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Engineering practice in the Tri-State District

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ENGINEERING PRACTICE IN THE TRI-STATE DISTRICT

by

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ENGINEERING PRACTICE IN THE TRI-STATE DISTRICT.

Mining operations of the zinc and lead deposits of Southwest Missouri, Southeast Kansas and Northeast Oklahoma forming what is known as the Tri-State District are peculiar in many ways. The "old country" with its shallow gougings and more or less crude methods has practically passed; methods have been improved with the increased size of operations, and the Engineering Department has grown into an indispensable link in the mining operations of practically all the operating companies.

But traditions often die hard. Many phases of mining operations are peculiar to this District alone, and likewise engineering practice has its peculiarities. However, it is the outgrowth of practice showing it best suited for the conditions, and there need be no apology made for any phase of it especially among the larger and more progressive companies. It is adapted to fit the conditions, and if any part appears off color to an outside engineer he may rest assured that it is the outgrowth of much practice and is adopted as being the most satisfactory for existing conditions. I do not mean that it cannot always be improved upon, but that in general it fills the bill.

The engineers' work of course includes milling and a multitude of surface jobs, but I will confine this article to the actual mining end of the work and problems allied.

Let us assume a company having a block of leases some three miles square and operating or subleasing thirty or forty independent mines. Manifestly, the first surveying problem is one to make a common or control survey, one that ties all mines together to a common base and 0-0 point, so drifts can be cut from one mine to another, property lines established in the ground, ore bodies cut to at the proper levels, etc., and with the greatest degree of accuracy and least amount of subsequent work. Furthermore, the work must continually be kept in such condition that any job that needs to be done may be done quickly when needed. The volume of work handled is large, and speed is essential. Property lines and lines for drifts must be set when needed (and not tomorrow) from latitudes and departures calculated while in the ground. This work must always be accurate as well as fast. The Engineer may be holding up a bunch of ~~mine~~ men while making calculations. His stations may be on a haulage track or he may be holding up hoisting, and while ground men are as a rule very good fellows and quite willing to take a rest, too much cannot be tolerated. It is very essential to have latitudes and departures in all mines from a common O-O point and to constantly keep advancing these latitudes and departures on permanent points in the ground as the workings advance, and to have elevations on these permanent underground stations in all mines from some common datum on the surface, preferably sea-level.

To do this and include the area above mentioned the first thought would be to establish a triangulation system. But investigation soon shows it to be unnecessary if not impracticable. The country is treeless and very flat. Triangulation stations would have to be raised considerably above the ground. Shacks, tailing piles, and mill buildings have a habit of jumping up promiscuously and often where least expected to cut off the line of sight. Furthermore, why triangulate when conditions are practically as good to measure every course on an extensive traverse system (the principal points of which are the forty-acre corners) as it would be to measure the base lines of a triangulation system? This is what is done, and it is satisfactory. Latitudes and departures can be carried to any shaft or shafts within this area, dropped into the ground, and carried to any desired point in a very few hours.

Carrying the Azimuth Underground.

This phase of the work is simplified in the majority of cases by the numerous shafts that it is the practice to sink.

Shafts are shallow, hence cheap, and the limited tonnage that can be hoisted from one tends toward making necessary several shafts in a single ore body even if small. Many shafts are sunk for ventilation purposes only. This makes conditions ideal to establish the azimuth underground by a simple two-shaft problem. In probably 95% of the cases (of operating mines) this method can be used. No. 14 iron wire with an 8 or 10 pound weight attached admirably serves the purpose. Occasionally a hoisting cable with a can hooked on and left two or three feet off the bottom can be used, but it should have time to come to a complete rest, and in general is not as satisfactory as wires.

Sometimes it is necessary to carry the azimuth down a single shaft. Then two wires with heavier weights attached and strung as far apart as possible should be used. Probably the simplest procedure is the best: that is, that of lining in with the wires both top and bottom rather than trying to triangulate to them.

One thing that is usually condemned by persons not familiar with conditions in the District is the use of the magnetic needle for small workings and particularly mines during the development stage having but one shaft down that do not warrant a regular survey. Where the quantity of work is large this work can be done in a small fraction of the time required to plumb the shaft. If done carefully it is good for everything up to a radius of about 250 feet. Drill holes can be cut squarely with a 5 x 7 foot drift at this distance, and drifts can be made to meet without fear of missing, if ordinary precautions are taken. The needle on a transit is generally to be preferred, but remarkably good work can be accomplished with a Brunton compass, and it can be taken into places difficult to carry a regular transit.

However it should be realized that while compass surveying has a place it's use is limited. It should never be used entirely in any operating mine of any size, or to set a property line by, or any other work of importance.

Underground Surveying Work.

Of course, the first thing after tieing in the underground of a mine to the surface is to put the azimuth, latitudes, and departures, and elevations onto some permanent points or stations underground. In short, you want to establish some base lines underground. Roof stations are in general impracticable because of the height of the roof in most places. Not one station in fifty can be put in the roof. So it is necessary to put them in the bottom. Pieces of old 1¼" Leyner steel, or rails 2 or 3 feet long, pointed and hardened, can in some places be driven into the bottom securely and left sticking up 2 to 6 inches, making a fairly permanent point. Probably a better methed is to have a Jackhammer or Leyner machine to run a starter downward, allow it to "muck" in the hole, and leave it. This cannot readily be pulled out. In general these stations are satisfactory. Sometimes some of them are knocked out because of being in the way of haulage, or through ignorance of their purpose, or shot out or buried, but if a mine is properly "steeled" this only means dropping back onto other stations and carrying the traverse forward again. It is not good practice to set stations too near working faces, but rather they should be kept back of all fly dirt.

With the permanent stations thus back of the workings it is necessary to set temporary points ahead to survey the working places from. These are usually common wire nails stuck into the bottom, used once and forgotten. This work where only the outline of the working face and pillars is desired need not be as accurate as the traverse on the permanent stations. So, to be consistent, do not take any information more accurately than it is to be used. The permanent stations are of course platted by latitudes and departures, while the temporary points and face shots platted by scale and protractor. Face shots should be measured to the nearest foot, and angles measured to quarter degrees.

Temporary points should be measured to tenths in distance and minutes in angle. Permanent stations should be measured to hundredths, and angles to single minutes.

The following sheet of notes, in addition to showing the form used, shows two new permanent stations set and then the traverse carried on to temporary points to survey the extension. These notes are not complete but cover only a small portion of a

Dick
Red

SWIFT
#23 & 25
Extension

7-23-22

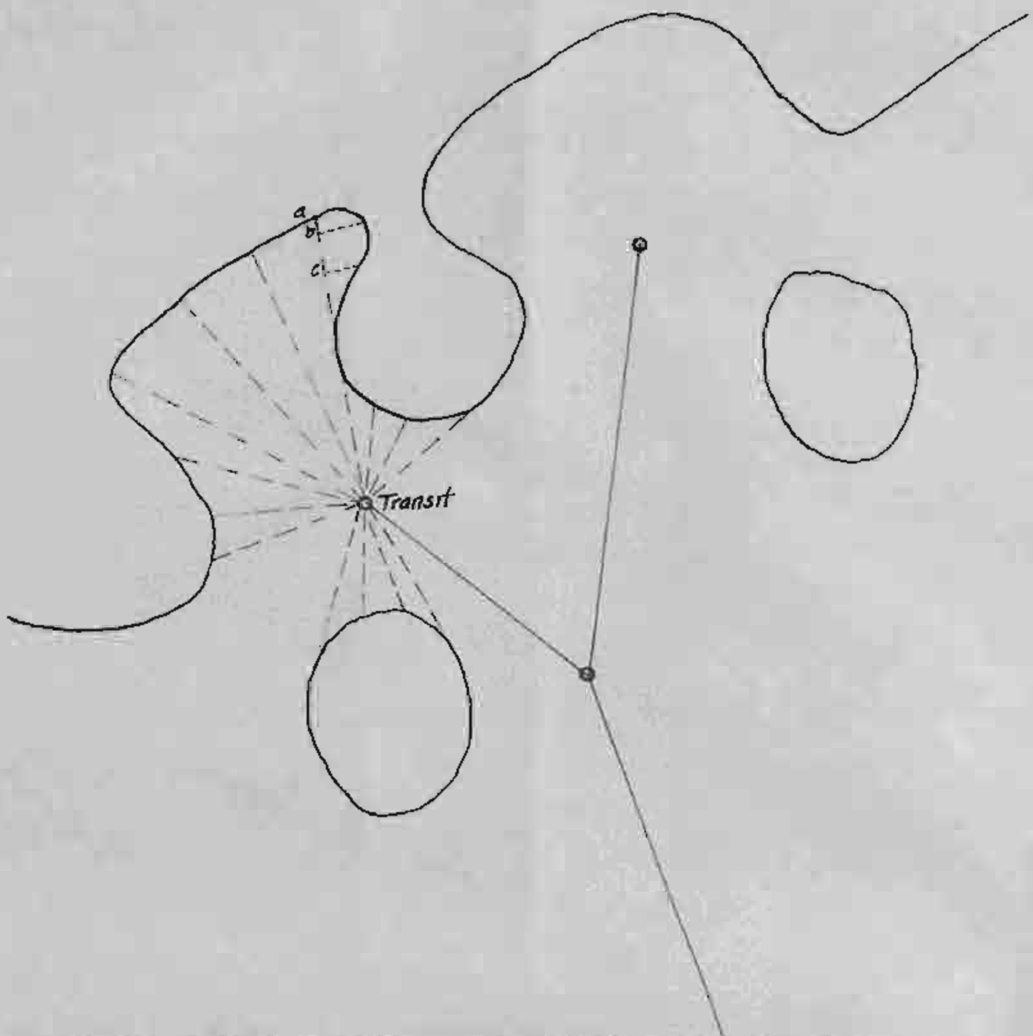
B.S.	Inst.	F.S.	Dist.	Hor ∡
Steel 4	Steel 6	New Steel 7	136.62	169-06
		Pt. 1	72.0	165-54
Steel 6	Steel 7	Pt. 2	52.51	53-38
		Pt. 3	87.4	232-12
Steel 7	Pt. 2	Pt. 4	46.4	232-44
		Pt. 5	37.3	28-43
Steel 7	Pt. 2	New Steel 8	69.85	224-10
Pt. 2	Steel 8	New Rail R.R. 2070	72-04
		Pt. 6	34.1	173-34
		Pt. 7	115.5	256-52

LEFAX FILING INDEX

(Pt. 1)	62-161	(Pt. 7)
29-45½	59-166¾	11-70½
27-164¼	62-176	15-104
35-186	55-183-3R	28-112
open	47-183½	43-135
55-198½	43-184½	52-152
56-207	38-197	50-162½
60-213¼	31-221½	(47-161 Drill Hole)
71- "	all	54-166
73-217	(Pt. 4)	55-171
75-220¼	12-27½	50-180
open	14-72½	50-191½
70-223	24-86½	37- "
67-232	32-90	29-204½
61-246¼	41-91½-6L	28-218
44-252½	51-93	37-229½
30-269	48-111	53- " 2L
all	52-142	53-240
(Pt. 3)	44-148	57-242½
14-81¾	42-160	60-256
29-95½	35-164¾	57-263½
47- " 2L	23-175½	59-272½
53-102	23-205	63-280
53-113½	all	55-290½
46-129-Y+18°		56-300
44-138-Y 17		39-312¾
46-145-Y 17		24-320
57-151-Y 18		all

In taking shots around on the face, it is desired to take the points of farthest advance; that is, the headings. As the roof in some places approaches 60 feet or even more in height considerable inclination of the chain is necessary and this must be corrected. The vertical angle and distance may be recorded as read and later corrected for horizontal distance from traverse tables, or where the inclination is not too great it can be corrected mentally as read and the corrected distance recorded. A little experience is necessary to do this and it should not be attempted for large vertical angles, but it is a labor-saver if it does not degenerate into mere guessing.

Offset shots are another source of saving time and labor and are satisfactory if properly used. Suppose from the transit point in the sketch below you cannot see quite all of the face. Instead of making another setup, take shots to the points marked "a", "b", and "c", and record distances right or left at right angles to the line of sight.



The preceeding of course applies only where a survey of the outline of the rough workings is desired. Where there is a property line to establish, or a drill hole to cut to, or two drifts to meet, the work must be carried right up with all the accuracy used in setting the permanent stations. Everything then must be kept in latitudes and departures, calculated as you proceed if need be. For instance, if we want to drift to a drill hole whose latitude and departure we know, from a surface survey or to a point in another mine, we carry latitudes and departures up to the point where it is desired to start the drift, calculate the closure, and set the line to be followed with the drift.

It is sometimes difficult to actually put in points for property lines, ~~or~~ or lines to be followed in cutting drifts. The gangue rock, which is chert, is very hard and difficult to drill and it is necessary to set up a machine or get a Jackhammer to drill a hole for a wooden plug to hold the point. Holes cannot satisfactorily be drilled by hand.

Prospecting and Blocking out Ore Bodies, from Drilling.

One of the most difficult things that faces the Engineer in the Tri-State District is to prove the presence (or non-presence), tonnage, and grade of an ore body. Many tracts of land upon which there have been drilled a sufficient number of good holes to be called by mining men a "good ore body" have later proved failures, often both as to size and grade. Similarly, many tracts of land which have apparently been drilled out without success later developed into good mines. It is remarkable the number of instances in which a tract of land is drilled and re-drilled by several parties until it is literally "punches full of holes", and then someone comes along and finds a good ore body. Study the following blue prints No. 1 and No. 2, and you can see how difficult it is to prove the existence of an ore body from the drilling, and how much more difficult to calculate tonnages and grade. What size mill will this acreage warrant? what are the tonnage figures we can deplete against? and what can be the expected recovery of galena and sphalerite? are serious questions, and must be answered in some manner.

Too often shafts are sunk and mills erected when no answer to any of these questions is known. When this is the case mining is put on a purely gambling basis, yet some of the best mines in the District have such a beginning. An ore body like that shown in blue print No. 3 can be very successfully blocked out by drilling, but the majority are very irregular runs that are often quite narrow, and are shown in this extreme by blue prints Nos. 1 and 2. Often one deposit lies directly below another at a lower level. This fact emphasizes the necessity for deep drilling, especially in wild-cat work. Instances are numerous where holes have been stopped in some marker below a certain ore horizon, and later drilling has proved up a deeper deposit.

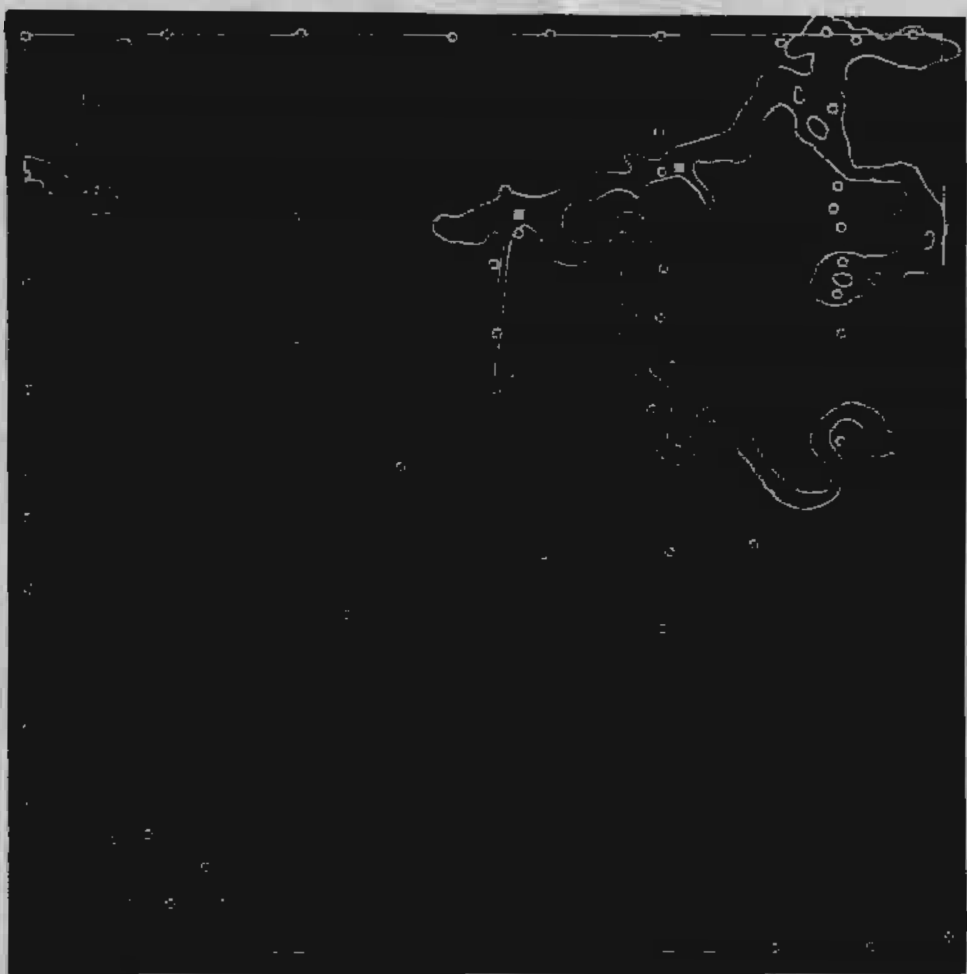
In regard to locating holes in prospect work, there are no hard and fast rules to follow. In general, it may be said that holes should be placed around the strike hole in such a manner as to lead out the run if any exists. If one of these holes picks it up continue in that direction and perhaps a third hole will find ore. For such a deposit as shown in blue print No. 3 holes can be spaced more uniformly, but every different tract presents different problems.

Some of the things that may be of help in locating prospect drill holes are (1) adjoining workings, if any; (2) surface topography; (3) subsurface topography (bottom of Cherokee if you believe in the "shale theory"); (4) adjacent drilling; (5) knowledge of formations drilled through; and, (6) general trend of runs of ore throughout the District.

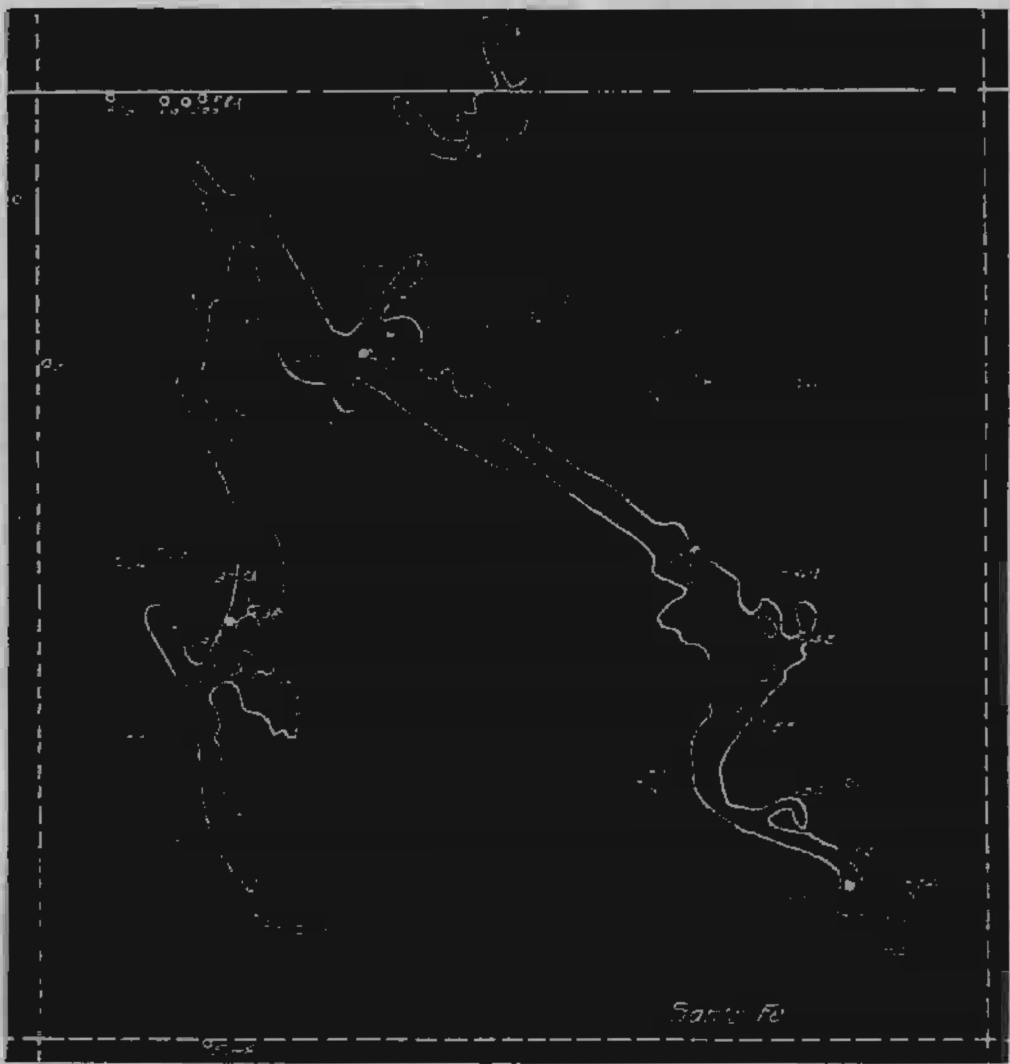
Tonnages can be calculated very satisfactorily on the type of deposit shown by blue print No. 3, but to get the grade accurately presents a difficult problem. The chief troubles lie in the fact that the drill cuttings as piled out and assayed are not representative samples of the deposit drilled through, and if we assume them to be representative samples, what area do they represent because of the spotty nature of many deposits? Some of the things that may affect the sam;e are (1) loss of cuttings in crevices and openings; (2) all the cuttings not being saved; (3) grab sample often taken; (4) fines washed out by driller; (5) is ground dewatered or not; (6) float lead poured off; (7) hole not bailed out clean; (8) too long screws taken; (9) shale not cased off; (10) salting, through material falling in from above.

A sample sheet of actual tonnage calculations follow. It will be noted that this is not scientifically correct. Each hole, regardless of location, is given the same weight in the results. Other assumptions are made.

General knowledge of similar conditions must prevail rather than trying to put it on a strictly scientific and mathematical basis. Note the way the ore bodies in blue prints Nos. 1 and 2 have mined. When such deposits are encountered, any figures an Engineer can present is hazardous to his reputation, for it is beyond the realm of mathematics, and sound commonsense much prevail.



No. 1



№ 2

№ 3

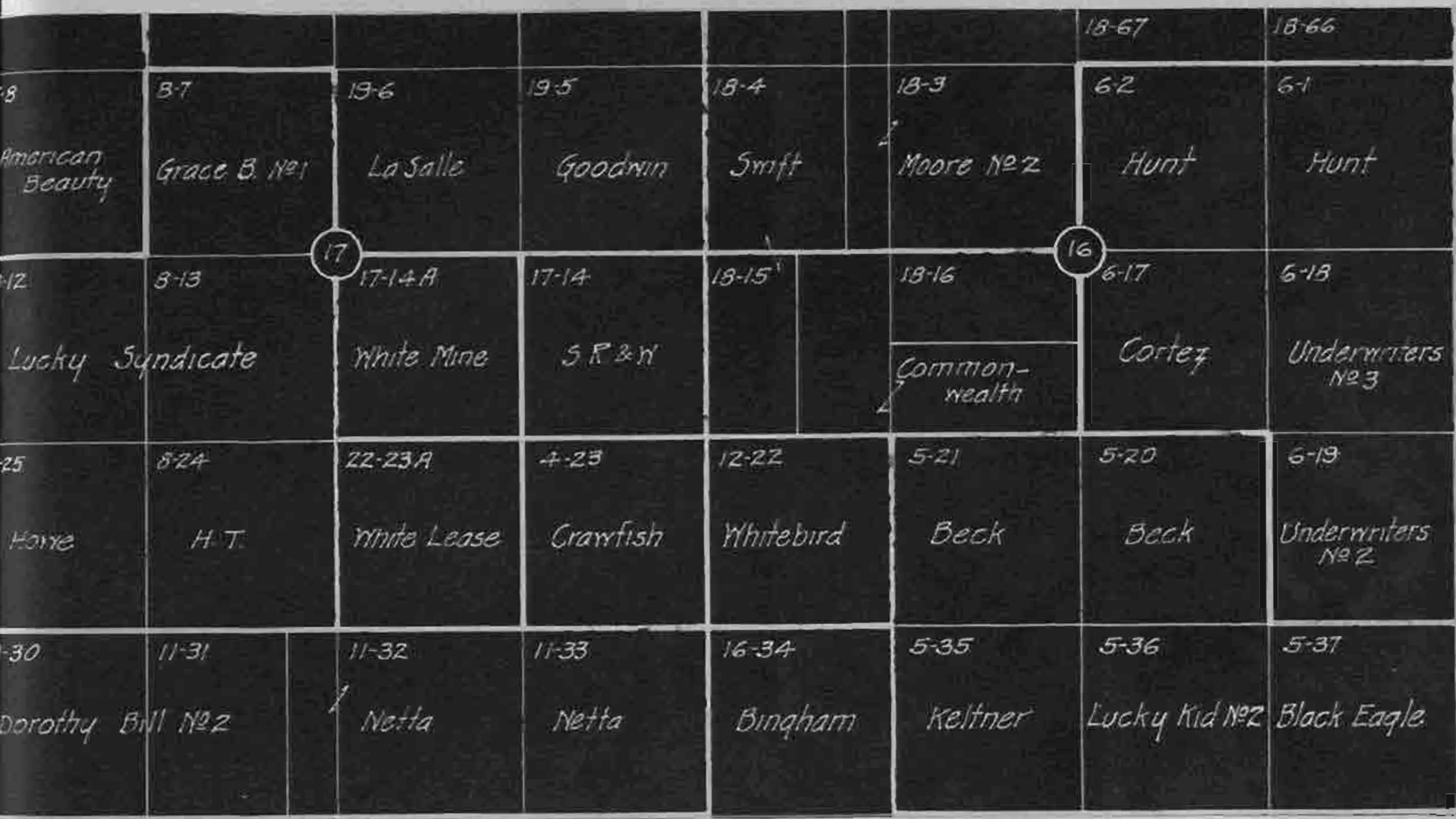
BLOCK "C"

Analysis of drill records.

Hole Number	Depths	Feet	Percentage	Foot Percentage
K 5	195 - 215	20	10.00	200.00
K 3	195 - 218	23	8.00	184.00
K 2	195 - 215	20	20.00	400.00
K 1	205 - 226	21	10.00	210.00
24	170 - 215	45	4.12	185.40
22	200 - 215	15	14.05	210.75
2	200 - 215	15	8.00	120.00
23	205 - 215	10	2.62	26.20
Totals	8 holes	169 feet		1536.35

CALCULATIONS

Total area blocked	85,600 sq.ft.
Average height of ore deposit	21 feet.
Tons of ore ($12\frac{1}{2}$ cu.ft = 1 ton)	143,808
Less 15% for pillars, and mining loss	122,237
Percentage of sulphides in ore, based on facts	9.09
Tons concentrates: (ZnS + PbS)	11,111
At 80% mill recovery	10,223



This print shows the method of dividing up the land, and indexing it. Each of the squares above represents a forty-acre tract; each separate lease or allotment is given a parcel number, indicated by the first number shown; the second number is the index number given only for convenience in filing matter pertaining to that mine or tract. For example: "6-18" is Parcel 6, Index (or tract) 18.

Notes, Working Drawings, and Records.

Notes as taken in the field are on loose-leaf Lefax sheets. These are taken out of the book and each mine or tract filed separately. This system has its drawbacks, but if not abused is satisfactory. There is a chance for losing sheets, but all important data, such as new permanent stations, etc., is transferred to a ledger book containing latitudes and departures and elevations of all mines. With this method you must know what you are going to do before going into a mine, and take information for that work. You do not have all the information pertaining to a mine in a single or several field books to ferret out after you are in the ground. If the work is far away from the Main Office this may be an advantage, but under the existing conditions here knowledge of what you are doing and a single Lefax note book and a log book is far superior to carrying around a bunch of field books for each mine, and it is not uncommon to visit three to five mines a day.

Extension Surveys are made every month. This is the drudgery of the Engineer's work. However, with a good helper remarkable time can be made. In one case a mine working 1400 feet of continuous face was surveyed for extension by a two-man party in three and one-half hours, making 26 setups and shooting the face with more than 250 shots from 22 points; making an average of about 8 minutes setup on each point, and a face shot about every 50 seconds. But conditions must be ideal to attain this speed.

Working drawings, or details, are put on a good grade of paper preferably mounted on muslin. It is found to be better to roll these sheets, index, and file them, rather than to file them flat, although they take up much more room. The sheets are divided into 200- or 300-foot co-ordinates. The standard scale for working drawings is 1" = 50'. Tracings are made of these details, and when an extension is platted it is also put on the tracing so blue-prints can be made.

Sublease maps, drill records, production records, etc., must be filed in the same order.

A sample drill record is here introduced, showing how they are numbered. The first number indicates the Parcel, the second number the index or file number, and the last number the hole number:

Property: South Bingham; Drill owner: M D Montgomery;
Commenced 1/18/23 Finished 1/24/23 Water level: Dry
Drill runner: Leslie Goodboy and Clyde Lynn.

Depth From	To	Formation
0	20	soil and clay
20	40	white shale
40	52	brown shale
52	110	gray lime
110	140	white and brown lime
140	160	white flint, brown lime
160	179	blue and brown flint, brown lime
179	180	opening
180	185	very loose ground, no cuttings
185	187	opening
187	190	very loose ground, no cuttings
190	200	blue and white flint with few jack shines
200	230	white flint
230	235	white speckled flint with few jack shines
235	240	white speckled flint with fair jack
240	250	white and brown hard flint

Assay:

235 - 240 9.97% ZnS 0.21 % PbS
Cochrane Laboratories.