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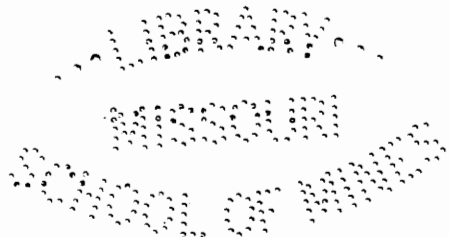
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UNDERGROUND RECORDS

T 247

by

Robert Hardy Bedford.



A

T H E S I S

submitted to the faculty of the
SCHOOL OF MINES AND METALLURGY OF THE UNIVERSITY OF MISSOURI
in partial fulfillment of the work required for the
D E G R E E O F
ENGINEER OF MINES

Rolla, Mo.

1911

Approved by C.R. Forbes,

Assistant Professor of Mining.

It may save confusion later to now state that "Underground Records" is used in sense of information regarding labor, supplies, and output of the underground proper, in distinction from "Costs" - a term here used for results of the sum total of all records after they have passed through the hands of the book keeping-accounting staff. The essentials of underground records are more or less carefully collected by all mining companies of any importance, but are too often, before they have come under the eyes of the mine management in intelligible or suggestive form,-obscured by the addition of a "witches cauldron" mixture of a proportion of "surface charges", supply, power and what not,- and the inevitable fixed charges. From the first dollar spent in drilling holes in the stopes to the final total ~~mining~~^{mining} cost, flows - as it were - a river of expense, augmented periodically by the various tributaries of charges incidental to the work.

From the standpoint of mine management, nothing appears more important than a clear and very much localized knowledge of (1) Underground Labor, (2) its results. Since on this information depends the final total cost, it must be obtained in any event. The point not to be lost sight of is the importance of seizing these facts

of the underground (obtained by time-keepers, samplers, shift bosses, and others) and reducing them, while yet in a simple state, to some form which will instantly point an accusing finger at the weak points. The mine staff is interested much more deeply in the "output per shoveler", "per miner", or "per tramming system", than in a statement in dollars and cents of the cost of any one of these things. A statement of "cost of shoveling" too often means figuring back through a maze in which "supplies" or "a part of superintendence" have to be "mucked back" before the actual amount of ore handled per man is better than a guess. The trouble of figuring backward suggests the alternative of designing a system from the inside out, bearing constantly in mind the ultimate needs of the book-keeper proper. Starting with the one in place, the first operation is drilling. The time-keeper, if segregation indulged in, has reliable data on the number of men drilling in any stope. The rock is blasted by the miner or by a separate force of "blasters". The shoveler transfers it to the chute, the tramming system to the shaft bin, the shaft crew and equipment to the surface. From first to last we have reliable - (but usually badly assorted) - information on every one of these operations. The question

which is most important is seldom put in conspicuous form. Efficiency has to be "figured". One figure - total output per man for yesterday - is apt to be more useful to the foreman this morning than a sheet covered with details. Some such figure shows any change - asks instantly - why? This constant facing of the note of interrogation is, in the writer's opinion - the price of underground efficiency. In large mines the Shift Boss, besides being as a rule unsuited to the work, has sufficient "troubles of his own" without the addition of any system of graphic accounting;- in such places the work may well be left to time-keepers. In small mines the superintendent can keep some such record himself - at little trouble. The fundamental may be taken as $\frac{\text{Tons Output}}{\text{Men Employed}}$. For the average uses of book-keeping the business office requires from the mine an account of (1) men employed, (2) output of each level or stope, (3) hoisting account, (4) supplies. The questions of power, fixed charges, etc., need not be discussed here - save to the extent of finding out the cost of power, supplies, and repairs for the "drill shift" quantity used later. The design of a system suitable for an average mine will need little change for any other, provided some such fundamental as $\frac{\text{output}}{\text{labor}}$ be kept constantly in mind.

For an example - take the case of a property large enough to employ regular time-keepers. The men are "checked off" (usually before going underground) by time checks or actual count. After the shift has gone below the time-keeper makes the round of the mine. Working "from the inside out" - consider first the face of the stope. Here are working - say - 10 miners, 12 shovelers, and perhaps a timberman using for one-half shift another shoveler as helper. Following may serve for type of note under such conditions:-

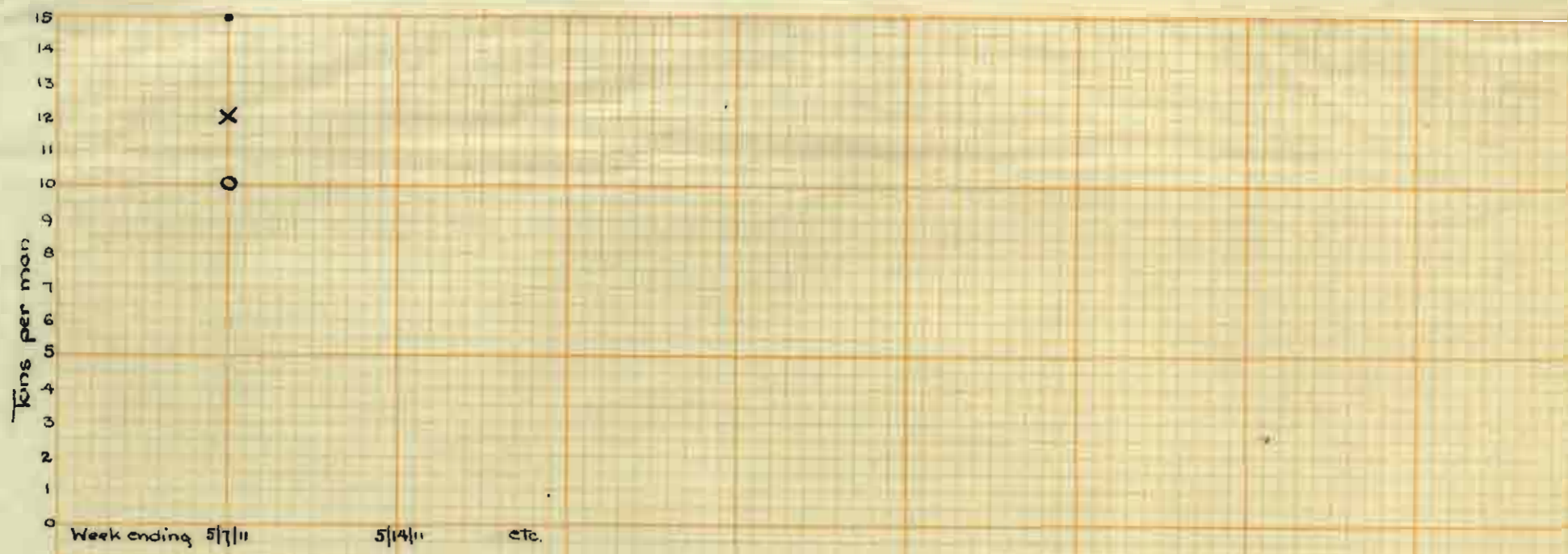
Location. 1200 Level. #3 Stope.

Date.	Miners.	Shovelers.	Tons.	Remarks.
5/10/11	10	13	20	5 machines running - 1/2 Shovel timbering

Ore produced may be taken from tally boards on level chute. It is common enough to combine - for the purposes of general cost keeping - the records of all the stopes on a level; - for purposes of mine management they should, however, be kept segregated to each stope.

Exhibit "A" (Graphic record of stope from week to week.)

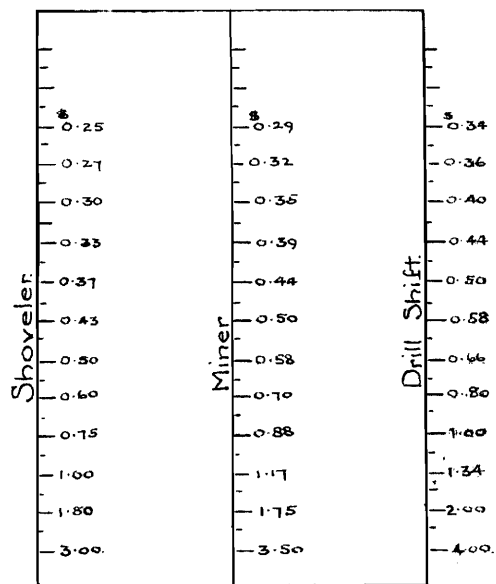
1200 Level
Stope "3."



Explanation. Totals for week = 300 tons ore.

Week ending 5/7	{	30 Miners shifts	ratio	$\frac{300}{30} = 10$	(Symbol O)
		25 Shovelers "	"	$\frac{300}{25} = 12$	(" X)
		20 Drill "	"	$\frac{300}{20} = 15$	(" •)

Exhibit "B" (Scale to be used with exhibit "A")



Note. Wages. Miners \$ 3.50
 Shovelers \$ 3.00
 Drill Shift \$ 4.00 (Cost for power-repairs-steel)

For each month - or preferably week - there may be made a total of the above records. The result will show for each stope - (1) total miners shifts, (2) total shovelers shifts, (3) total output. Some suitable record - graphic and simple - should be kept. The following, which was suggested by the Director of the Company, has proved satisfactory at the North Star Mine. (See Exhibit "A"). Such a record - kept even any considerable period of time - shows in its average the average of the stope. Any sudden falling off in output per man is at once noticed - in this connection reference may be made to the "Remarks" column of the time-keepers underground book. Any case of "multiple" shoveling, "tapering", or weakness in system of dirt handling, is at once self evident. Any experiment which may have been tried in the interests of progress shows at once its results. There may be carried at the same time some account of the ore produced per shift by the drills - see remarks note on time-keepers sheet - where $\frac{x}{5}$ is the "ore per drill shift" on the day under consideration. This figure gives a good opportunity for comparison of different drills. In conjunction with Exhibit "A" there may be devised and used some suitable "near slide rule" contrivance - to show by scaling the cost per ton

for any of the several operations under discussion. (Exhibit "B")

Take for instance miners at \$3.50 per shift; 10 tons per miner represents 2 inches on the graphic sheet; therefore, a space of 2 inches into 10 parts - division No. 10 will represent 10 tons (write 35 opposite the tenth division. Similarly for every other division to any number likely to be needed. The shovelers scale may be similarly constructed. The "drill snift" scale calls for some knowledge of the cost in power and repairs or running a drill. Such information can usually be obtained without much trouble from the general cost sheet. (In this case \$4.00 (Preston) has been taken). This figure having been obtained - a third scale may be laid off similar to the two already constructed for the miner and the shoveler. A cost figure obtained by the use of these scales is usually accurate enough for all ordinary purposes, and is quite accurate when used as a basis of comparison between any two stopes. A separate factor to be remembered, however, is the question of tramping. This - in the case of mules, or any compressed air or electrical system - demands that there be plenty of dirt in the level chutes; - the economy of any high capacity system falling off when it is

not worked to capacity. "Manifestly, if the ore supply to a particular roadway is insufficient to keep a mule busy, the economy soon runs off." (Hoover)

Nothing has yet been said of sampling - the value of which varies probably more than any other factor - with the nature of the deposit under consideration. The only complete story of a mine, or any of its stopes, must be a charging of cost of production against value of product. However, while in many copper mines - particularly those of the low grade, disseminated type - values are remarkably uniform, - many gold properties are so "pockety" that the best and, in fact, the only satisfactory assay must be the bullion return. Here - in the case of a going mine - as distinguished from a prospect or a mine under examination - the necessity for sampling is doubtful. Wherever the deposit is of such a kind that a sample - taken across the face - will give a fair idea of the value for the next round, samples should perhaps be taken. "The whole theory of sampling is based upon the distribution of metals through the ore body with more or less regularity; - if the ore is of the extreme type of irregular metal distribution, then sampling has no place." (Hoover) In a gold mine of the "pockety" kind, however, stope samples are

practically worthless - save in development work - where - when figured to a "unit width of vein" average, they are useful in the consideration of future stoping operations. For instance - an assay plat of two levels giving some idea (possibly little better than a "reinforced" guess) of the location of an ore chute - is invaluable to the foreman as a guide, (when he commences stoping operations), in such matters as the location of gravity trams, chutes and tracks - things which are costly to install and costly to move. In general - assay results - in working stopes - must be handled with caution - in that much stoping is a kin to prospecting. Sometimes - when men and equipment are handy it is expedient to work very close to the loss margin - some stope which if not handled with these facilities would have to be abandoned entirely. Where sorting is necessary - one use of sampling not to be despised seems to lie in its tendency to keep the shift-bosses on the alert in the matter of discarding waste. If a sample record is kept it may be averaged over such period of time as has been chosen for the graphic sheet - and the average value plotted beside the miners, shovelers, and drills. This last figure may be criticized as a refinement - certainly anything of

the kind has to be taken with discretion,- but it would seem cheaper to pay a little for refinements than to work out a stope which is not paying expenses. Refinements merely mean, at the worst, paying a couple of small salaries, in return for which - even if no evident reduction in "per ton cost" results - the shift bosses and foreman, who are usually far from experts at clerical work, are relieved from an uncongenial task that takes a lot of relatively high priced time - leaving them free to give their attention to the more vital questions of the operations of to-day and the developments of to-morrow. "Efficiency of the mass is the resultant of that of each individual under a direction which coordinates effectively all units". (Hoover). Anything which will keep the foreman in accurate touch with the essentials of underground work will produce results not to be measured without considering the work of every man under him. The system must, however, be built up by some one - preferably technically trained - thoroughly familiar with underground work in general and the mine under consideration in particular. Certainly no suitable method can be devised by anybody knowing only either the mining department, or the business department.