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MINE SURVEYING.

BY PROF. F. A. RAY.

The ancients have left but very little behind them to tell us of their practices in mine surveying. The oldest mine map of which we have any record is a papyrus in the museum at Turin. It was made during the reign of King Mineptha, 1400 B. C., and shows the works of an Egyptian gold mine.

The Egyptians were the first to practice land surveying, in replacing land marks along the Nile, obliterated by the river's continual overflow.

There is a papyrus in the British Museum believed to have been copied 1700 B. C. from a much older work. It gives rules for the solution of triangles, trapezoids and circles, and is said to be the oldest evidence we have of the solution of mathematical problems.

Hero, of Alexandria, in his works treats of mine surveying problems 250 B. C. and invented the deopeter, the oldest surveying instrument of which we have any record. It consisted of two straight edges fastened together at the center at right angles to each other. At the center was fixed a vertical rod sharpened at the foot which supported the instrument. At each end of the straight edges were placed sights for alinement and plumb bobs for leveling it. Hero could only measure right angles with this crude instrument, but he afterwards improved it so that any angle could be measured. This instrument is recorded as the origin of the modern Theodolite, and from this small beginning has been evolved the many perfected mathematical instruments of the present day.

There seems to be a break in the records of mining from the beginning of the Christian era to the middle ages.

Robert Hunt in his work gives a fac simile of a plat representing the Mynes deeps made 1480 A. D. It is said to be a rude attempt at map drawing.

Georgeus Agricola in 1556 was the first writer to systematically treat of mining. He tells us that ye olden time mine surveyor endeavored strenuously to keep his art a secret. That the divining rod and hazel twig were as much relied upon as

their most careful surveys. Not until the 17th century did writers advocate the platting of surveys by means of co-ordinates; since that time the art of mine surveying has steadily advanced, though unfortunately it has not by any means kept the pace with other arts and sciences that it ought to have done. It is one of the branches of surveying and is the art of making such measurements on the earth's surface and in the mine workings underneath which will show the relative position which any of the points bear to each other and from which maps, profiles and sections can be made, areas and cubical contents can be calculated, and which will graphically present to the eye a condensed view of all the facts connected with a mine and its surroundings.

To a certain degree mine engineers and mine surveyors are responsible for the systematic workings of the mine. A mine can not be worked systematically without plans, accurate surveys and maps kept up to date.

We consider an operator as doing good work if he realizes 90 per cent. of the coal from land mined over, yet any of us can cite instances where individual operators reach far better results than this, and on the other hand numerous examples where 90 per cent. of the coal is far from being approximated.

In the year 1892 there was mined in Ohio seven million, six hundred and seventeen thousand, seven hundred and seventeen tons of coal, for which was paid \$5,455,272, and which was valued at the mines at \$8,232,200. Assuming that ninety per cent. of all the coal from all the land mined over in Ohio for the above year was obtained, then the coal mined would be ninety per cent. of the coal land exhausted. For every one per cent. of the coal that is needlessly lost by bad mining, means a loss to the miners of \$60,614, or to each of fifteen thousand, five hundred and ninety-nine mines of \$3.80, or a loss to the State resources of \$91,468, of \$700 to each member of the Institute.

The cost of monthly surveys for a mine of two thousand, four hundred tons monthly output will not exceed \$150 per month, or a little more than one-half cent. per ton mined, which for the State's output for the year 1892 would be \$38,088, which is forty-six one-hundredths of one per cent. The surveyors have then only to improve the methods to realize a saving of lost coal of forty-six one hundredths of one per cent. to pay all of the expenses of surveys. Who among us will not say that good, systematic mining will not save more than that. We have good surveyors, but we need more of them. Our surveys and maps will compare well with any in the other branches of surveying.

With the exception of the work done by the U. S. Coast Survey there is no survey that will compare in accuracy with our best mine surveys. Yet we lack system. System in work, system in maps, system in kind of instruments, system in our levels, and the frequency of surveys.

It is important to have mines accurately leveled and the contours platted on the mine map. Contours should show a difference of level of from two and one-half to five feet. The levels should be extended as often as is necessary to insure complete contours for the mine. The datum should be either mean tide or Lake Erie for Ohio mines. This information would be of great value in establishing the grades of mine tracks and in establishing the water courses or location of pumping stations for draining the mines of water. The expense of accurate mine maps is money well invested and will save many times their cost if used with intelligence and judgment.

PRESIDENT ORTON: Are there any remarks on Professor Ray's paper?

MR. ROY: I think this is a paper that we can all agree upon. I don't think there is any room for argument. I think we should thank Professor Ray for the paper, for it is full of valuable information.

PROFESSOR LORD: Of the points made in Mr. Ray's paper, one at least was to me a suggestive one; that is, that the cost of the most accurate and careful survey of all the mines of the state of Ohio,—that is, monthly surveys that should indicate accurately the progress of each mine for the month—would average a cost covered by less than one-half of one per cent. of the coal mined. That is to say, the difference between the present system, which for many mines in the State, judging from the discussions heard here at the Institute and from the maps, or excuses for maps in the State Mine Inspector's office—the difference between this unsystematic, untrustworthy, irregular survey and careful surveys would be covered by an expense equal to one-half of one per cent. of the value of the coal mined. It strikes me as a suggestive thing, if true. It looks to me as if it should at once increase the demand for accurate mine surveys to a startling degree, because there is no question but that the

difference of coal mined from a properly surveyed mine and one improperly surveyed will far exceed this one-half of one per cent. I would like to ask, for information, if there is a single member of the Institute here who does not think that the difference in the yield of coal from a mine properly surveyed, as against one that is poorly surveyed, will far exceed this difference of a half of one per cent. in profit?

PRESIDENT ORTON: Are there any further remarks, or reply to that question?

CAPTAIN MORRIS: There is no doubt of that. Where you have a properly surveyed mine, the superintendent and mine boss then can know just exactly where they are all the time. Otherwise, they don't know and leave large pillars where they ought not to be, and in other places make the pillars very thin until they bring the whole top in.

MR. HARRY: It seems to me that his estimate of the cost is a little too small, — is drawn a little too fine. It is encouraging the operators a little too much. I know in our country we can't do that, and I think if you add on the other fifty-seven hundredths, it would cover it.

PROFESSOR RAY: Mr. Harry is correct in his estimate, considering all the mines in Ohio. I was basing it on a large Hocking Valley mine. I did not take into account the numerous small mines and the delays and lost time the engineer corps would have. Taking this into account it is too small an estimate. But in a large mine where the company employs their own surveyor, a hundred and fifty dollars will do it nicely after the first map is made. That does not include the first map, but just covers keeping the work up to date.

MR. HARRY: I have no doubt it can be done in a big mine, but in our country we have too much work to do and it takes too long to do the work to do it for that. But I should think in the mines of the State, if properly kept up, it could be done for a cent per ton, and it would be the most profitable thing the operators could do.

MR. KANE: I would like to ask Professor Ray in what manner, without the survey, is the coal lost? In what particular is the coal mostly lost without the survey?

PROFESSOR RAY: In running entries together and rooms together; in not leaving proper pillars,—not enough coal left to support the roof when a squeeze comes and it is lost. It cuts off, it may be, a half dozen rooms. There may be quite a large area, an acre or such a matter, when a squeeze comes on from the pillars not being uniform, and they lose all that coal left in the pillars that way.

MR. ROY: Is this not true, that the mine owners do not often go into the mines and bad work is not seen.

PROFESSOR RAY: That is true. They may come to a place which is a little up hill, or some physical obstruction which makes the working a little expensive, and it is very easy to cut out some pillars and let it drop in, and it is gone for good. But where the engineers are made responsible this would not be possible, for it would be the engineer's ambition to reach as high a percentage as possible.

MR. KANE: Isn't there a danger, too, in not having these surveys,—isn't there danger sometime in the future of cutting into those deep shaft mines.—not in the drift mines because there is more or less natural ventilation and running water,—but in the drift mines there is danger of fire damp. There are numerous mines down around Jacksonville where there is danger on account of it. I believe, though, they have them surveyed now?

SECRETARY HASELTINE: Yes.

MR. KANE: And the Sunday Creek mines up to at least two years ago were not properly kept up, but they are now going over them and making a complete survey of all their mines.

SECRETARY HASELTINE: We have no assurance, though, that these maps are correct. We had an instance in putting down an air shaft, and if the rest of the surveying is done on that basis,

it is a question whether the maps are worth the storage room. That is a sample of the maps by which we are now guided, and they are worse than no maps at all.

I am inclined to think there is a misapprehension here of Professor Lord's statement as to being able to keep up the survey of the mines at a half cent per ton. That is true under the best circumstances and in the best mines, where they are putting out large quantities of coal,—over a thousand tons a day. But when you take the small mines of other counties, it can't be done, because it takes an engineer just as long to get ready to go in a small mine as a large one. I don't think you could make a scale accurately as to what it would cost in any community. You figure so much a ton in thick coal, and in thin coal he would have to go over a larger area and it would take more measuring to less tons of coal.

PRESIDENT ORTON: I recollect from my own experience one case where the inestimable value of accurate surveys was fitly illustrated. It happened several years ago at Homestead, Pennsylvania. I was employed there at the steel works and had no special connection with mining at that time. The famous Dunbar accident happened while I was there, and there was feverish anxiety with regard to the fate of those men, as to how long it would be before the rescuing party could get to the men. The only feasible plan by which they could get to where the men were, was to cut across the works of another mine. The mines had been surveyed and the maps made by different engineers. Each man had started from his own datum, and each man was probably fairly accurate, but the necessary comparison had never been made to establish the identity of the basal lines. But the lines were brought together and lines assumed as being common to both. A comparatively small cutting was made through rooms which had partially fallen, and shifts of miners relieved each other hourly. Everyone was anxious to hear of thir progress and would buy the papers to see whether they had broken through to these men. It was only represented to be thirty or forty feet from the starting place, and it was only after they had gone one hundred and fifty feet or more and changed

direction several times that they did strike the other mine. As a matter of fact, it neither caused or saved a life, as the men were dead before the rescuing party was fairly organized. But it might have been otherwise. The importance of mining surveys cannot be overdrawn. There ought to be a department under the management of the mine inspector by which the surveying system would be kept up and looked after, and only such men as are competent to make surveys be allowed to make them. There is no line of surveys where the difficulty of accuracy is so great and the importance of accuracy greater. Outside it is comparatively easy to rectify mistakes; inside there is every obstacle.

Are there any further remarks on this subject? If not, we will proceed. Mr. Ede is not here: what is your pleasure?

Mr. Jones moved an adjournment.

PRESIDENT ORTON: Before I put this question, there is another point I wish to bring up. To-morrow morning we have a business session and election of officers. It seems to me that it would be well to have a nominating committee appointed to give the matter some consideration.

It was agreed that the chair should appoint such a committee, and the following members were named: Messrs. Kane, Jones and Lord.

Vote being taken on Mr. Jones' motion, meeting was adjourned.

THURSDAY, JANUARY 17. — MORNING SESSION.

In the absence of the president, who was necessarily detained by his classes at the University, the Institute was called to order by Vice-president Harry.

THE CHAIR: We have a large amount of business to transact this morning and are a little late in convening, so we must lose no time in getting to work. The first thing on the program this morning is the election of members.

SECRETARY HASELTINE: Mr. President, we have an unusual list of members to present this morning, and it is partially the result of the new policy, bringing the Institute to the attention of people interested in such matters. I sent out quite a number of copies of the last Journal to people interested in this subject, with enclosed blank for application, and it resulted in a larger number of applicants than at any former meeting and more of them of that class of people who take an active part in preparing papers and participating in discussions. Following is the list:

- Harry J. Lewis.....Pittsburg, Pa.
- George Carding.....Rose Farm, O.
- C. E. Holden.....Mineral Point, O.
- J. A. Beidler.....Cleveland, O.
- C. J. Brokenshire.....New Philadelphia, O.
- Thos. West.....Sherrodsville, O.
- C. G. Newton.....Congo, O.
- Alex Palmros.....Columbus, O.
- Frank G. Brown.....Omaha, Neb.
- Selwyn M. Taylor.....Pittsburg, Pa.
- Wm. G. Wilkins.....Pittsburg, Pa.
- George W. Schleuderberg.....Pittsburg, Pa.
- J. C. Mellinger.....Nelsonville, O.
- E. A. Hitchcock.....Columbus, O.
- J. K. Geddes.....Zanesville, O.
- Elmer D. Kelly.....Union Furnace, O.

W. A. Woodworth.....	Nelsonville, O.
Samuel Llewellyn.....	Coalton, O.
Henry Lavers.....	Wellston, O.
Chas. F. Smith.....	Chillicothe, O.
Thos. McGough.....	Bridgeport, O.
Rees T. Davis.....	East Palestine, O.
T. E. Hughes.....	Pittsburg, O.

One of the encouraging features of this list is the number from other states, which is the result of the broadening of our constitution by the committee appointed for that purpose last winter.

Moved by Mr. Jones that the rules be suspended and the secretary be instructed to cast the ballot of the Institute for these applicants, electing them to membership in the Institute. Seconded and carried.

THE CHAIR: Has anyone any suggestions to make under this head for the benefit of the Institute? If not, we will have election of officers. We will hear the report of the Nominating Committee.

MR. JONES: Mr. President, the other members of that committee are not here, and it was decided at the meeting of the committee last night that the one who would be present should proceed to recommend to this Institute for election the staff of officers who served last year.

On motion of Mr. Dalrymple, duly seconded, the report of the Nominating Committee was adopted.

Moved by Mr. Jones, and seconded, that the rules be suspended and the staff of officers recommended by the Nominating Committee be elected by acclamation. Carried.

THE CHAIR: The next thing on the program is a paper on "Steel Outside Rigs" by Mr. Harry J. Lewis, of Pittsburgh, Pennsylvania.

MR. LEWIS: My idea has been to write a suggestive paper and bring out as far as possible the difficulties that have turned

up in designing this class of rigs, and I want the criticism of others who have done work in the same line. This is not what I think is all finished work, but rather suggestive of what I think is needed.