORY. IT MUST BE BORNE IN MIND THAT IN ORDER FOR SLUDGE AND CORE ASSAYS TO CLOSELY APPROACH ONE ANOTHER THE DRILL HOLES MUST BE KEPT IN A WELL CEMENTED CONDITION AT ALL TIMES IN ORDER TO AVOID CONTAMINATION OF CURRENT SAMPLES FROM PREVIOUS DRILLED AREAS.

8. WE HAVE FOUND THAT IT IS NECESSARY FOR OUR DRILLERS TO CONSTANTLY CHECK AND SUPERVISE THE COMPANY SAMPLERS BECAUSE ALL OF THEM SEEM TO HAVE THE TENDENCY TO BECOME CARELESS AND IT IS, THEREFORE, OUR ASSUMPTION THAT THIS WOULD BE THE CASE WITH ALMOST ALL DRILLING OPERATIONS WHERE THE COMPANY DOES NOT HAVE AN ENGINEER IN ATTENDANCE AT ALL TIMES.

9. EXPERIENCE TO DATE HAS INDICATED THE DIAMOND DRILL METHOD WHEN USING THE SAME PROCEDURE AS AT PRESENT PRACTICED AT THE BINGHAM PIT TO BE CONSIDERABLY CHEAPER THAN CHURN DRILLING. WE HAVE BEEN INFORMED THAT CHURN DRILLING COSTS WERE APPROXIMATELY $15.00 PER FOOT, WHEREAS NET DIAMOND DRILLING COSTS TO THE COMPANY HAS BEEN LESS THAN $9.00 PER FOOT TO DATE. AVERAGE TIME FOR A 1,200 FOOT HOLE TO DATE HAS BEEN TWO MONTHS, BUT ON ONE OCCASION THE TIME DID EXCEED TWO AND A HALF MONTHS.

WE TRUST WE HAVE COVERED ALL OF THE REQUIRED POINTS IN THE FOREGOING.

YOURS VERY TRULY

R T Goldsworthy

R. T. GOLDSWORTHY

RTG:BG

EASTMAN OIL WELL SURVEY COMPANY

Received
JAN 15 1948
File

January 12, 1948

Diamond Drilling

Mr. L. Kenneth Wilson, Chief Geologist
Southwestern Division
American Smelting and Refining Company
P.O.B. 2229
Tucson, Arizona

COPY

Dear Mr. Wilson:

This is in reply to your letter of January 9 requesting any information we might have regarding surveying and directional drilling of diamond drill holes. From your letter I take it that Mr. Courtright is now stationed in your Southwestern Division. Fortunately he was with us in the Garbutt Mine at Leadville when we made a survey of the three drill holes in that location. At the time we showed the equipment to Mr. Courtright and demonstrated to him the simplicity of its use.

I am enclosing our Catalog No. 46, Instruction Booklet No. 453 dealing with the single shot instrument, a price list for our services, and a separate instruction sheet for the inside single shot survey instrument. This 1 1/2" diameter machine is the one which we used in the Garbutt Mine, since the diameter of the drill hole was 1 7/8". I am also enclosing a copy of the survey report which was submitted to Mr. Landwehr after completion of the survey operations in the Garbutt Mine.

There are certain limitations in the use of this single shot machine which I should mention:

1. Direction is obtained by use of a magnetic compass. If any magnetic material is present very near the point at which a reading is taken, the compass will be attracted and the directional reading will be erroneous. Magnetic material will not affect the inclination reading however.

W.R.L.
JAN 15 1948

2. If the holes you are drilling are over 1 7/8" diameter the use of our machine will necessitate the construction of a special thin wall barrel, since you will notice that the machine is normally run in a 2 1/8" diameter barrel.

3. If a thin wall protective barrel is used the hydrostatic head of the water in the drill hole should be determined, since the collapsing strength of this thin section is not too great.

4. We recommend that as nearly as possible our machines be run on the drill rods to insure against losing the machine in the hole. This necessitates a round trip of the rods for each reading.

5. An accurate estimate should be made of the time required to run the rods in to the greatest depth, since our regular 33 minute contact watch may not provide enough delay time. If necessary, we can furnish a 66 minute watch for this purpose.

6. Throughout our literature you will find the word "drift" used. This is angular inclination from vertical expressed in degrees. I believe geologists normally use the word inclination to denote angle from horizontal. Thus 30° drift equals 60° inclination from horizontal.

We are not at present able to assist you in the directional drilling of small size diameter drill holes. I am sure you will be interested in looking over the directional drilling tools in our catalog. However you will notice they are all of quite large diameter for use in oil wells. If, after reviewing the literature enclosed, you are interested in our services, we would appreciate a letter from you giving all the local conditions and suggesting the manner in which it would be most satisfactory for you to run the instrument. At that time we could more nearly give you an accurate estimate of the cost for special equipment.

Yours very truly,

J. B. Murdoch, Jr.
Chief Survey Engineer

JBM/jbn
Enclosures

cc: W. R. Landwehr

COPY

Mr. Landwehr
T-1.1

AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona

Dec. 16, 1947

MINING DEPARTMENT
Salt Lake Office
Received DEC 18 1947
My Artist
Suspense:
File

A I R M A I L

Mr. Roland Blanchard,
153 S. Hermosa Avenue,
Sierra Madre, Calif.

Surveying Diamond Drill Holes
(Including Directional Drilling)

Dear Mr. Blanchard,

When you were in Tucson recently you inquired about literature available on the above subject. I have now checked our files and our exploration library and have the following references to suggest for your consideration.

E. J. Longyear Company has compiled, with the assistance of Engineering Societies Library in New York, an excellent mimeographed pamphlet titled "Bibliography of Diamond Drilling" and dated January, 1947. An excellent list is given on pages 28-31 inclusive. These pages name 44 different papers covering directional drilling and borehole surveys at many properties and by many methods, which include photometric, gyroscopic and seismic techniques.

"Mining Technology" of January, 1946 and published by A.I.M.E. contains four good papers. They are:

(1) "Deviation of Diamond drill Holes in the Metaline District, Washington"
By Sampson & Griggs, see Page 3.

(2) "Some Problems Involved in the Interpretation of Diamond drill hole Sampling and Surveying"
By Collins, see Page 17.

(3) "Surveying and Controlling Diamond drill Holes"
By Yates

(4) "Application of Oil-well Surveying Instruments and Technical Services in the Mining Industry"
By Kothny

Mr. Roland Blanchard
Re: Surveying Diamond
Drill Holes

Dec. 16, 1947

Two recent papers published by the Bureau of Mines in May of this year are of some interest. They are titled "Technique of Surveying Diamond-Drill Holes with the Wright Radiolite Borehole-Surveying Instrument", R. I. 4061, and "A Simple Device for Measurement of Angles of Azimuth and Deviation from the horizontal on glass tubes used for surveying diamond-drill holes", R. I. 4062.

The Longyear Company also has a catalog, their No. 9 titled "Diamond Core Drilling", which refers very briefly on Page 15 to the conventional clinometer.

I trust these references may be of some usefulness during your forthcoming return to Mt. Isa.

It was good to see you again, although too briefly. Again please accept my very best wishes.

Yours sincerely,

L. KENNETH WILSON

LKW:W

BCC: WHLoerpabel
DJPope
WRLandwehr

Salt Lake City, Utah
May 26, 1947

Mr. W. H. Loerpabel, Manager
Mining Department
American Smelting and Refining Co.
120 Broadway
New York 5, New York

DIAMOND DRILL CORE-BARRELS

Dear Sir:

Pursuant to your letter of May 2, I have today received from Sprague and Henwood the 1 - EX and 1 - AX special core-barrels for the account of Boyles Brothers Drilling Company, and have today turned them over to that company.

We will currently receive reports on efficiency of these core-barrels and will advise.

Yours very truly

J. FRED JOHNSON

JFJ:ES
cc:WRLandwehr
SEZelenkov
JHCourtright

W. R. L.
MAY 27 1947

MINING DEPARTMENT
Received
MAY 27 1947
Suspense:
Note | Handle | Rev. | Send Return | Ack. Advise | File

Salt Lake City, Utah
May 9, 1947

Mr. W. H. Loerpabel, Manager
Mining Department
American Smelting and Refining Co.
120 Broadway
New York 5, New York

DIAMOND DRILLING
COREBARRELS

Dear Sir:

Pursuant to your letter of the 2nd to Mr. Landwehr, I attach copy of letter of the 8th from C. L. Lindhe, Manager, Boyles Brothers Drilling Co. and copy of order for EX and AX corebarrels for Boyles Brothers account. Will advise on experience with the corebarrels in the field, probably at Kokomo.

Yours very truly

J. FRED JOHNSON

JFJ:ES
cc:WRLandwehr
DJPope
SEZelenkov
JHCourtright

W. R. L.
MAY 12 1947

MINING DEPARTMENT
Salt Lake City
Received
MAY 8 1947
My File
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BOYLES BROS. DRILLING COMPANY
Diamond Drilling Contractors and Manufacturers
1321 South Main
Salt Lake City 4, Utah

C O P Y

May 8, 1947

Mr. J. Fred Johnson
Manager of Operations
American Smelting and Refining Company
700 Pacific National Life Bldg.
Salt Lake City, Utah

Dear Mr. Johnson:

Thank you a lot for sending the information on the Series M Core Barrel, manufactured by Sprague and Henwood Inc.

After studying the cut and assembly it would appear to me to be a very efficient core barrel as far as core recovery is concerned although it may retard the drilling speed somewhat. We would like to buy a couple of these core barrels to test out on your work at Kokomo, but for the reason that we are manufacturers of drill equipment ourselves, I am not quite sure that Sprague and Henwood Inc. will sell to us direct, never having been a customer of their's before. In order to avoid possible delays we would very much appreciate if it would be possible for you to order these barrels from Sprague and Henwood Inc. and charge them to us. We would like to have them sent to Salt Lake to look them over before sending them on to Kokomo. We would like to have a five foot AX and a five foot EX core barrel complete with blank bit and shell. Both with the standard bit and core tube shell.

Yours very truly

/s/ C. L. Lindhe

W. R. L.
MAY 12 1947

May 9, 1947

Sprague & Henwood
P. O. Box 446
Scranton 2, Pennsylvania

Gentlemen:

Reference is made to your Bulletin #175, "Series 'M' Double Tube Corebarrel".

Please ship by express and bill the writer for:

1 - 5' EX Series "M" Double Tube Corebarrel, complete with Standard Inner Tube Core Shell and Blank Bit for Standard Core Shell, as shown on Page 3 of the Bulletin, being parts 15001, 15009, 15017, 15021, 15025, 15029, 15037.

1 - 5' AX Series "M" Double Tube Corebarrel, complete with Standard Inner Tube Core Shell and Blank Bit for Standard Core Shell, as shown on Page 3 of the Bulletin, being parts 15002, 15010, 15018, 15022, 15026, 15030, 15038.

Yours very truly

JFJ:ES

J. FRED JOHNSON

Blind cc:WHLoerpabel
WRLandwehr
DJPope
SEZelenkov
JHCourtright

1

Diamond Drilling at the Hollinger Mine

By

W. Roy Dunbar

Compliments of
E. J. LONGYEAR COMPANY
MINNEAPOLIS, MINNESOTA

*Chief Geologist, Hollinger Consolidated Gold Mines, Limited.

Compliments of

E. J. LONGYEAR COMPANY

MINNEAPOLIS, MINNESOTA

AMERICAN SMELTING AND REFINING COMPANY
MINING DEPARTMENT
120 BROADWAY, NEW YORK 5

W. H. LOERPABEL
MANAGER

May 2, 1947

AIR MAIL

Mr. W. R. Landwehr, Chief Geologist
American Smelting and Refining Co.
700 Pacific National Life Bldg.
Salt Lake City, Utah

DIAMOND DRILLING
COREBARRELS

Dear Sir:

When we were in Leadville you will remember that I raised a question as to whether we were using the most up-to-date corebarrels for maximum core recovery.

Attached hereto is a copy of Sprague & Henwood's Bulletin #175 describing their Series "M" Double Tube Corebarrel.

I understood from Mr. James A. Ross that these corebarrels can be obtained from Sprague & Henwood, Box 446, Scranton 2, Penna.

It may be worth your while to look further into the matter.

Yours very truly,

W. H. LOERPABEL

Encl.

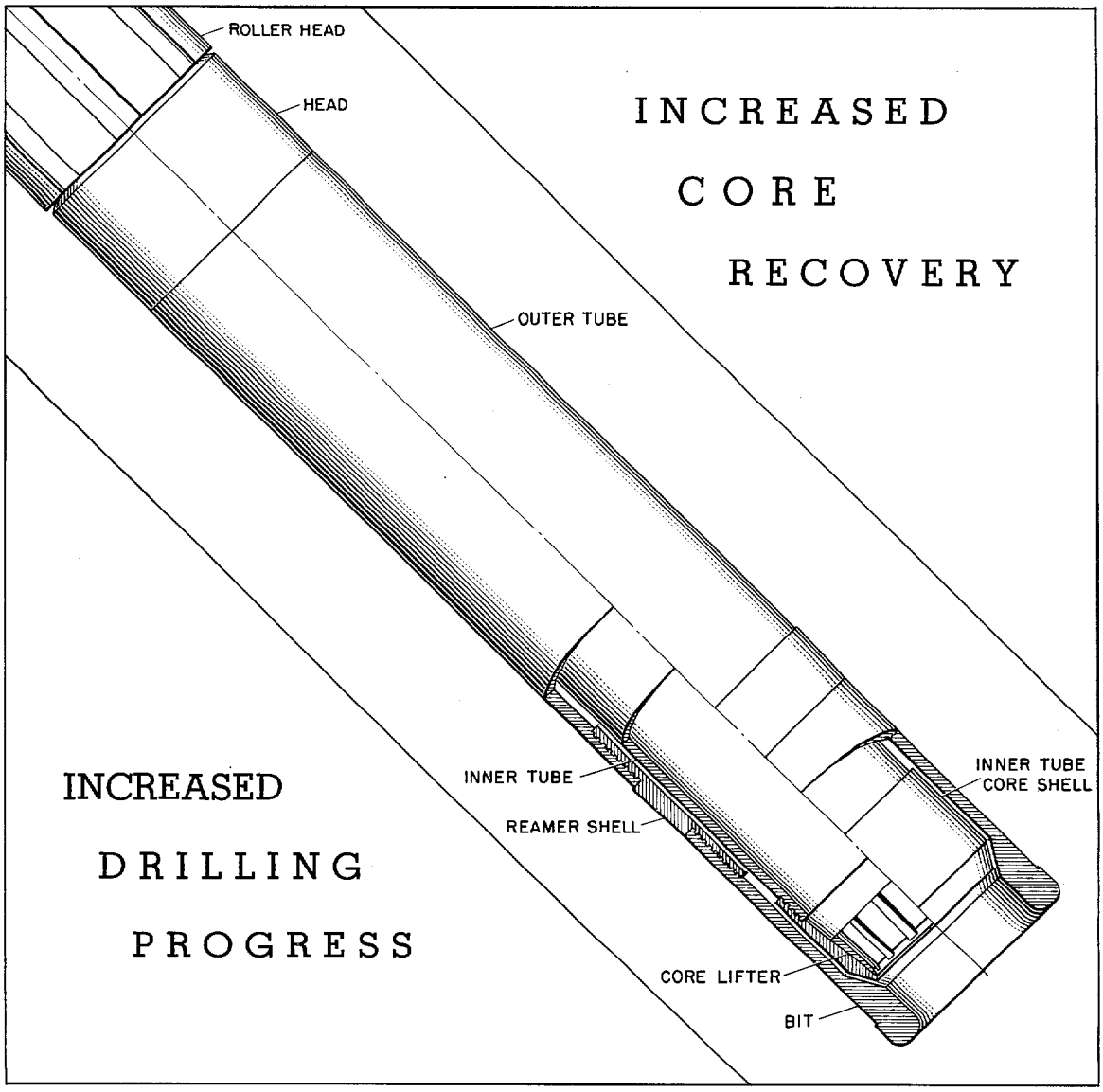
cc: JFJohnson, w/encl., A/M
SEZelenkov, " , "
DJPope, " , "
JHCourtright," , "

W. R. L.
MAY 5 1947

MINING DEPARTMENT
Salt Lake Office
Received
MAY 5 1947
Suspense:
Note | Handle | Rev. | Ind Return | And Advise | File

SPRAGUE & HENWOOD
SERIES "M"
DOUBLE TUBE COREBARREL

BULLETIN No. 175



Manufactured By

SPRAGUE AND HENWOOD, INC.

Main Office and Factory

Scranton 2, Pennsylvania, U. S. A.

SERIES "M" DOUBLE TUBE CORE BARREL

Acknowledgment is made to Dr. Stanley A. Tyler, Professor of Geology, University of Wisconsin, Madison, Wisconsin, not only for his contribution to this pamphlet, but also for the assistance rendered by him in the design and development of the Series "M" Corebarrel.

It is a foregone conclusion that the primary purpose of diamond drilling is the recovery of core and, therefore, the percentage of core recovered as a result of such drilling should be as large as possible.

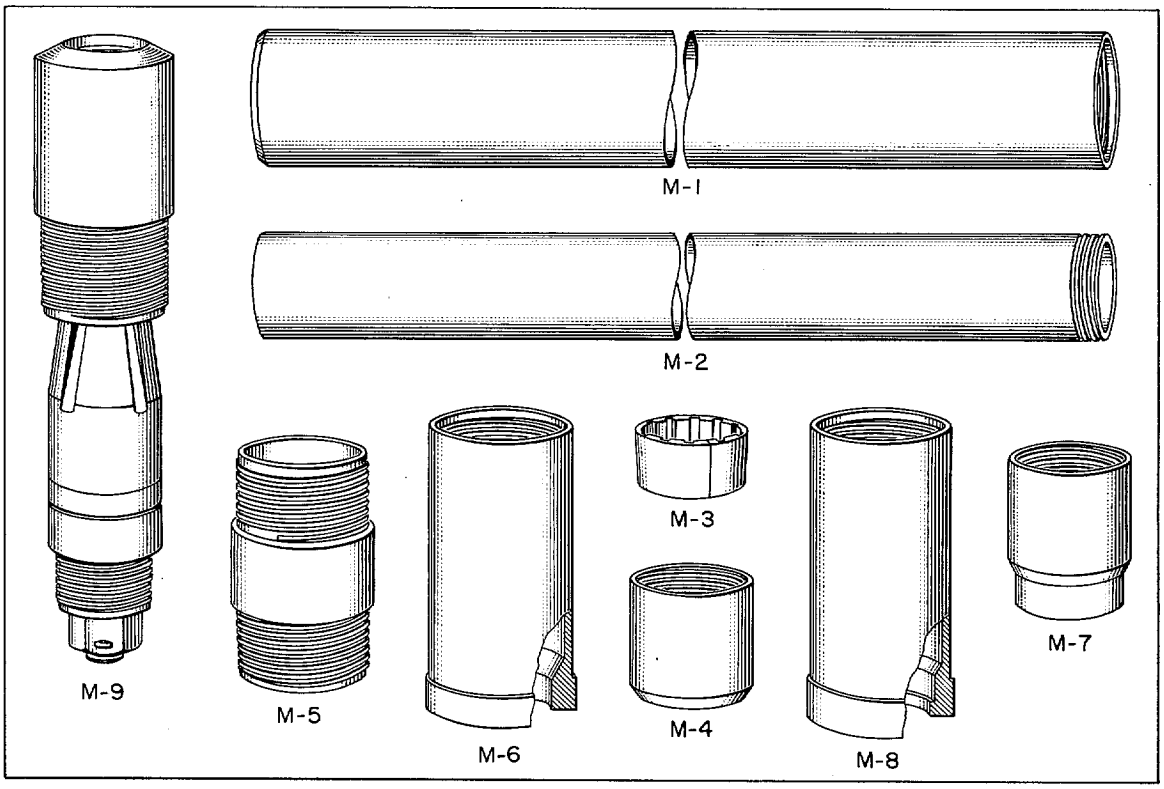
In his recent paper on "Diamond Drilling in the Marquette District of Michigan with Emphasis Upon Core Recovery",* Dr. Stanley A. Tyler, Professor of Geology at the University of Wisconsin, Madison, Wisconsin, has the following to say about "Core Recovery":—

> "The amount of core recovered per unit footage drilled, or the percentage of core recovery, is dependent upon three factors:— 1, the character of ground; 2, the type of equipment used; 3, the drilling practice employed. In any given case, the last two factors may be varied. When a hole is once located, however, nothing can be done to condition or change the type of ground the drill is to penetrate. It is, of course, common knowledge that fractured, porous, or soft ground is difficult to core, whereas massive ground free from fractures is relatively easy to core. This situation has led the average diamond driller to attribute low core recovery to the nature of the ground, without giving any consideration to the other factors. If it be granted that the chief purpose of diamond core drilling is to recover core rather than to make hole, then the basic problem becomes one of determining the physical drilling conditions which are necessary for coring. The wedging or blocking of core in the core lifter or inner tube is the chief factor which terminates the formation of core. If drilling be continued after such a block develops, no core for the footage so drilled will be recovered, and some of the core formed previous to the block may be ground up. Thus, equipment as well as drilling practice which tends to minimize the chances for core to block will increase both the core recovery and the length of the run."

It was with this thought in mind that the Sprague & Henwood, Inc., Series "M" Double Tube Core Barrel was developed. The Series "M" Core Barrel is a double-tube swivel or ball-bearing type core barrel. The inner tube in this type of core barrel is suspended upon ball bearings, the theory of which is to free it from rotation of the outer tube. Actually, however, the inner tube probably does not remain absolutely stationary while drilling is in progress, for frictional resistance in the ball race, and other factors, may cause it to rotate slowly. However, even the slowing down of the rotation of the inner tube is a very important factor in decreasing the amount of grinding and blocking of the core within the core barrel.

*Engineering and Mining Journal, Vol. 147, No. 2, February, 1946, PP 119-121.

PARTS FOR SERIES "M" DOUBLE TUBE COREBARREL



NAME OF PART	Symbol	PART NUMBERS			
		EX	AX	BX	NX
Head	M-9	15001	15002	15003	15004
Outer Tube 10 Ft.	M-1	15005	15006	15007	15008
Outer Tube 5 Ft.	M-1	15009	15010	15011	15012
Inner Tube 10 Ft.	M-2	15013	15014	15015	15016
Inner Tube 5 Ft.	M-2	15017	15018	15019	15020
Reamer Shell	M-5	15021	15022	15023	15024
Core Lifter	M-3	15025	15026	15027	15028
Inner Tube Core Shell (Standard)	M-4	15029	15030	15031	15032
Inner Tube Core Shell With Extension	M-7	15033	15034	15035	15036
Blank Bit for Standard Core Shell	M-6	15037	15038	15039	15040
Blank Bit for Extension Type Core Shell	M-8	15041	15042	15043	15044

With the ordinary type of ball bearing or swivel double-tube core barrel, the core lifter is located in the bevel part of the diamord bit, which is attached to the outer tube, and the inner tube terminates above this core lifter. The blocking of core, which always causes grinding and loss of core, nearly always takes place in this space between the face or cutting edge of the bit and the bottom of the inner tube.

In the Series "M" Core Barrel, the bottom of the inner tube is equipped with an inner tube shoe or core shell and this shoe extends down as close as possible to the face of the bit. The core lifter operates inside this inner tube shell and since the core is already in the inner tube when it passes through the core lifter the tendency to block is reduced considerably.

The ordinary type of core lifter, as used with the standard ball-bearing type of core barrel and which operates in the taper of the standard bit, frequently tilts or cocks to one side, particularly in broken strata, and very effectively blocks the entrance to the inner tube. In some cases, the lifter will rotate with the bit and either grind the softer portion of the core or tear off angular pieces from the harder phases which will eventually cause the core to block in the inner tube. In the Series "M" Core Barrel, the core lifter which operates in the inner tube shell attached to the lower end of the inner tube consists of a thin 2½-degree taper, fluted spring-type lifter similar to the standard type.

Since the core spring has only a 2½-degree taper to work in, and is attached to the inner tube which rotates slowly if at all, the spring remains oriented at all times and operates satisfactorily in both hard and soft ground; thus the tendency to block or grind core is almost entirely eliminated in the Series "M" Corebarrel.

Two types of Inner Tube Shoes or Core Shells are available for use with the Series "M" Core Barrels. The only difference in the shoes is that the one has an extension on it of a very thin metal, the effect of which is to extend the inner tube almost to the very cutting edge of the bit. Either type of shell can be furnished as desired.

The Series "M" Core Barrel has a female straight-wall bit, which is considerably longer than the standard type of diamond bit. A short reamer coupling in which stones may be set to maintain the gauge of the hole is also furnished. The inner tube extends through the reamer shell.

In order to remove core from the Series "M" Core Barrel, it is necessary to remove the diamond bit and then take off the inner tube shoe or shell from the inner tube. It is for this reason that a long bit with a female thread is necessary.

The Series "M" Double-Tube Core Barrel can be furnished in all standard sizes. Cast-Set Diamond Bits and Reamer Shells of both the hand-set and insert type can be supplied upon very short notice.

The results obtained through actual use of this new type core barrel, as compared with the use of the ordinary swivel-type double-tube core barrel, fully justify the confidence its designers had in predicting a far greater percentage of core recovery through the use of the Series "M" Core Barrel.

AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona

March 10, 1947

Mr. W.R.Landwehr, Chief Geologist
American Smelting and Refining Co.,
700 Pacific National Life Bldg.,
Salt Lake City 1, Utah

SURVEYS

Dear Sir:

Thank you for your letter of March 5th, with which you sent the copy of the Eastman Oil Well Survey Company report on the survey of some diamond drill holes at Leadville.

Up to the present time we have been doing our own surveying,and it has been accurate enough. However, we do have some work coming up where we may desire something more elaborate, in which case we shall keep in mind this Eastman Oil Well Survey Company.

Yours very truly,

D. J. POPE

DJP:blc

MINING DEPARTMENT
Salt Lake Office
Received MAR 13 1947
My Note:
Suspense:
Note | Handle | Rev | Add Action | Add Advise | File

W. R. L.
MAR 13 1947

Diamond Drilling

March 5, 1947

Mr. D. J. Pope, Manager
Southwestern Mining Department
American Smelting & Refining Co.
P. O. Box 2229
Tucson, Arizona

Dear Sir:

We recently employed the Eastman Oil Well Survey Company to survey some diamond drill holes for us in Leadvill, and their work was so satisfactory that I thought it well to call the matter to your attention in case you have similar surveying to do.

There is enclosed herewith a copy of their report on the survey of drill holes 1, 2 and 5 of the Garbutt mine.

The address of their office in Denver is 1360 Speer Boulevard, P. O. Box 1500, Denver 1, Colorado. Mr. J. B. Murdoch, Jr. is manager.

Very truly yours,

W. R. Landwehr

WRL:si
Blind cc: J.B.Murdoch, Jr.

February 25, 1947

E. J. Longyear Company
1701 Foshay Tower
Minneapolis 2, Minnesota

Gentlemen:

This is to acknowledge the receipt of, and to thank you for the 1947 edition of the "Bibliography of Diamond Drilling."

Very truly yours,

W. R. Landwehr

WRL:si

EASTMAN OIL WELL SURVEY COMPANY

GENERAL OFFICES:
1360 SPEER BOULEVARD. PHONE MAIN 7151
P.O. BOX 1500 • DENVER 1, COLORADO

November 13, 1946

Mr. W. R. Landwehr, Chief Geologist
Amer. Smelting & Refining Company
620 Pacific National Life Bldg.
Salt Lake City, Utah

Dear Mr. Landwehr:

I recently received your letter of November 6th in which you mentioned the pamphlet being published by the E. J. Longyear Company. I have just written a letter asking them to send me two copies for our use at this office. I appreciate very much your remembering my interest in learning something of diamond drilling methods and letting me know of this bibliography.

Yours very truly,

EASTMAN OIL WELL SURVEY CO.

J. B. Murdoch Jr

J. B. Murdoch, Jr.
Chief Survey Engineer

JBM/dm

MINING DEPARTMENT
Salt Lake Office
Received NOV 15 1946
My attn:
Suspense:

Note	Handle	And Return	And Advise	File

November 6, 1946

Mr. J. Benton Murdoch, Jr.
Eastman Oil Well Survey Co.
1360 Speer Boulevard
P. O. Box 1500
Denver 1, Colorado

Dear Mr. Murdoch:

When you were in Salt Lake you asked me to recommend to you some good books dealing with diamond drilling. The only one I was able to recommend at that time was Peale's Handbook, which contains the best general treatment of the subject.

However, the E. J. Longyear Company, 1701 Foshay Tower, Minneapolis, Minnesota, have just published a pamphlet entitled "Bibliography of Diamond Drilling", and I would suggest that you write for one for it contains references to all the literature covering the subject.

Very truly yours,

W. R. Landwehr

WRL:si

November 6, 1946

E. J. Longyear Company
1701 Foshay Tower
Minneapolis 2, Minnesota

Gentlemen:

I wish to thank you for a "Bibliography of Diamond Drilling" which I received today.

Kindly put me on the mailing list for any corrections or additions that will be made in the future.

Very truly yours,

W. R. Landwehr

WRL:si

July 15, 1946

Eastman Instrument Company
1320 Spear Boulevard
Denver, Colorado

Gentlemen:

I have been informed that your company may possibly have a new method for surveying diamond drill holes. If so, I would be interested in knowing something about the method and whether or not you are equipped to make surveys.

Very truly yours,

W. R. Landwehr

WRL:si

Diamond Drilling

General estimate by Boyle Bros - 1991 - Bayhan gt.

		E-X		a-X
0 - 250 ft	—	$2.40	+25¢	= 2.65
250 - 500 "	—	2.60		= 2.85
500 - 750 "	—	2.85		3.10
750 - 1000	—	3.15		3.40

Reaming for casing 95¢/ft which includes rental of casing furnished by Boyles.

Cementing — 75¢/ft of hole, A.S.&R.T. furnish cement.

A.S.&R.T. furnish power.

Diamond Drilling

I. C. 7111. Haile Gold Mine.

66 holes.

Depth ranges from 90 to 575 feet.

Total feet drilled 15,706.

Av. total cost per foot $1.266

Diamond Drilling Cost Estimate

Figure $3.50 a foot up to 1000 ft and $4.00 /ft beyond that according to Boyle Bros.

Shenandoah - Dives

Drilling with Mitchell Drill.

Month of April

Labor	$0.377
Bits	0.236
Reaming Bits	0.04
Compensation	0.02
Air, water, etc.	0.12
	0.893

2 men in drift.

Largest hole 300 feet, remainder 25' 6 1/2"

Amount includes all moving and setting up.

"

"Diamond-Drill Sampling Practice"

by

W. Rex Storms

E. & M. J., February, 1933.

Describes methods of caring for core and sludge.