Department of Mines and Resources
Surveys and Engineering Branch

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Dominion Observatory

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SEISMIC RESEARCH PROGRAM
ROCK BURST PROBLEM
LAKE SHORE MINES

Report No. 10
July 1 - December 31
1942

Ernest A. Hodgson

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OTTAWA

The attention of the reader is directed to Section VII. Data supporting the conclusions and recommendations of that Section were obtained from the observations made during the six months concerned. Many of these data are given in some detail either in the body of this Report or in the Appendixes.

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The general account of the work was brought up to the end of June, 1942, in Report No. 9. A description of the Obert recorders was there given in full, together with an outline of the re-organized program which came into operation on July 1. The present report deals with the program for the period ending December 31. As in previous issues, a general summary is first given, with details relegated to subsequent sections or to appendixes.

I. Plan of Attack on Rock Burst Problem: As described in Report No. 9, initial listening programs indicated the so-called "west pillar" of Lake Shore Mines as providing the best opportunity for experimenting with the subaudible recorders. The period covered by this report has been devoted to the following procedure, somewhat in the order given, but obviously with the programs prosecuted, more or less, simultaneously:

(1) Elimination of instrument trouble, very much in evidence at the beginning of the period under review.

(2) Checking of pillar locations by listening tests at a series of drill holes to determine the best positions for installing recorders.

(3) Layout of a system of test holes and recording rooms with an adequate system of connecting cables.

(4) Calibration of instruments to a definite, intercomparable, standard of sensitivity, with provision made for regular checking to insure maintenance of that standard.

(5) The adoption at the earliest possible date of a set, regular, observing program, to be maintained rigorously in a concentrated effort to learn the relation between recorded subaudible activity and bursting ground.

The above may be considered a summary of the work as planned for the last half of 1942,- the first six months of the new program. At the end of that time, the five aims had been attained to a point where the equipment was partly calibrated and a fair approximation to a regular set program was in operation in a section of the west pillar where considerable pressure was clearly evidenced by the records.

II. Instrument Trouble:

(1) Writer Coils Burning Out: When the program began on July 1, the chief trouble with the equipment was due to the burning out, one after another, of the "writer coils" which translate the amplified electrical oscillations of the input to mechanical writing of a stylus on the Teledeltos paper (see Report No. 9). In spite of experiments with various types of wax and paint coatings, these burned out at the rate of nearly one a day for some weeks, until Hallick, insisting that the cause was the damp air charged with explosion fumes, installed a 50-watt lamp in each recorder; since when no coil has burned.

During the period when the coils were burning out, it was necessary to take at least one recorder to surface nearly every day, with the result that for the first month there is little continuity of instrumental hook-up, as will be noted in looking over the tabulations in Appendix II. As soon as possible, the sets were operated as 111, 222, and 333, keeping the three units of each set together.

A complete statement of operating conditions requires one to give the numbers of the Obert units, the hole number, geophone number, and attenuation in decibels. This is usually abbreviated as: 222 H4 G2 D10.

(2) Recording Paper Fires: Soon after the program began, a series of fires occurred in the recording units, due to the recording paper catching fire from the stylus. Sometimes the only result was the loss of a record. On other occasions, the plastic spools were burned and

had to be replaced by wooden ones.

At first, fires were due to the record running sideways on the recorder and so becoming warped up off the contact platen just enough to permit fires to start. Later they were due to the traction of the drive roller being too little to move the paper. When this was remedied by reducing back tension, the paper moved from the supply roller in jumps which lifted it from the platen and again caused fires.

Finally, on Sep. 22, recorder 2C caught fire early in the morning and burned the unit quite badly (see Fig. 3 Appendix III). This fire threatened to spread in the recording room. The wooden recorder boxes were then replaced by ones made of steel, the drive rollers were made of knurled brass (which tend to snuff out a smoldering record), and the C units were checked for alignment (and found to be quite badly out). When these changes had been made the fires ceased.

(3) Other Instrument Troubles Encountered:

(a) Shorting of stylus to chassis by filaments of steel wool which were so small as to be almost invisible.

(b) Failure of soldered joint holding stylus point on the arm. Some points also burned off.

(c) Disintegration of geophone crystals due to moisture penetrating the case.

(d) Poor contacts at amphenol connectors.

(e) Broken strands in shielded cable caused slight holes in casing, leading to infiltration of water and the development of electrolytic action, with resulting electrical disturbance (static) on the recording lines.

(f) Burning out of radio tubes and a transformer, the latter of a type which could not be exactly duplicated. (Nearly all replacements have had to be substitutions more or less unsatisfactory).

(g) Some record paper rolls were a shade too wide, resulting in a failure of the drive. Such rolls when found (usually only one in a package of ten) had to be discarded.

(h) Voltage fluctuations in AC power line.

III. Listening Program: In order that the pillar might be surveyed as thoroughly as possible, to locate strategic operating positions, a listening program was begun at once. From the beginning it was found necessary to do all listening during the off-shift periods, but a sufficient length of time after blasting. Hodgson decided to carry on the listening program from 5-30 to 7-30 a.m. each day. This was carried out regularly every day he was at Kirkland Lake,- about half the time during the interval July 1 to December 31.

At first the listening was done by means of L.S.M. 11 or L.S.M. 12, which are amplifiers permitting the use of head phones but not affording any record. Later, when the Obert recorders were hooked up by long cable lines from central recording rooms to widely distributed geophones which could be connected at will, it was found desirable to listen in over the Obert units which furnishes a record at the same time.

To permit the use of an extra listening set (L.S.M. 11 or L.S.M. 12) and get a record from one hole while recording on the Obert set from another, Gibbs devised an extra stylus manually operated (see Fig. 4, Appendix III). Using it, the operator listened over the extra set and recorded what he heard by the extra stylus. The listening from one hole was thus recorded and correlated with the Obert record from another.

This procedure resulted in the operator attaining a most useful familiarity with the nature of the records. The timbre of the sound heard is often sufficient to permit the identification of the source, whereas the record gives much the same sort of response to many types of disturbance. It thus became possible to note the slight differences in the records

and to know more about the nature of the activity from day to day.

Beginning Oct. 5, the day shift went on duty at 8 a.m. instead of 7 a.m., the night shift remaining on the schedule 7 p.m. to 3 a.m. It was thus possible to do listening up to 8 a.m. or even a few minutes later. From Oct. 16 on, whether Hodgson was at Kirkland Lake or not, Hallick went underground at 7 a.m. and carried on the listening program using the Obert recorders. When at Kirkland Lake, Hodgson carried out his own regular schedule beginning at 5-30. In this way both operators became quite familiar with conditions throughout the section of the mine under observation. The gradual layout of test holes (see Appendix I) and the final adoption of a standard program were based on this experience.

Beginning early in November, daily reports were given to Mr. Adamson by Hodgson when returning from underground. When the latter left for Ottawa on Nov. 10, Adamson asked that the reports be continued; they were accordingly supplied each day by Hallick. Beginning Dec. 1, mimeographed forms were used. These are filled out each day in duplicate, one copy going to Mr. Blomfield and the other to Mr. Adamson. The procedure has become regular routine.

IV. Layout of System of Test Holes and Underground Recording Rooms: A visit was paid to the mine by Dr. Obert (Oct. 26-29). At the time, the burned unit 2C was being rehabilitated by Gibbs. Most of Obert's time was spent on this and other instruments and in discussion on instruments with Gibbs. He visited the underground installations only once, Oct. 29. Based partly on advice given by him, partly on the experience of Hodgson and Hallick, and on consultations with Mr. Robson and Mr. Adamson, a system of routine observing was planned. This system was to be evolved from that which had been already developed.

Late in June, an underground recording room (A in the diagrams of Appendix I) had been built in 4201W7. This was visited by Mr. Blomfield and Mr. Selnes on July 29 and condemned, as being in a dangerous location. A second room (B in the diagrams of Appendix I) was selected in the fill region about 110' to the east in 4201W6. This was completed and the first records obtained there on August 5.

A location for a third recording room was selected in 3801W9 (C in the diagrams of Appendix I) and completed early

in August. There was some delay in getting BXL cable to carry in the AC power supply, so that the station was not occupied until Aug. 29. Owing to the fact that while calibration of an Obert set was going on in the laboratory only two sets were available underground the recording on 3800' and 3900' levels was very much interrupted. When only two sets were available they were used at station B on 4201W6.

Lines of Belden cable were run from station B to holes: H4, H25, H19 and H20 all on 4200. A line of the same cable was run from station B down through the manway just to the west of the station (about 15' east of section line 6W) to the flatback above 4301W7. This served to connect H23, and later H24, to station B. Another line was run west from station B in 4201W for about 185' to the flatback above 4201W7, thence up the manway at section line 8W to 4001W, and thence east to H27. Similar lines were run in 3801W, west from station C to H22 and east for 250' to the manway, which is about 30' west of section line 6W, thence down to the flatback above 3901W6, and thence west in the more southerly of the divided drifts (3908W) to H13 and H18.

After the conference with Obert, it was decided to drill a 30' hole (H28) beside H25, another 30' hole (H29) in 3801W9, and a third 30' hole (H30) in 3908W6. These holes were to be connected to their respective stations and the program was to consist of regular daily runs on schedule b (4-5 and 6-7, a.m. and p.m.) There were to be two recorders at station B, recording from two selected holes of the available H24, H25, H26, H27, and H28 and listening from the others. There was to be one recorder at station C, recording from H29 with listening from H30.

It was planned that a testing oscillator should be built by Gibbs as designed by Obert, and that the recording sets should be calibrated and maintained at a selected, intercomparable standard of sensitivity which was to be tested at regular intervals.

Gibbs proposed also to build a capacity bridge to test, from the observing stations, the lines with the geophones attached without disturbing the setup at any given hole.

Further, it was decided to firmly wedge 7' steel bars, 1 3/8" diameter, into 6' holes drilled near each geophone position. On the projecting ends of each of these was

to be mounted a tapping mechanism to be designed and built by Gibbs. These were to be operated from the station concerned. The tappers were designed to give a slight kick to the buried geophone which should record as an offset on the record. While these offsets might differ among themselves, they should always be the same for any given hole, regardless of what geophone or recorder was being used.

Also, Gibbs planned to build a shaking table to test and calibrate the geophones.

As the supply of Belden cable was strictly limited, and it might be destroyed in a burst, arrangements were made to replace all lines by BXL cable and to run parallel to each line of BXL a line of style B wire which could be used to operate the tapping mechanisms.

In order that the coverage of the pillar might be greater with the limited equipment available, Gibbs was to design and build time switches, so that two geophones could operate for alternate half hours on the same recorder.

The wiring was completed and the steel bars set for the tappers by Nov. 9. A laboratory form of the oscillator was completed by Gibbs and an initial testing of the recorders completed by the middle of December. Regular underground calibration was not begun nor were the oscillator or capacity bridge completed for this purpose. The time switches were completed by the end of December but were found to be very troublesome. It was necessary to make them entirely, piece by piece, from scrap material. The electric clocks used had to be modified. Altogether it was a slow, unsatisfactory, and discouraging process which could have been done efficiently and quickly had it been possible to purchase the cheap, commercial switches already on order for nearly six months.

V. New Equipment Ordered: In order that more adequate coverage of the pillar might be made, it was decided at the time of Obert's visit to make a special effort to obtain authority to purchase:

(1) Three complete new Obert recorders.

(2) The switches for time switches.

(3) Fifty crystals and twenty-five transformers for new geophones.

(4) A supply of cable to meet the proposed needs.

(5) A supply of spare tubes, transformers, amphenol connectors, etc., etc. to take care of requirements for the next six months at least.

The requirements were tabulated and on Nov. 11 Mr. Blomfield and the writer interviewed the authorities at Ottawa with a view to obtaining the necessary priorities. These were obtained promptly and the orders were placed at once. No orders had yet been filled by Dec. 31 except that for the crystals for the geophones.

VI. Handling of Records: As the records come from the recorders they are in rolls, each containing at least 30' of 2" paper strips. Early in July, Hodgson devised a system of making these up into books by pleating the records accordion fashion. These books show 8" of record on each page. Every inch of the entire record is open to inspection by simply turning the pages.

To facilitate the making of these books, a mechanical pleater was designed and made at the Observatory workshop by Mr. Bird (see Fig. 1, Appendix III). It was quite successful. The records are quickly made up into books, each having a cover of material similar to that used in the cover of this report and bearing a mimeographed form which provides for the registering of all relevant data. The books are numbered consecutively and this number, followed by a page number, is stamped by means of an automatic numbering machine. All records obtained during the period of this report have been made up into books. These are filed in specially designed boxes.

It is thus easily possible to refer to any part of any record and to index data appearing therein by the page number. Only the right hand pages are numbered. To specifically designate the left hand page in a reference the letter A is appended. To specifically indicate the right hand page the letter B is used. Thus to indicate a reference to the left hand page, 14 say, of record 120, the designation becomes 12014A. This is the meaning to be assigned to the first entry at the top of each sample record in Figs. 5 and 6 of Appendix III.

For the period covered by this report it was decided to estimate the maximum, average, and minimum number of snaps (c.p.m. = cracks per minute) by inspection of the records, taking no account of the coincidences between various records

and making no separate estimate for large, medium, or small offsets.

Obert suggested that, when the new program came into operation with the recorders calibrated and the locations producing regular records, the snaps should be counted in nine categories according as the offsets are large, medium, or small on the slow stylus and large, medium, or small on the fast stylus. Moreover he suggested that the coincidences between concurrent records be noted.

The conditions for beginning this procedure were not completed until the end of the year. Hence all the activity figures tabulated in Appendix III are estimates arrived at by inspecting the records and selecting the section which is apparently maximum, average, and minimum respectively, and counting all the offsets in a selected minute in each region. The estimates are not far from the values which would be obtained by counting for long periods and averaging, but show no differentiation into the nine classes suggested by Obert. He states that, in their work, it was found that the medium-slow, medium-fast group was the one which gave the best index for predicting the time of a burst. This procedure is being applied to the records beginning Jan. 1, 1943.

VII. Conclusions and Recommendations: Based on the work carried out during the period covered by this report, the following conclusions and recommendations may be tabulated:

(1) It has been clearly demonstrated that anything less than a 6' hole is quite useless (indeed misleading). The 30' holes are much more satisfactory and seem to be deep enough. It is proposed to make the 30' hole the standard for this work and to have such holes cased for a depth of 6' - 8', the casing extending at least a foot beyond the wall and forming an attachment for the testing tappers. It has been found that the 100' hole (H25) does not extend beyond the zone of compression. The bottom of this hole is sometimes more active, sometimes less active, than the bottom of the 30' hole (H28) drilled right beside it (see Appendix III).

(2) A sensitivity somewhat less than that used during the period covered by this report, but not much less, should be adopted as standard.

(3) Tapping on the north (foot) wall is not picked up by geophones on the south (hanging) wall at distances at all comparable with those over which tapping on the south wall is picked up by the same geophones. Geophones set in holes on the north wall on several different levels have shown little or no ground activity either for listening or recording. When bursts occur, it is the hanging wall that comes in. The foot wall is seldom broken.

(4) The "slow" tracks of the three Obert recorders have proved of very little value; and, with adequate coverage of the pillar with a sufficient number of geophones, they become even less important. The new recorders have two "fast" tracks instead of one fast and one slow. It is recommended that, as soon as possible, the three earlier sets be changed to two-track models. It is further suggested that the order for the necessary equipment be made out at once and that steps be taken to secure the necessary priorities to ensure their purchase. The actual cost of making the change would not be great, but it is desirable to reduce the delay to a minimum.

(5) If at all possible, a voltage regulator should be obtained for each observing station (doghouse). At present there is one only at 4201W6.

(6) The making of records into books after they have been scanned, compared, and analysed has proved most valuable, rendering the data readily available for checking and comparison as further ideas grow from later observations.

(7) Effective listening is impossible in Lake Shore Mines except during off-shift hours. Continuous recording is possible only at such times. However, when activity in any region becomes acute, it is recommended that the recorders and geophones concerned be run on 24^h schedule in an effort to record up to and through a burst. When ground is not dangerously active, it seems sufficient to record at alternate half hours from each geophone for the hours 3-7, a.m. and p.m. When records are run 24^h a day, only the

schedule hours are to be used in the statistical study.

(8) It is recommended that all records taken on schedule hours be retained, annotated, analysed, and made up into book form, and that sections of 24h runs, not in the schedule, be carefully labelled and dated but kept in roll form unless and until some part of them becomes important.

(9) Many small and not a few medium snaps (as recorded at the sensitivity level in use during the period under review) record on one geophone and not on another, and vice versa, when distances of 50' to 75' separate the geophones. The underlined words show that this is not a matter of relative sensitivity of equipment nor of the efficiency of emplacement of the geophones.

A study of Fig. 7 of Appendix III seems to show that some snaps are recorded on one geophone and not on the other, and vice versa, when the geophones are less than 25' apart.

However, some medium snaps, as so recorded during the period of this report, have been clearly shown to be simultaneous over several levels. The significance of these anomalies is not clear as yet but may become apparent with the analysis of the records.

(10) In general, the ground about to burst (within a week or so) shows great subaudible activity, even when the walls do not "talk". So far, data are lacking to show whether this activity increases or falls off immediately prior to a burst. It is safe to say that the subaudible method clearly indicates the sections actively dangerous, but, so far, prediction as to the time of a burst has not been clearly demonstrated. It is hoped that an analysis of the records into large, medium, and small offsets may show prediction trends in one special group. Work along this line is now in progress.

(11) Small pre-bursts occur in badly strained ground for some days prior to destructive pillar bursts. These are so small as not to register on the

surface seismograph and, in fact, to show a (probable) falling off in intensity at a distance of 70' between adjacent geophones.

There seems to be no prediction of these bursts either by increase or decrease of activity at the geophone showing the best record. After-snaps are very numerous and continue from half a minute to five minutes or more. Many of these are now recorded and several have been heard during the listening periods by both Hallick and Hodgson.

(12) An examination of the back records in conjunction with the records of the surface seismograph will be made as soon as possible to determine the shift of pressure after a burst. The small bursts occurring in strained ground and presumably indicating serious conditions have not been known to record on the surface seismograph nor, so far, except in one case, is there known to be any relation between a burst in one part of a pillar and a change in ground activity in another part.

(13) It seems probable that a section of the pillar, not under strain at the moment, might be suddenly subjected to critical strain, within a few minutes, by a heavy burst either above or below it in the pillar. It is, however, reasonable to suppose that, even if this be the case, the danger could be detected promptly if equipment designed for such emergencies were available. There is usually a lag of several minutes between the large burst and another set off by it.

(14) As soon as an Obert set is available for use on a mobile listening post, the listening program at the recording stations should be abandoned in favour of using the short time available each day in exploration over a greater section of the pillar.

(15) It is recommended that steps be taken at once to put in pipe conduits (1".5 diameter at least) from each level to adjacent levels throughout the pillar. Each time a rill is completed, a

pipe conduit should be put in place before the fill is poured, unless a connection has already been made between the levels concerned. This will result in a great saving of cable which is so hard to get and still harder to replace after a burst and which completely holds up the program until it can be obtained.

(16) It seems vitally important that some more direct and regular connection be made between the progress of mining in the region under study and the activity of the ground as shown on the records. It is clear that much of the fluctuation in activity is due to the amount of powder used, the number of holes blasted and the approach of the rill to the top and toward the pickup geophone. It is strongly recommended that steps be taken to make this mining information readily available in some simple routine manner for the regular use of the rockburst survey.

(17) A good deal of valuable equipment is maintained in the underground observing stations (doghouses). The fact that it is vital to the work and almost irreplacable makes it more valuable than its cost would indicate. Much of the time of trained observers is spent in these doghouses. In view of the experience so far gained, it is strongly urged that these doghouses should always be built:

(a) Well in the fill region with no part of the pillar between the doghouse and the cross cut.

(b) Against the north (foot) wall.

(c) With timbers competent to take pressure and sided with 2" plank.

The doghouse at 4201W6 may be cited as an example of a satisfactory structure. The only specification above which it fails to meet is that it was built against the south wall.

(18) Until the calibration and standardization of the

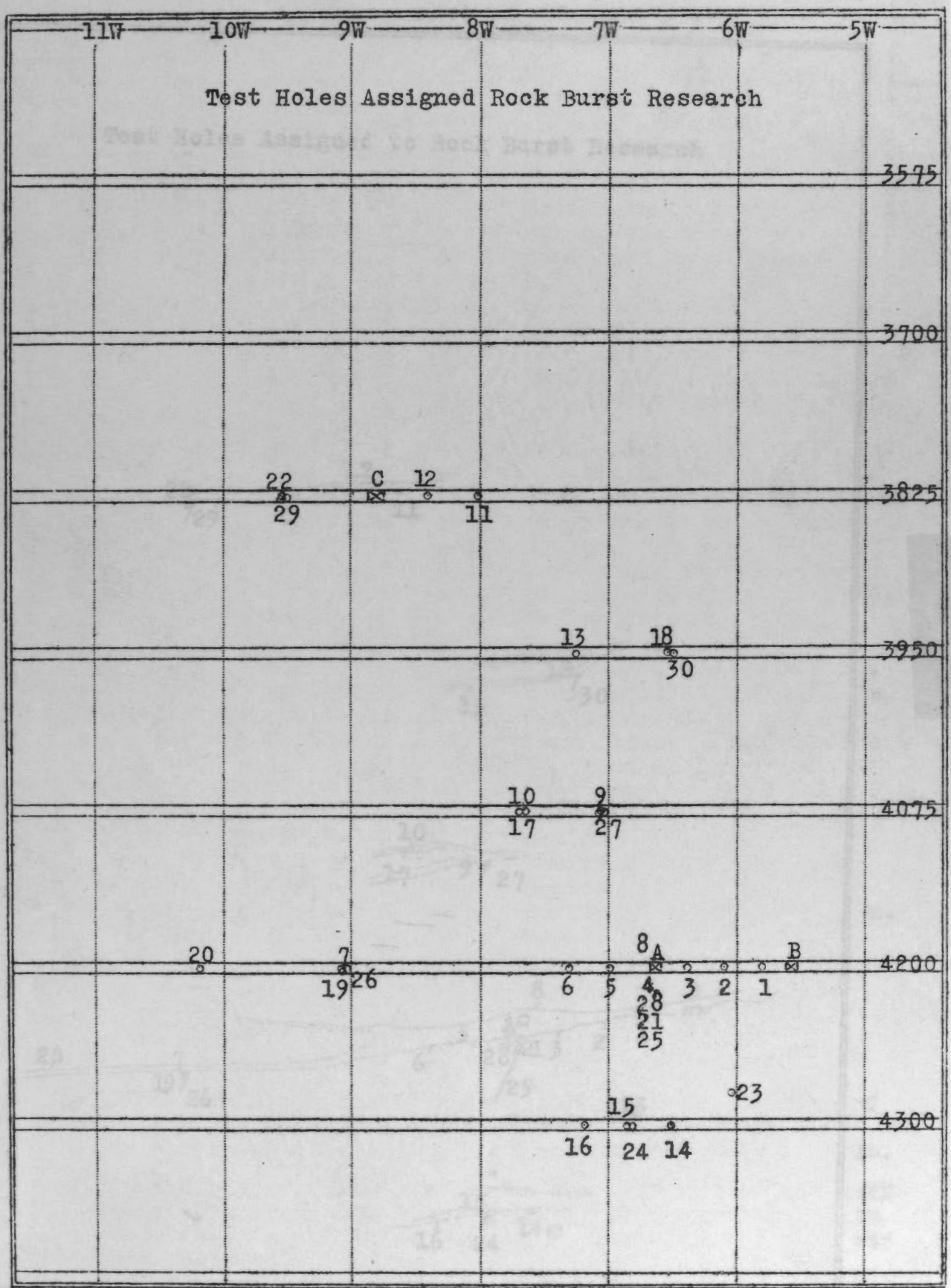
recorders and geophones is accomplished and checking is done regularly as a routine procedure, the program operates at a considerable loss since undisputed conclusions can never be drawn from the observations.

Dominion Observatory,
Ottawa, Canada,
April 1, 1943.

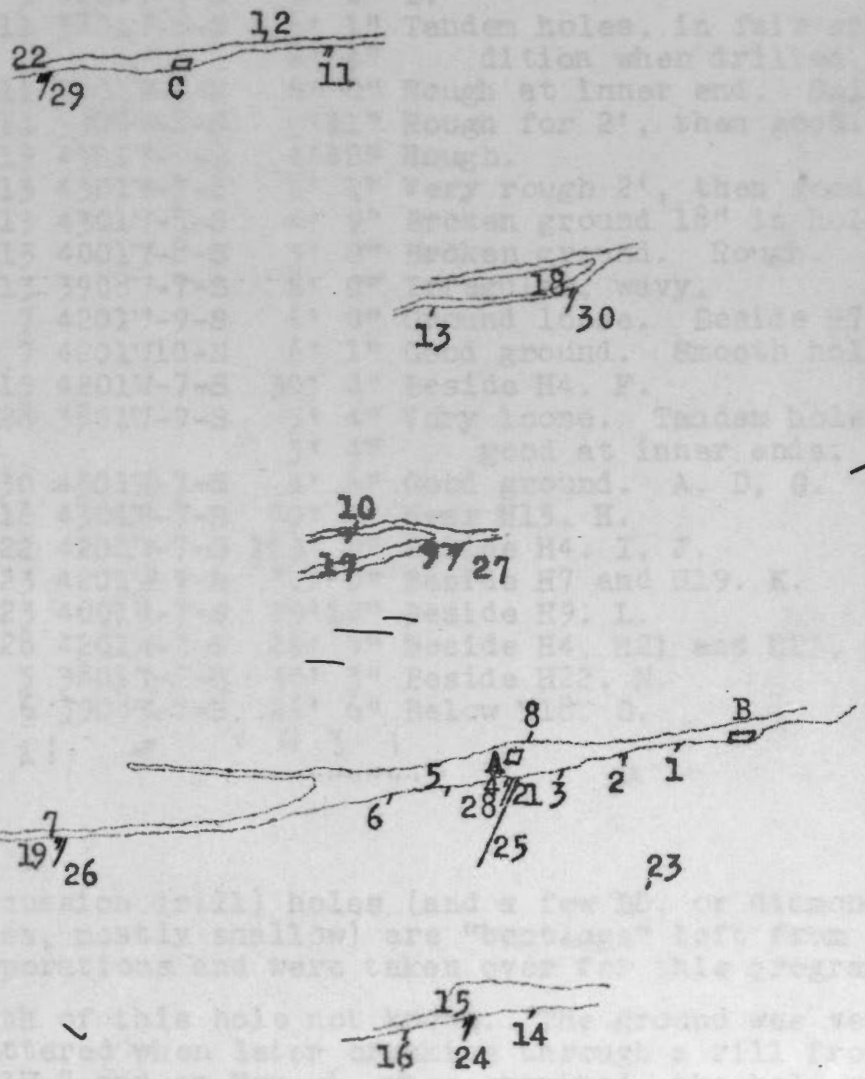
APPENDIX I

Test Holes Assigned to Rock Burst Research

The test holes (Nos. 1-30) drilled for use in the rock burst program during the period covered by this report are plotted in plan and in elevation. Plan and elevation have each a vertical scale indicated by the 125' difference in the levels. The section lines on each chart are 100' apart. In each diagram, east and west are respectively to the right and left, as one faces the charts. In the projection of the plans, the oblique lines run down and to the left (south) and up and to the right (north), the minimum scale division both east-west and north-south being 50'.


Test Holes Assigned Rock Burst Research
11W
10W
9W
8W
7W
6W
5W
3575
3700
3825
3950
4075
4200
4300
22
29
C
12
11
13
18
30
10
17
9
27
20
7
19
26
8
A
B
6
5
4
28
21
25
3
2
1
23
15
16
24
14

Test Holes Assigned to Rock Burst Research



Test Holes Assigned to Rock Burst Research

No.	PD or DDNo.	Date	Location and Wall	Depth	Remarks
1	PD	May	4201W-6-S	6' 1"	Good hole, fairly solid rock
2	PD	"	4201W-6-S	3' 7"	Good hole in solid rock. A.
3	PD	"	4201W-7-S	4' 6"	Ground shattered. A.
4	PD	"	4201W-7-S	5' 2"	Good hole in solid rock.
5	PD	"	4201W-8-S	?	B.
6	PD	"	4201W-8-S	?	B.
7	DD	July 2	4201W-9-S	1' 0"	A, C, D.
8	DD	" 2	4201W-7-N	3' 6"	Good hole, solid rock. A, D.
9	PD	" 3	4001W-7-S	5' 0"	Tandem holes, in fair con-
				5' 0"	dition when drilled.
10	PD	" 3	4001W-8-N	5' 0"	E.
11	PD	" 11	3801W-8-S	6' 1"	Tandem holes, in fair con-
				6' 4"	dition when drilled.
12	PD	" 11	3801W-9-N	6' 0"	Rough at inner end. Solid.
13	PD	" 11	3908W-8-S	5'11"	Rough for 2', then good.
14	PD	" 13	4301W-7-S	4'10"	Rough.
15	PD	" 13	4301W-7-S	5' 1"	Very rough 2', then good.
16	PD	" 13	4301W-8-S	4' 9"	Broken ground 18" in hole.
17	PD	" 13	4001W-8-S	5' 0"	Broken ground. Rough.
18	PD	" 13	3908W-7-S	6' 0"	Irregular, wavy.
19	PD	Aug. 7	4201W-9-S	6' 0"	Ground loose. Beside H7.
20	PD	" 7	4201W10-N	6' 1"	Good ground. Smooth hole.
21	DD-3679	" 15	4201W-7-S	30' 0"	Beside H4. F.
22	PD	" 28	3801W-9-S	5' 4"	Very loose. Tandem holes
				5' 4"	good at inner ends.
23	DD	" 30	4301W-7-S	4' 6"	Good ground. A, D, G.
24	DD-3704	Sep.16	4301W-7-S	30' 3"	Near H15. H.
25	DD-3679	" 22	4201W-7-S	103' 0"	Beside H4. I, J.
26	DD-3707	" 23	4201W-9-S	30' 0"	Beside H7 and H19. K.
27	DD-3708	" 23	4001W-7-S	29'10"	Beside H9. L.
28	DD-3735	Oct.28	4201W-7-S	29' 9"	Beside H4, H21 and H25, M.
29	DD-3742	Nov. 5	3801W-9-S	30' 3"	Beside H22. N.
30	DD-3744	" 6	3908W-7-S	29' 6"	Below H18. O.

217 | 4121 9 | 431

Notes:

A. Some PD (percussion drill) holes (and a few DD, or diamond drill holes, mostly shallow) are "bootlegs" left from earlier operations and were taken over for this program.

B. Original depth of this hole not known. The ground was very badly shattered when later breaking through a rill from stope 4301W-7 and on Nov. 6, when examined, the hole was quite blocked.

C. Clean, smooth DD bootleg in what was later found to be a slab of loose.

D. Diamond drill hole; number not known.

E. Hole blocked at depth of about 2' when steel was pulled.

F. This hole was the first deep diamond drill test hole. It was drilled right beside H4. The work was finished Aug. 15 but the hole was not used until Sep. 1. It was later deepened to 103' and numbered H25. The ground is fairly good. Hole gave good results as H21.

G. Hole found in south wall of 4301W-7 stope, on flat-back.

H. DD-3704 (H24), begun Sep. 16; finished Sep. 16.
0'-30'3" all porphyry.
0'-8'3" core badly broken up. 14 pulls with 3" or 4" of ground core at each pull.
8'3"-30'3" core not so badly broken up; rock jointed with planes about 3" or 4" apart. 12 pulls; no ground core.
No sludge.

I. See F above. This hole was originally H21 (30' deep). It was deepened to 103' and given the number H25. The ground in the extension was very good.

J. DD-3679 (H25), begun Sep. 17; finished Sep. 22.
Hole deepened from 30' to 103'.
Old hole (H21) required reaming 18" at 2' and 18" at 10'.
30'-31' shattered porphyry.
31'-31'7" ground core.
31'7"-37' porphyry badly broken up. Pieces average 2" long. 4 pulls.
37'-61' porphyry not badly borken up. 9 pulls.
61'-63'9" porphyry not shattered.
63'9"-88'4" porphyry not shattered. 4 pulls.
88'4"-103' porphyry not shattered. 3 pulls.
No sludge returned to collar of hole.

K. DD-3707 (H26), begun Sep. 22; finished Sep. 23.
0'-19'9" porphyry core badly shattered. 18 pulls.
19'9"-30' blocky porphyry. 7 pulls.
No sludge.

L. DD-3708 (H27), begun Sep. 23; finished Sep. 23.
0'-6' shattered porphyry.
6'-11' shattered porphyry; few quartz stringers.
11'-29'10" shattered porphyry.
19 pulls in 30'. No sludge.

M. DD-3735 (H28), begun Oct. 28; finished Oct. 28.
0'-11' badly shattered porphyry. 17 pulls with 2" to 6" of ground core at each pull.
11'-29'9" porphyry not badly broken up.

N. DD-3742 (H29), begun Nov. 5; finished Nov. 6.
0'-2'8" crushed porphyry. 4 pulls; core badly broken up.
2'8"-6'6" crushed lamprophyre and quartz (75 percent quartz). Core not badly crushed. 3 pulls.
6'6"-22' lamprophyre. Core in short pieces 1" to 2" but not badly crushed. 9 pulls.
22'-30'3" lamprophyre. 3 pulls. Core not badly crushed.

O. DD-3744 (H30), begun Nov. 6; finished Nov. 6.
0'-10' badly shattered porphyry. 12 pulls. 2" to 4" ground core at each pull.
10'-29'6" not badly broken porphyry. 7 pulls.

This hole was not drilled in position intended. It is about 50' too far east.

*

APPENDIX II

Record Analysis Holes 1-30
July 1 - Dec. 31
1942

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In the following tabulation the successive headings are:

Rec = Record number.
Fr = from.
To = to.
A, B, C = The three units of an Obert set.
Db = Attenuation in decibels.
G = Geophone number.
S = Schedule, where:
a = 3^h-4^h and 6^h-7^h, a.m. and p.m.
b = 4^h-5^h and 6^h-7^h, a.m. and p.m.
c = 4^h-4^h30^m and 6^h-6^h30^m a.m. and p.m.
d = 4^h30^m-5^h and 6^h30^m-7^h a.m. and p.m.
Max., Av., Min. = Maximum, Average, and Minimum number of snaps per minute (estimated).

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Dates of Recording from Test Holes

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The only holes used in the recording program were: Nos. 3, 4, 7, 8, 9, 11, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28; which were occupied on the dates indicated in the tabulation below.

****

JULY

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
4	4	4	4	4	4		4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	7	4	4	
									8								8	8	8	8	7	7	7	7	7	7		7	7	
																				8	8	8	8	8						

AUGUST

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
7	7	7	7	7	7	19	19	19	19	19	19	19	19	19	19	19	19	19	19	9	9	9	9	9	9	9	9	11	11	9
								20	20	20	20	20	20	20	20	20	20	20	19	19	19	19	19	19	23	23		23	23	11

SEPTEMBER

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	3	3	4	4	3	3	3	3	3	3
9	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	19	9	9	9	9	4	4	22	22	4	4	4	4
11	22	22	22	22	22	22	22				22	22	22	22	22	22	22	22	22	22	22								

OCTOBER

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
3	3	3	3	3	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	25
4	4	4	4	4	25	25	25	25	25	25	25	25	25	22	22	22	22	22	22	22	22	22	22	22	22	22	26	28	26	28
														25	25	25	25						25	25	25			28		

NOVEMBER

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25
28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28

DECEMBER

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
25	25	25	25	25	25	24	25	25	25	24	24	24	24	25	24	24	24	24	24	24	24	24	24	24	24	24	25	25	25	24
28	28	28	28	28	28	25	25	25	25	25	25	25	25	27	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25
						28	28	28	28	28	28	28	28	28	28	28	26	26	26	26	26	26	26	26	26	26		25	25	26
																	28	28	28	28	28	28	27	27	27	27				28
																							28	28	28	28				

H3

Rec	Fr	To	A	B	C	Db	G	S	Max.	Av.	Mn.	Remarks
	Sp	Sp										
167	21	22	1	1	1	5	4	a	4	2	0	
170	22	23	1	1	1	5	4	a	6	3+	0	
176	25	26	3	3	3	5	4	a	2	1-	0	A.
178	26	28	3	3	3	5	4	a	3	1-	0	
180	28	29	3	3	3	5	1	a	3	1-	0	
182	29	30	3	3	3	5	1	a	5	1+	0	B.
		Oc										
184	30	1	3	3	3	5	1	a	7	2	0	
	Oc											
186	1	2	3	3	3	5	1	a	5	2	0	
188	2	3	3	3	3	5	1	a	6	4	0	
190	3	5	3	3	3	5	1	b	4	2	0	New schedule b.
192	5	6	3	3	3	5	1	b	8	4	0	

3 1 2 1 2 8 1 1 2 2 2 2 2 2

Remarks

A. Stylus writes very lightly.

B. Record of a burst at 3-46 a.m. Sep. 30. Compare note K' for H4. Activity greater for the remainder of the hour then return to slight activity. No bursts are reported by the mine for this time but burst 286C occurred in 1607W drift at 2-05 a.m. Sep. 30. That was well recorded on the surface seismograph. The burst at 3-46 a.m. does not appear on the surface seismograms but it is undoubtedly a small burst not far from 4201W7.

Rec Fr to ABC-G-Db S

A

60
31
29
22

H4

Rec	Fr	To	A	B	C	Db	G	S	Max.	Av.	Mn.	Remarks
	Jn	Jl										
1	30	2	1	1	1	5	2	a	-	-	-	A, B.
	Jl											
2	2	4	1	1	1	0	2	a	-	-	-	A, B, C.
3	4	6	2	1	2	22	2	a	6	3	1	D.
7	8	9	2	1	1	22	2	a	18	?	0	E, F.
8	9	10	2	2	3	15	2	a	35	?	1	G, H.
9	10	11	2	2	3	15	2	a	15	?	1	I.
11	11	13	2	2	3	20	2	a	4	2	0	J.
12	13	14	3	1	1	20	2	a	-	-	-	K.
13	14	15	2	2	2	20	2	a	2	1+	0	
14	15	16	2	2	2	20	2	a	2	1+	0	
15	16	17	2	2	2	15	2	a	2	1+	0	
16	17	18	2	2	2	15	2	a	2	1+	0	
19	18	20	3	1	3	2	2	a	-	-	-	K.
20	20	21	2	2	2	15	2	a	1	1-	0	
23	21	22	3	1	3	2	2	a	0	0	0	L.
26	22	23	2	2	2	10	2	a	2	1-	0	
30	23	24	3	1	3	2	2	a	2	1-	0	M.
32	24	25	3	1	3	2	2	a	-	-	-	N.
36	25	25	3	1	3	2	2	0	2	1-	0	O.
38	25	27	3	1	3	2	2	a	-	-	-	K.
42	29	30	1	1	1	10	2	a	34	9	1	P, Q.
43	30	31	2	2	2	5	2	a	-	-	-	R.
	Ag	Ag										
45	1	3	2	2	2	5	2	a	15	4	1	
47	3	4	2	2	2	5	2	a	6	3+	2+	S.
49	4	5	2	2	2	5	2	a	-	-	-	K.
52	5	6	2	2	2	5	2	a	T	T	T	T.
53	6	7	2	2	2	5	2	a	10	4	2	U.
55	7	8	2	2	2	5	2	a	10	5	3	
57	8	10	2	2	2	5	2	a	7	4	3	
59	10	11	2	2	2	5	2	a	6	4	1	
62	11	12	2	2	2	5	2	a	5	2+	0	
65	12	13	2	2	2	5	2	a	14	5	2	
68	13	14	2	2	2	5	2	a	6	3	2	
71	14	15	2	2	2	5	2	a	6	3	0	
74	15	17	2	2	2	5	2	a	-	-	-	K.
77	17	18	2	2	2	5	2	a	8	5	0	V.
80	18	19	2	2	2	5	2	a	8	6	1	W.
83	19	20	2	2	2	5	2	a	6	3	1	
86	20	21	2	2	2	5	2	a	30	15	0	W, X.
89	21	22	2	2	2	5	2	a	14	8	0	
92	22	24	2	2	2	5	2	a	12	6	0	Y.

H4 (Continued)

Rec	Fr	To	A	B	C	Db	G	S	Max.	Av.	Mn.	Remarks
	Ag	Ag										
95	24	25	2	2	2	5	2	a	5	3	0	
98	25	26	2	2	2	5	2	a	5	3	0	Z.
101	26	27	2	2	2	5	2	a	20	10	5	A'.
104	27	28	2	2	2	5	2	a	6	4	0	B'.
107	28	29	2	2	2	5	2	a	6	4	2	C'
109	29	31	2	2	2	5	2	a	5	3	0	B'.
		Sp										
111	31	1	2	2	2	5	2	a	3	2-	0	
	Sp											
115	1	2	2	2	2	5	2	a	12	5	1	
119	2	3	2	2	2	5	2	a	18	7	2	D'.
122	3	4	2	2	2	5	2	a	12	5	2	
125	4	5	2	2	2	5	2	a	15	6	3	A'.
128	5	7	2	2	2	5	2	a	14	5	2	E'.
131	7	8	2	2	2	5	2	a	10	5	2	A'.
134	8	9	2	2	2	5	2	a	7	4	1	
136	9	10	2	2	2	5	2	F'	F'	F'	F'	F'.
138	10	11	2	2	2	5	2	a	7	4	0	
140	11	12	2	2	2	5	2	a	7	4	2	
142	12	13	2	2	2	5	2	a	10	6	2	A'.
143	13	14	2	2	2	5	2	a	8	5	1	
148	14	15	2	2	2	5	2	a	7	4	1	A'.
151	15	16	2	2	2	5	2	a	11	6	1	A'.
154	16	17	2	2	2	5	2	a	10	5	1	A'.
157	17	18	2	2	2	5	2	a	-	-	-	G'.
160	18	19	2	2	2	5	2	a	6	4	1	A'.
163	19	21	2	2	2	5	2	a	6	4	1	A'.
166	21	22	2	2	2	5	2	a	6	3	0	
169	22	23	2	2	2	5	2	H'	-	-	-	H'.
172	23	24	1	1	1	5	2	a	4	2-	0	I'.
174	24	25	1	1	1	5	2	a	4	1-	0	J'.
175	25	26	1	1	1	5	2	a	5	2	0	
177	26	28	1	1	1	5	2	a	5	2	0	
179	28	29	1	1	1	5	2	a	9	4	1	
181	29	30	1	1	1	5	2	a	12	5	2	K'.
		Oc										
183	30	1	1	1	1	5	2	a	10	4	2	
	Oc.											
185	1	2	1	1	1	5	2	a	9	4	2	
187	2	3	1	1	1	5	2	a	20+	10+	3	

H4 (Continued)

Rec	Fr	To	A	B	C	Db	G	S	Max.	Av.	Mn.	Remarks
	Oc	Oc										
189	3	5	1	1	1	5/2	a		25+	15+	5	L'.
191	5	6	1	1	1	5/2	b		30+	15+	5	New schedule b.
193	6	7	1	1	1	5/2	b		15	10+	3	
195	7	8	1	1	1	5/2	b		40-	15+	5	M'.
197	8	9	1	1	1	5/2	b		15+	8+	3	N'.
199	9	10	1	1	1	5/2	b		20+	10+	4	O'.
201	10	12	1	1	1	5/2	b		20-	10-	3	
203	12	13	1	1	1	5/2	b		15+	8+	3	
205	13	14	1	1	1	5/2	b		15+	8+	3	
207	14	15	1	1	1	5/2	P'		-	-	-	P'.
210	15	16	1	1	1	5/2	P'		-	-	-	P'.
214	16	17	2	2	2	0/2	b		15+	8+	3	Q'.
217	17	19	2	2	2	0/2	b		15+	8+	3	Q', R'.
219	19	20	1	1	1	5/2	b		15+	8+	1	S', T'.
221	20	21	1	1	1	5/2	b		10+	5+	3	T'.
223	21	22	1	1	1	5/2	b		10+	5+	3	T'.
225	22	23	1	1	1	5/2	b		10+	5+	3	U'.
227	23	24	1	1	1	5/2	b		25+	10+	3	V'.
230	24	26	2	2	2	0/2	b		5	1+	0	W'.
233	26	27	2	2	2	5/2	b		5	2-	0	
235	27	28	1	1	1	5/2	b		10	5+	4	X'.
237	28	29	1	1	1	5/2	b		5+	4+	3	Y'.
239	29	30	1	1	1	5/2	b		5+	4+	3	
241	30	31	1	1	1	5/2	b		5+	4+	3	Z'.

Remarks

A. Only occasional small offsets.

B. Very insensitive. Only small offsets at long intervals.

C. Recorder coil burned out on 1C. Replaced 1A and 1C with 2A and 2C.

D. Slow stylus coil burned out early on July 5.

E. Sudden increased activity 3 a.m. July 9.

Remarks H4 (Continued)

F. The record on July 8 was averaging about 1 c.p.m. but when the set came on automatically and unchanged at 3 a.m. July 9 the activity had increased to about 18 c.p.m. It got down to about 2 c.p.m. by 7 a.m. July 9. July 8-9 was a Wed.-Thurs.

G. Sudden increased activity 3 a.m. July 10.

H. Again a greatly increased activity after the night shift blasting. Minimum by 7 a.m. July 10 was about 3 c.p.m.

I. Increased activity less on second day.

J. July 12 was a Sunday. Activity all small.

K. Record burned in service.

L. Record absolutely blank. Instrument trouble?

M. Just before 4 p.m. on July 23 the record ran crookedly and the rest of the record is distorted but partly legible. It is clear that the normal activity was maintained.

N. E.A.H. forgot to turn record on.

O. Record ran 3-4 and 6-7 p.m. July 25 and was then changed Saturday evening, July 25, by E.A.H. after the burst at 11 a.m. July 25 in stope 4301W9. Shortly after 6 p.m. July 25 the record ran crookedly but is legible. The activity in this 6' hole some 300' from the burst and closing off about 4 hr. previous is markedly low. The attenuation was only 2 Db.

P. Marked increase in activity.

Q. This is a marked increase in activity but it is to be noted that the instrumental set up has changed since the preceding records.

R. Record lost unaccountably.

S. Uniformly moderate activity.

Remarks H4 (Continued)

T. The activity through most of the record was about max. 6 c.p.m.; Av. 4 c.p.m.; Min. 2 c.p.m. but a succession of bursts registered from 3-4 a.m. Aug. 6. See note J. for H7.

U. First record in doghouse 4201W6.

V. Some small bursts (?) registered shortly before 4 a.m. Aug. 18.

W. Activity diminishes through record.

X. First definite evidence of ore skipping 3-4 a.m. Aug. 21 in No. 4 shaft.

Y. Activity on both styli.

Z. Well defined activity.

A'. Activity began 6 p.m. Aug. 26.

B'. Definite evidence of ore skipping in No. 4 shaft 3-4 a.m.

C'. Definite evidence of ore skipping 3-4 p.m. Aug. 28. Location not known.

D'. Small burst about 4 p.m. Sep. 2

E'. First tapping tests. When tapping done on south wall it registered very well but not when done on north wall.

F'. Record not turned on (by E.A.H.) till 6 a.m. Then there was a max. c.p.m. = 7, av. c.p.m. = 3, min. c.p.m. = 1. Record ran 6-7 a.m. Sep. 11.

G'. AC supply plug left improperly inserted by Z.E.G. No record.

H'. No record. Paper caught fire. Recorder badly burned. 222 taken to surface for extensive repairs.

I'. Record which looks like a burst recorded for about four minutes at about 6-55 p.m. Sep. 23.

Remarks H4 (Continued)

J'. Again evidence of activity at 6-55 p.m. Sep. 24 which coming at same time as previous day, discredits the records as being due to bursts. They do not resemble blasts, however. Cause not known.

K'. Record of what was almost certainly a burst at 3-46 a.m. Sep. 30. cf. I', J' notes above. The activity during the 14 min. which remained of the record after the burst averaged about 55 c.p.m. but it was down to 10+ c.p.m. when the record came on at 6 a.m. Compare note B for H3.

L'. Paper stuck for short time. Motor kept running and paper released.

M'. Record ran simultaneously with No. 194, this one in the 6' hole and No. 194 in the 100' hole. The activity was great in both, slightly greater in H25 (the deeper hole) and the coincidences were surprisingly few.

N'. First "pull out" test between H25 and H4. cf. record No. 198 in H25.

O'. Character of record changed since previous day due to adjustment of recorder. Lines now quite faint.

P'. Record stuck and nearly caught fire. No record till 6 a.m. when E.A.H. began listening program. Traction was weak on the feed and the back tension too strong. The record would run when tested and then fail to start when turned on by the time clock.

Q'. A most unusual sensitivity. Both styli records alike in appearance. The c.p.m. count seems valid however. See note F for H25.

R'. Very wide zero which almost moved the fast stylus to the edge of the record.

S'. Activity low for first hour then back to the level reported in the c.p.m. columns.

T'. Too much voltage on recording styli.

Remarks H4 (Continued)

U'. Fast stylus recording many of the offsets as double. Probably due to carbon on the writing point.

V'. Paper ran crookedly much of the record. Edge burned off for nearly 6 min. beginning page 22704. Fortunately record did not catch fire and smoldered out.

W'. Recorder decidedly out of adjustment. More activity recorded on slow stylus than on fast one. Beginning 3 p.m. Oct. 25 activity up to Max. = 15+, Av. = 4+, Min. = 0, but fell off again after an hour. Latter end of record seems good but activity very low - about Av. = 1+.

X'. Paper did not feed until E.A.H. began listening at 6 a.m. Many small holes burned in record but no fire.

Y'. First 40 min. of record show instrument insensitive but a sudden return to normal recording at a time when no one was near the instruments. Normal recording continued throughout the record.

Z'. For further recording from 4201W7 see tabulations for H21, H25 and H28.

H7

Rec	Fr	To	A	B	C	Db	G	S	Max.	Av.	Mn.	Remarks
	Jl	Jl										
24	21	22	1	3	1	10	1	a	0	0	0	Absolutely blank. Instrumental?
27	22	23	3	1	3	2	1	a	3	1-	0	
29	23	24	2	2	2	10	1	a	5	1	0	A.
31	24	25	2	2	2	10	1	a	5	2+	1	
35	25	25	2	2	2	10	1	B	27	6	3	B.
37	25	27	2	2	2	7	1	C	20	15	6	C.
39	27	28	2	2	2	5	1	a	30	15	10	Marked activity entire record.
40	28	29	2	2	2	5	1	a	30	10	3	D.
41	29	30	2	2	2	5	1	a	23	8	4	E.
44	30	31	1	1	1	10	1	a	135+	50	25	F.
	Ag	Ag										
46	1	3	1	1	1	10	1	a	150+	50	25	G.
48	3	4	1	1	1	10	1	a	85+	H	H	H.
50	4	5	1	1	1	10	1	a	70	I	I	I.
51	5	6	1	1	1	10	1	a	50+	J	J	J.
54	6	7	1	1	1	10	1	a	-	-	-	K.

Recording changed to H19, a 6' hole drilled in S wall right beside H7.

Remarks

A. A series of small continuous bursts from 6-32 p.m. on July 23 to the shutting off of the record at 7 p.m. When the record came on again at 3 a.m. July 24 it was again normal with a maximum of about 5 c.p.m. and an average of less than 1 c.p.m.

B. The stope nearest H7 (4301W9) burst at a little after 11 a.m. July 25. The record was changed by E.A.H. at 8 p.m. July 25 so ran only 3-4 and 6-7 p.m. on July 25. The activity was marked. It is to be noted that H7 is only a foot deep and was later found to be in a large slab of loose.

C. Activity markedly greatest beginning 3 p.m. July 26. By 6 a.m. July 27 (after a Sunday of no mining) the record was down to an average of less than 1 c.p.m.

D. Activity began to be great at 3 a.m. July 29. During the p.m. runs on July 28 it was an average of about 5 c.p.m.

Remarks H7 (Continued)

E. Activity began to be great at 3 a.m. July 30. During the p.m. runs on July 29 it was an average of about 5 c.p.m. A small burst registered 3-28 a.m. July 30 and a larger one, recording for more than a minute, registered at 3-43 a.m. July 30.

F. Marked activity throughout record. Burst about 6-31 p.m. July 31 recorded for nearly two minutes.

G. Very marked activity began 3 a.m. Aug. 2 and gradually diminished over the week end, Aug. 2 being Sunday. Most of the activity was small and on the fast stylus but there were about 2 c.p.m. on the average of strong throws on both. In spite of the very marked activity there were no bursts.

H. Record began very actively with average of more than 75 c.p.m. The activity fell off gradually during the record.

I. Beginning with an activity of about 25 c.p.m. on the average, all small, the activity increased during the period 6-7 p.m. Aug. 4. From 6-50 to 6-53 three small bursts recorded. Two others of short duration but strong offsets occurred at 3-10 and 3-18 a.m. on Aug. 5, and a succession of these followed almost continuously till 4 a.m. when normal strong activity was resumed to the end of the record.

J. Abnormal activity began 3 a.m. on Aug. 6 and continued till the closing off at 4 a.m. A succession of severe bursts occurred. Normal strong activity was resumed at 6 p.m. Aug. 6. See note I for H4.

K. Entire record open circuit oscillations.

Rec	Fr	To	A	B	C	Db	G	S	Max.	Av.	Mn.	Remarks
	J1	J1										
10	10	11	3	1	2	0	5	a	2+	1-	0	A.
17	17	18	3	1	3	2	5	a	1+	1-	0	
18	18	20	2	2	2	15	5	a	1-	1-	0	B.
21	20	21	3	1	3	2	5	a	1-	0	0	C.
22	21	22	2	2	2	15	5	a	1+	1-	0	
25	22	23	1	3	1	2	5	a	1	0	0	D.
28	23	24	1	3	1	0	5	a	0	0	0	E.
33	24	25	1	3	1	0	5	a	1	1-	0	F.
34	25	25	1	3	1	0	5	H	0	0	0	G, H.

Remarks

A. Slow stylus coil burned out July 11.

B. Very little on the entire record.

C. Record almost complete blank.

D. One snap only on entire record.

E. Record absolutely blank. Instrument trouble?

F. Very little activity. Instrument OK.

G. No activity recorded.

H. The instrument was in good order so far as known but no activity was recorded. It ran 3-4 and 6-7 p.m. July 25. After the burst in 4301W9 stope the record was removed by E.A.H. Saturday evening, July 25.

H9

Rec	Fr	To	A	B	C	Db	G	S	Max.	Av.	Mn.	Remarks
	Ag	Ag										
87	20	21	1	1	1	5	5	a	20	15	2	A.
90	21	22	1	1	1	5	5	a	100+	60	30	B.
93	22	24	1	1	1	10	5	a	100+	C	C	C.
96	24	25	1	1	1	5	5	a	25+	15	5	Mostly small amplitude.
99	25	26	1	1	1	5	5	a	30+	20	10	Well defined activity.
102	26	27	1	1	1	5	5	a	25+	15	10	
105	27	28	1	1	1	5	5	a	50+	25	10	D.
108	28	29	1	1	1	5	5	a	50+	25	10	E.
		Sp										
113	31	1	1	1	1	5	5	a	20	15	10	
	Sp											
116	1	2	1	1	1	5	5	a	8	5	1	F.
158	17	18	1	1	1	5	5	a	50+	30+	20+	G.
161	18	19	1	1	1	5	5	a	100+	75+	50+	H.
164	19	21	1	1	1	5	5	a	40+	25+	15+	I.

Remarks

A. Activity diminishes through record.

B. Activity diminishes very little.

C. Strong activity as indicated from 3-4 p.m. Aug. 22, then markedly less over the week end. Only 1-2 c.p.m. toward end of record. Compare Note H for H19.

D. Strong activity began 3 a.m. Aug. 28. Previously quite moderate.

E. Activity increased slightly 3 a.m. Aug. 29.

F. No evidence of anything like "static".

G. Slow stylus coil shorted to chassis by bit of steel wool. Not recording after first half hour. Strong activity on fast stylus seems real.

H. Strong activity seems real.

I. Definite falling off of activity (Sat., Sun.)

H11

Rec	Fr	To	A	B	C	Db	G	S	Max.	Av.	Mn.	Remarks
	Ag	Ag										
111	29	31 Sp	3	3	3	10	1	a	8	4	0	A.
114	31 Sp	1	3	3	3	5	1	a	20	10	5	
117	1	2	3	3	3	10	1	a	12	6	0	Very wide zeros.

Remarks

A. The geophone was placed in H11 by F.J.H. in mistake for H22 which accounts for the short run on this hole. This is the first recording done on 3801W.

H19

Rec	Fr	To	A	B	C	Db	G	S	Max.	Av.	Mn.	Remarks
	Ag	Ag										
56	7	8	1	1	1	10	1	a	200+	A	A	A.
58	8	10	1	1	1	10	1	a	65+	B	B	B.
60	10	11	1	1	1	10	4	a	100+	C	C	C.
64	11	12	3	3	3	5	4	a	20	10	2	D.
67	12	13	3	3	3	5	4	a	15	10	3	D.
70	13	14	3	3	3	0	4	a	25	10	3	D.
73	14	15	3	3	3	0	1	a	36	15	5	Much small amplitude activity.E.
76	15	17	3	3	3	0	1	a	100+	F	F	F.
79	17	18	3	3	3	0	1	a	50+	25	15	Mostly small amplitude.
82	18	19	3	3	3	0	1	a	70+	25	15	Mostly small amplitude.
85	19	20	3	3	3	0	1	a	100+	50+	25	Strong activity. G.
88	20	21	3	3	3	5	1	a	150+	60+	40	Strong activity throughout.
91	21	22	3	3	3	5	1	a	75+	40+	25	Strong activity throughout.
94	22	24	3	3	3	5	1	a	150+	H	H	H.
97	24	25	3	3	3	5	1	a	75	25	10	Mostly small. D.
100	25	26	3	3	3	5	1	a	85	30	15	Mostly small.
	Sp	Sp										
155	16	17	1	1	1	5	3	a	60	30	20	Slow stylus coil burned out. I.

Remarks

A. For earlier recording from this same position see the report for H7 which is right beside H19. The former is only about a foot deep while the latter is 6' deep. This is the first record from H19. Activity is very great throughout. During the latter part of the period 3-4 a.m. Aug. 8 a succession of bursts is recorded.

B. Activity was moderately strong on Aug. 8. Beginning 3 p.m. Aug. 9 (Sunday) strong activity was begun which continued, diminishing only slightly to the end of the record.

C. Moderately active to 3 a.m. Aug. 11 when the activity became very marked diminishing only slightly to the end of the record.

D. The small frequent activity of these records may be instrumental, due to non-grounding of centre tap of transformer of geophone.

Remarks H19 (Continued)

E. Installed internal transformer in G1.

F. Marked activity from beginning of record, diminishing toward the end of record which covers a week end.

G. Small burst 3-12 a.m. Aug. 20.

H. Very great activity 3-4 p.m. Aug. 22. Then diminishes gradually over the week end to about 10 c.p.m., all small, on Aug. 24. Compare note A for H9.

I. Decided change in character of record beginning 3 a.m. Amplitude greater. Slow coil burned out 3-42 a.m.

H20

Rec	Fr	To	A	B	C	Db	G	S	Max.	Av.	Mn.	Remarks
	Ag	Ag										
61	10	11	3	3	3	5	6	a	1	0+	0	Very quiet - Hole in N wall.
63	11	12	1	1	1	10	6	a	15	3	0	A.
66	12	13	1	1	1	5	6	a	150+	50	40	B.
69	13	14	1	1	1	10	6	a	38	25	10	C.
72	14	15	1	1	1	10	6	a	15	10	0	Small amplitude. Diminishing.
75	15	17	1	1	1	10	6	a	15	5	0	Nearly all on fast stylus.
78	17	18	1	1	1	10	6	a	10	4	0	All small amplitude.
81	18	19	1	1	1	5	6	a	20	D	D	D.
84	19	20	1	1	1	5	6	a	20	15	10	Activity small. Continuous.

Remarks

A. Some activity of small amplitude on fast stylus beginning 3 a.m. Aug. 12 but soon died down.

B. Mostly small amplitude activity on fast stylus only. This and the activity on the previous record may be static due to non-grounding of centre tap on geophone transformer. Also, cable not shielded.

C. Small amplitude activity. Markedly greater beginning with 3 a.m. Aug. 14.

D. Activity - all small - confined to 3-4 p.m. Aug. 18.

H21

Rec	Fr Sp	To Sp	A	B	C	Db	G	S	Max.	Av.	Mn.	Remarks
120	2	3	1	1	1	5	4	a	15	8	1	First record in a 30' hole.
123	3	4	1	1	1	5	4	a	12	8	2	
126	4	5	1	1	1	5	4	a	40+	20+	10+	A.
129	5	7	1	1	1	5	4	a	30+	15+	6+	Tapping test.
132	7	8	1	1	1	5	4	a	30-	15-	6-	
135	8	9	1	1	1	5	4	a	30-	15-	6-	A.
137	9	10	1	1	1	5	4	a	30+	15+	6+	B.
139	10	11	1	1	1	5	4	a	15	8	3	Good clean record.
140	11	12	1	1	1	5	4	a	15	8	3	A, C.
144	12	13	1	1	1	5	4	a	9	7	1	D.
145	13	14	1	1	1	5	4	a	9	7	1	
149	14	15	1	1	1	5	4	a	15	9	2	D.
152	15	16	1	1	1	5	4	a	18	9	2	D, E.

Remarks

A. Very pronounced evidence of skipping on shaft No. 4. The first noticed in the 30' hole 3-4 a.m.

B. Skipping very pronounced 3-4 a.m. Also what seems to have been a burst lasting about 2 min. at 3-48 a.m.

C. Much quieter 3-4 p.m. Sep. 11. Also 6-7 p.m. same date. Activity resumed at 3-4 a.m. Sep. 12.

D. Skipping very pronounced 3-4 a.m.

E. This hole was deepened from 30' to 103' on Sep. 22 and began operating on Oct. 6 as H25.

H22

Rec	Fr Sp	To Sp	A	B	C	Db	G	S	Max.	Av.	Mn.	Remarks
118	2	3	3	3	3	10	1	a	5	1-	0	Wide zero.
122	3	4	3	3	3	10	1	a	5	1-	0	
124	4	5	3	3	3	5	1	a	10	4	2	A.
127	5	7	3	3	3	5	1	a	7	3	2	B.
130	7	8	3	3	3	5	1	a	10	5	3	B.
133	8	9	3	3	3	5	1	a	-	-	-	C.
146	12	14	3	3	3	5	1	a	-	-	-	D, E.
147	14	15	3	3	3	5	1	a	3	1	0	F.
150	15	16	3	3	3	5	1	a	2	1-	0	
153	16	17	3	3	3	5	1	a	2	1-	0	G.
156	17	18	3	3	3	5	1	a	2	1-	0	
159	18	19	3	3	3	5	1	a	2	1-	0	
162	19	21	3	3	3	5	1	a	2	1-	0	H.
165	21	22	3	3	3	5	1	a	2	1-	0	
168	22	23	3	3	3	5	1	I	2	1-	0	I.
171	23	24	3	3	3	5	1	a	2	1-	0	Wide zero.
173	24	25	3	3	3	5	1	J	2	1-	0	J.
	Oc	Oc										
209	15	16	3	3	3	0	3	b	3	1-	0	New schedule b. K.
212	16	17	3	3	3	0	3	b	4	1	0	Wide zero.
215	17	19	3	3	3	0	3	b	4	1	0	L.
218	19	20	3	3	3	0	3	b	4	1+	0	
220	20	21	3	3	3	0	3	b	4	1+	0	M.
222	21	22	3	3	3	0	3	N	-	-	-	N.
224	22	23	3	3	3	0	3	b	3	1-	0	
226	23	24	3	3	3	0	3	b	4	1+	0	
228	24	26	3	3	3	0	3	b	2	1-	0	O.
231	26	27	3	3	3	0	3	b	2	1-	0	
234	27	28	3	3	3	0	3	b	2	1-	0	

Remarks

A. Mostly small. Wide zero.

B. Many small offsets on fast stylus increase during progress of record. Zero very wide. The numerous small offsets possibly instrumental trouble. First tapping tests on walls made on this record, well marked when tapping done on south wall but little or none when done on north wall.

C. Record not turned on by E.A.H.

Remarks H22 (Continued)

D. Record valueless.

E. First hour of record continuous oscillations as if due to open circuit. Then wide zero for remainder of record. Some line trouble apparently.

F. Zero still too wide.

G. Second half of record shows an increased activity at the rate of 11-12 c.p.m. but it seems probable that the record is a result of instrument trouble. This is especially true since the next record (R156) shows a return to slight activity.

H. Instrument seems OK.

I. Only first two periods recorded. Recorder out of order.

J. Only first period recorded. 3C recorder taken to surface for adjustment.

K. Record shows very poor pickup. May be instrumental but may be due to poor rock conditions.

L. Wide zero continued to 3 p.m. Oct. 18 when an open circuit recorded with a few small interruptions for two hour-records, after which the wide zero was resumed.

M. Too much voltage on slow stylus. Toward the last half of the record considerable very small activity recorded on the fast stylus only. May be instrumental.

N. Paper did not run due to slippage in drive. No record.

O. The record showed very small activity as reported in the c.p.m. columns except for the period 3-4 p.m. Oct. 25 when it ran Max. = 8, Av. = 4, Min. = 1 after which the low activity was resumed. Zero was too wide throughout but especially during the active hour.

H23

Rec	Fr Ag	To Ag	A	B	C	Db	G	S	Max.	Av.	Mn.	Remarks
103	26	27	3	3	3	10	1	a	25	15	10	A, B.
106	27	28	3	3	3	10	1	a	40	30	10	B.
110	29	31	1	1	1	5	6	a	25	15	10	

Remarks

A. Mostly small. Possibly partly instrumental.

B. Definite evidence of ore skipping 3-4 a.m.

H24

Rec	Fr	To	A	B	C	Db	G	S	Max.	Av.	Mn.	Remarks
	Dc	Dc										
306	7	8	1	1	1	10	3	b	5+	2+	0	A.
318	11	12	1	1	1	10	3	b	15-	10-	2	
321	12	14	1	1	1	10	3	b	5+	3+	0	
324	14	15	1	1	1	10	3	c	5+	3+	0	New schedule c. B.
330	16	17	1	1	1	10	3	C	15+	10-	3	C.
333	17	18	1	1	1	10	3	b	20+	10-	0	
336	18	19	1	1	1	10	3	d	30+	10+	0	New schedule d. D.
338	19	21	3	3	3	10	3	c	-	-	-	E.
340	21	22	3	3	3	10	3	b	20-	10-	5-	F.
342	22	23	3	3	3	10	3	d	20-	10-	5-	
344	23	24	3	3	3	10	3	d	40-	20+	20-	
346	24	28	3	3	3	10	3	d	10+	10-	5+	G.
		Ja '43										
358	31	2	3	3	3	7	3	d	15+	10-	5-	

Remarks

A. Friction of writing styli with record much too great.

B. Time switch installed to run H24 and H26 each alternate half hour from 4-7 a.m. - p.m. with H24 coming on at the hour and H26 at the half hour. But the time switch did not close properly so that it was always open circuit for the H26 with much oscillation and no record.

C. Last half of record was entirely lost due to open circuit oscillations.

D. Last half of record shows noticeable falling off in activity.

E. Entire record lost due to ineffectual contacts on time switch.

F. Considerable time lost due to ineffectual contacts on time switch.

G. Activity increased during record till at the end it was about Av. = 30+.

H25

Rec	Fr	To	A	B	C	Db	G	S	Max.	Av.	Mn.	Remarks
	Oc	Oc										
194	6	7	3	3	3	0	4	b	40+	20+	10+	First record in a 100' hole. A.
196	7	8	3	3	3	0	4	b	50+	25+	15+	
198	8	9	3	3	3	0	4	b	40+	20+	10+	B.
200	9	10	3	3	3	0	4	b	40-	20-	10-	
202	10	12	3	3	3	0	4	b	40+	20+	10+	C.
204	12	13	3	3	3	0	4	b	20+	15+	10+	D.
206	13	14	3	3	3	0	4	b	20-	15-	10-	E.
208	14	15	3	3	3	0	4	b	40+	20+	10+	
211	15	16	2	2	2	10	4	b	15+	10+	5+	F.
213	16	17	1	1	1	5	4	b	50+	30+	15+	
216	17	19	1	1	1	5	4	b	40+	20+	10+	G.
229	24	26	1	1	1	5	4	b	2	1-	0	H.
232	26	27	1	1	1	5	4	b	3	1-	0	I.
		Nv										
242	31	2	3	3	3	5	6	b	10-	5+	1	J.
	Nv											
245	2	3	1	1	1	5	4	b	20+	15+	5+	
247	3	4	1	1	1	5	4	b	20+	15+	5+	K.
248	4	5	3	3	3	0	4	b	10-	5+	1	L, M, N.
251	5	6	1	1	1	5	4	b	20+	15+	5+	
253	6	7	1	1	1	5	4	b	15+	10-	3	
255	7	9	1	1	1	5	4	b	15+	10-	3	
257	9	10	1	1	1	5	4	b	10-	5+	3	O.
259	10	11	1	1	1	5	4	b	10+	5+	3	O.
261	11	12	1	1	1	5	4	b	5	1+	0	
263	12	13	1	1	1	5	4	b	10-	5+	2	O.
265	13	14	1	1	1	5	4	b	20-	10+	4	O.
267	14	16	1	1	1	5	4	b	20-	10+	3	O.
269	16	17	1	1	1	5	4	b	15+	10-	5	P.
271	17	18	1	1	1	5	4	b	10+	5+	3	O.
273	18	19	1	1	1	5	4	b	40-	15+	5	O.
275	19	20	1	1	1	5	4	b	30+	10+	5	O.
277	20	21	1	1	1	5	4	b	20+	10+	3	O.
279	21	23	1	1	1	5	4	b	20+	10+	3	O.
281	23	24	1	1	1	5	4	b	20-	10-	3	O.
283	24	25	1	1	1	5	4	b	20-	10+	3	
285	25	26	1	1	1	5	4	b	20-	10+	3	O.
287	26	27	1	1	1	5	4	b	10+	10-	3	
289	27	28	1	1	1	5	4	b	10+	10-	3	Q.
291	28	30	1	1	1	5	4	b	15+	10-	2	R.
		Dc										
293	30	1	1	1	1	5	4	b	20+	10-	0	S.

H25 (Continued)

Rec	Fr	To	A	B	C	Db	G	S	Max.	Av.	Mn.	Remarks
	Dc	Dc										
295	1	2	3	3	3	5	4	b	20+	10+	5+	Zero too wide.
297	2	3	3	3	3	10	4	b	15+	10-	5-	Good record.
299	3	4	3	3	3	10	4	b	20-	10-	5	T.
301	4	5	3	3	3	10	4	b	20-	10-	5	
303	5	7	3	3	3	10	4	b	20+	10+	4	U.
305	7	8	3	3	3	10	4	b	20-	10-	3	
308	8	9	3	3	3	10	4	b	20-	10-	3	V.
309	8	9	1	1	1	10	4	b	20-	10-	3	V.
311	9	10	3	3	3	10	4	b	15+	10-	3	V.
312	9	10	1	1	1	10	4	b	15+	10-	3	V.
314	10	11	3	3	3	10	4	b	20+	10-	3	V.
315	10	11	1	1	1	10	4	b	20+	10-	3	V.
317	11	12	3	3	3	10	4	b	25+	10+	4	
320	12	14	3	3	3	10	4	b	25+	10+	4	W.
323	14	15	3	3	3	10	4	b	40+	10-	6	X.
326	15	16	3	3	3	10	4	b	25+	10-	4	
329	16	17	3	3	3	10	4	b	25+	10+	2	Y.
332	17	18	3	3	3	10	4	b	40-	20-	10-	
335	18	19	3	3	3	10	4	b	40+	20+	5+	
337	19	21	2	2	2	10	4	d	20+	10+	5+	New schedule d.
339	21	22	2	2	2	10	4	d	20+	10+	5+	
341	22	23	2	2	2	0	4	d	40-	20-	5+	
343	23	24	2	2	2	0	4	d	40+	25+	20-	Z.
345	24	28	2	2	2	0	4	d	20+	10+	5+	A'.
348	28	29	2	2	2	0	4	b	20-	5+	0	B', C'.
349	28	29	3	3	3	2	4	b	25+	10-	2	B', C'.
350	28	29	1	1	1	5	4	b	20+	10+	3	B', C'.
351	29	30	2	2	2	0	4	b	20-	10-	5	D'.
352	29	30	3	3	3	7	4	b	20+	10+	5+	D'.
353	29	30	1	1	1	7	4	b	20+	10+	5+	D'.
354	30	31	2	2	2	0	4	b	30+	10+	5+	D'.
355	30	31	3	3	3	7	4	b	30+	10+	5+	D'.
356	30	31	1	1	1	7	4	b	30+	10+	5+	D'.
		Ja '43										
357	31	2	2	2	2	0	4	c	20+	10+	5+	

Remarks

A. Ran simultaneously with No. 195 in H4. See note M' for H4.

Remarks H25 (Continued)

B. First "pull out" test between H4 and H25. cf. record No. 197 in H4. Deeper hole is much the more active.

C. Activity fell off somewhat toward end of record which ran over Sunday.

D. Fairly continuous activity.

E. Record caught fire but went out only leaving small burned hole.

F. Feed seems irregular. Frequent small stoppages marked by burned holes beginning on page 21115. Very bad on page 21119. It was fortunate that the record did not catch fire. Both styli give records which look the same - a most unusual setting. This is the first record from 222 since it was repaired after the fire of Sep. 22. See note Q' for H4.

G. Paper caught fire and burned quite a section off one edge for nearly 2 min. on page 21603. The paper was feeding crookedly at the time. It came back to normal after about 40 min. Burned off at about 3-50 p.m. Oct. 18 and record stopped. During last hour paper slipped badly remaining stationary, hence the burn off. Did not catch fire, however.

H. Most remarkable change in H25 since Oct, 19.

I. Paper ran crookedly during much of record. No fire. Voltage high on styli.

J. Styli have too much friction with paper. Does not prevent most of the recording but makes record very irregular as stylus does not return to zero after each throw.

K. May be small burst registered at 6-57 p.m. Nov. 3. Slight trace on 24613A and well recorded on 24713A.

L. Record began to run crookedly on page 24809. The edge was burned off the record for nearly 7 min. on page 24810. The record came back into position and no fire resulted.

Remarks H25 (Continued)

M. The stylus friction is much too great.

N. Looks like small burst at 6-57 p.m. Nov. 4. In view of note K above the record may be instrumental. It appears also on 24912 which seems to show that the disturbance is mechanical but it may not be seismic. If not, cause is not known. See also 25813A.

O. Many electrical disturbances lasting some minutes at a time, causing slight 25 cycle oscillation and a widening of the zero. - Instrumental.

P. Well recorded burst lasting about 4 min. on page 26903. Less well registered on 26803 for H28.

Q. Severe oscillations resembling bursts on page 28919 for H25 do not appear on corresponding pages of record 288 for H28, the latter being the newly adjusted 222 set.

R. Burst felt by E.A.H. at 6-22 a.m. Nov. 30. See page 29144A (H25) and cf. 290 43B (H28).

S. Burst at 4-12 p.m. Nov. 30 (see page 29306B). cf. 29206B for H28.

T. Some good records of ore pass noise during the listening period.

U. A series of bursts registered beginning 6 p.m. Dec. 6 becoming quite violent at 6-12 p.m. (page 30337B). cf. 30230b on H28.

V. Recorders 333 and 111 run on an input divider giving two records from same hole.

W. Activity falls off considerably toward the end of the record to Av. = 5- c.p.m.

X. Maximum activity falls off rapidly.

Y. Activity becomes greater in second half of record reaching Max. = 30+, Av. = 20+, Min. = 10-.

Remarks H25 (Continued)

Z. Activity reported was on first period of record. The activity fell off to about Max. = 20+, Av. = 10+, Min. = 5+.

A'. Activity fell off to about Av. = 5+ by end of record.

B'. H25 G4 was run through a voltage divider onto 111, 222, and 333. The results were far from satisfactory as regards equivalent recording.

C'. Heavy burst at 6-06 p.m. Dec. 28 recorded on all 3 sets.

D'. Simultaneous recordings on 111, 222, 333 from H25 G4. Adjustment of sensitivity much better.

H26

Rec	Fr	To	A	B	C	Db	G	S	Max.	Av.	Mn.	Remarks
	Oc	Oc										
236	28	29	3	3	3	0	1	a	3	1-	0	A.
240	30	31	3	3	3	0	1	B	3	1-	0	B.
	Dc	Dc										
336	18	19	1	1	1	10	1	c	5	3	1	
338	19	21	3	3	3	10	1	c	-	-	-	C.
342	22	23	3	3	3	10	1	c	20-	10-	5-	D.
344	23	24	3	3	3	10	1	c	10-	5-	0	
346	24	28	3	3	3	10	1	c	10-	5-	0	E.
		Ja '43										
358	31	2	3	3	3	7	1	c	-	-	-	F.

Remarks

A. Recorder all in good order as blasting is well recorded. But in this 30' hole in 4201W9 the activity has fallen to almost zero. For previous recording in this region see tabulation for H19.

B. Last hour (6-7 a.m. Oct. 31) of this record was run 111 H28 G6.

C. Entire record lost due to ineffectual contacts on time switch.

D. Considerable time lost due to ineffectual contacts on time switch.

E. Greatly increased activity toward end of record. Av. = 50+. May be instrumental but does not appear to be so.

F. Time switch contacts ineffectual. Continual oscillations during H26 part of record.

H27

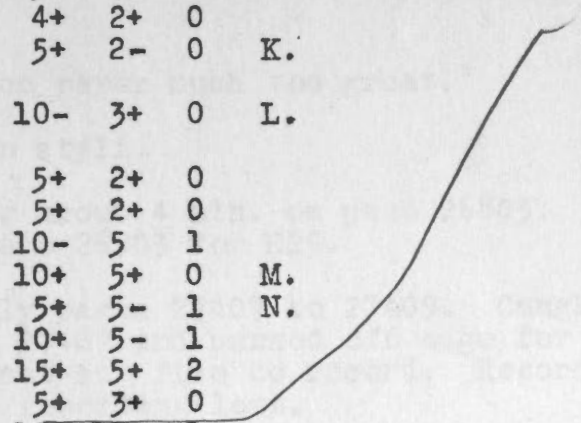
Rec	Fr Dc	To Dc	A	B	C	Db	G	S	Max.	Av.	Mn.	Remarks
327	15	16	1	1	1	10 6	b		A	A	A	A.
347	24	28	1	1	1	10 6	b		10-	2-	0	B.

Remarks

A. Record very active. Av. = 25+ c.p.m. but this may be instrumental as the connecting cable is very long. If not, H27 must be very active. The activity increased slowly to 4 a.m. Dec. 16 when it became quite pronounced as noted above and so continued.

B. Voltage too high on styli.

Rec	Fr	To	A	B	C	Db	G	S	Max.	Av.	Mn.	Remarks
	Oc	Oc										
238	29	30	3	3	3	0	6	b	1	0+	0	A.
240	30	31	3	3	3	0	6	b	6	3	1	B.
		Nv										
243	31	2	1	1	1	5	2	b	20-	10+	2	
	Nv											
244	2	3	3	3	3	0	2	b	10+	5+	2	C.
246	3	4	3	3	3	0	2	b	5+	2+	0	D.
249	4	5	1	1	1	5	2	b	5+	2+	0	
251	5	6	3	3	3	0	2	b	20-	10-	2	D.
252	6	7	3	3	3	0	2	b	5+	1+	0	
254	7	9	3	3	3	0	2	b	15+	5+	0	
256	9	10	3	3	3	0	2	b	10-	5+	1	
258	10	11	3	3	3	0	2	b	10-	5+	1	
260	11	12	3	3	3	0	2	b	10-	2	0	E.
262	12	13	3	3	3	0	2	b	10+	10-	3	
264	13	14	3	3	3	0	2	b	20-	10+	4	
266	14	16	3	3	3	0	2	b	20-	10-	3	
268	16	17	3	3	3	0	2	b	15+	5+	3	F.
270	17	18	3	3	3	0	2	b	15-	10-	3	E.
272	18	19	3	3	3	0	2	b	20-	10+	3	E.
274	19	20	3	3	3	0	2	b	10+	10-	3	G.
276	20	21	3	3	3	0	2	b	20-	10+	3	H.
278	1	23	3	3	3	0	2	b	20-	10+	3	
280	23	24	3	3	3	0	2	b	20+	10+	4	I.
282	24	25	2	2	2	5	2	b	5	2+	0	J.
284	25	26	2	2	2	5	2	b	5+	2+	0	
286	26	27	2	2	2	5	2	b	5+	2+	0	
288	27	28	2	2	2	5	2	b	4+	2+	0	
290	28	30	2	2	2	5	2	b	5+	2-	0	K.
		Dc										
292	30	1	2	2	2	5	2	b	10-	3+	0	L.
	Dc											
294	1	2	2	2	2	5	2	b	5+	2+	0	
296	2	3	2	2	2	0	2	b	5+	2+	0	
298	3	4	2	2	2	0	2	b	10-	5	1	
300	4	55	2	2	2	0	2	b	10+	5+	0	M.
302	5	7	2	2	2	0	2	b	5+	5-	1	N.
304	7	8	2	2	2	0	2	b	10+	5-	1	
307	8	9	2	2	2	0	2	b	15+	5+	2	
310	9	10	2	2	2	0	2	b	5+	3+	0	
313	10	11	2	2	2	0	2	b	15+	10-	1	
316	11	12	2	2	2	0	2	b	15+	10-	1	
319	12	14	2	2	2	0	2	b	15+	10-	1	O.



H 28 (Continued)

Rec	Fr	To	A	B	C	Db	G	S	Max.	Av.	Mn.	Remarks
	Dc	Dc										
322	14	15	2	2	2	0	2	b	15+	10-	1	
325	15	16	2	2	2	0	2	b	10-	5+	0	
328	16	17	2	2	2	0	2	b	10+	5+	2	
331	17	18	2	2	2	0	2	b	20+	10-	2	O.
334	18	19	2	2	2	0	2	b	20+	10-	2	
337	19	21	2	2	2	0	2	c	20+	10-	2	New schedule c. P.
339	21	22	2	2	2	0	2	c	40-	20+	15+	
341	22	23	2	2	2	0	2	c	40-	20+	15+	
343	23	24	2	2	2	0	2	c	50+	40+	20+	Q.
345	24	28 Ja '43	2	2	2	0	2	c	30+	20+	10+	R.
357	31	2	2	2	2	0	2	d	5+	2+	0	New schedule d.

Remarks

A. This inactivity is plainly instrument trouble. 111H4G2 for the same period gives a normally active record (see No. 239 for H4). G6 was taken to surface and the crystal was found to have been destroyed by moisture.

B. New crystal in G6. Works very well.

C. A number of disturbances lasting a minute more or less which are probably due to electrical disturbance since some are so identified during the listening period, 6-7 a.m.

D. Friction of styli on paper much too great.

E. Too much voltage on styli.

F. Some bursts lasting about 4 min. on page 26803. Very pronounced on page 26903 for H25.

G. Record ran crookedly pages 27407 to 27409. Caught fire on edge on page 27407 and burned off edge for nearly 5 min. but did not set fire to record. Record resumed position and no recording lost.

Remarks H28 (Continued)

H. Toward end of record there were many small offsets registered on the fast stylus - May have been instrumental.

I. Activity falls off toward end of record.

J. Note that this falling off of activity is not real. The set 222 has been substituted for 333.

K. Burst felt by E.A.H. at 6-22 a.m. Nov. 30. See page 29043B (H28) and cf. 29144A (H25).

L. Burst at 4-12 p.m. Nov. 30 hardly registers on 29206B but is very well marked on 29306B (H25). Is this due to lack of calibration or due to the fact that H25 is the deeper hole?

M. Activity falls off toward end of record.

N. Fairly well marked burst occurred at 6-12 p.m. Dec. 6 (page 30230B) but it was much better marked on 333 H25 G4 D10 on page 30337B.

O. Record falls off considerably toward the last giving an Av. = 5- c.p.m.

P. Some lost time due to poor contacts on time switch.

Q. Activity reported was for first period only. It fell off until at the end of the record it was down to Max. = 20+, Av. = 10+, Min. = 5+

R. Activity fell off gradually to about Av. = 5+ by end of 4-day record.

APPENDIX III

Notes on Illustrations 1-7

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Notes on Illustrations 1 - 7
Rockburst Report No. 10

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The first four figures are self-explanatory. Fig. 1 shows the pleater, press, and numbering machine for making over the rolled records into pleated books. There are shown also a finished record book in the foreground and, behind it, the template for marking the two tab positions. Fig. 2 presents a top view of the rehabilitated 2C unit after the fire damage was repaired. The recorder was burned due to paper stoppage on Sep. 22. The unit as it was taken from the burned case appears in Fig. 3 and a general view after repairs were completed is given in Fig. 4.

In Figs. 2 and 4 may be seen the extra lever designed and installed by Gibbs to permit the manual recording of snapping heard by means of supplementary listening equipment (L.S.M. 11 or L.S.M. 12). The stylus carries a writing voltage as do the regular styli for recording on the Teledeltos paper. It is put in operation by means of the switch in the top centre of the front panel (see Fig. 4) and is worked by means of the lever shown folded up out of the way near the bottom centre of the illustration.

It was impossible to get some parts to repair the burned unit. The ends burned off the stylus arms were replaced by new ends spliced and soldered on the undamaged stubs. The microswitch for the timing was replaced by a less sensitive switch (seen just above the record paper beneath the styli in Fig. 4).

The sample records shown are reduced to approximately half size. Some interesting interference records are shown in Fig. 5 (9-13). In sample 9, the 15 offsets beginning to the right of centre are due to blasts which did not occur in Lake Shore Mines. They could barely be heard with the unaided ear. It is to be noted that they are of longer duration than the snaps to the left and that they have a full record on the upper (slow) stylus - an indication that they originate at a considerable distance.

In sample 10 is shown the type of record obtained if the line from the geophone to the recorders is open or partially open. At first some of these records (obtained from lines which were sometimes open and sometimes closed giving short runs of such a type) were thought to have been caused by rock-slides in stopes near the pick-up geophones.

Sample 11 is a record of "static" caused by slight electrical impulses picked up by the geophone-to-recorder cable or due to electrolytic action at a poor joint or a broken strand in that cable. It will be noted that all the static is on the lower (fast) stylus and that three small snaps are to be identified by small irregularities on the upper line. This "static" can be eliminated by making sure that good cables are used with proper joints and no broken strands and with a good ground shield. For this reason we are installing BXL for the geophone-to-recorder lines.

At about 6-30 a.m. each day a peculiar electric disturbance comes in over the power supply. There is always a series of three buzzes about 3 sec. long with a pause slightly less between. These three buzzes are usually followed by three more after an interval of about 20 sec., and in some cases these series of three have recorded as many as five times with decreasing amplitude and clarity as is shown in sample 12 for Aug. 16. The first group of three can be heard by radio on surface. Even when only two sets of three record, one can sometimes hear succeeding groups on the phones through the Obert unit underground. They do not interfere appreciably with the records as they are easily recognized and do not occur often. The exact cause has not been identified, but it is not in Lake Shore Mines.

Sample 13 shows the record obtained in 4201W8 due to sliding of ore in the pass at the cross cut, 800' or more away, when skipping ore on No. 4 shaft. The skip intervals are approximately 70 sec. Two small sections some 20 min. apart are here given to show the effect as the amount of ore in the pass diminishes. After about an hour it fades down to merely a slight irregularity on the lower (fast) stylus.

In sample 8 appears a marked increase of snapping. The left hand side of the record was made at 7 p.m. on July 9 and the right hand side shows the conditions when the recorder again went into service at 3 a.m. on July 10. Such increases are said to indicate critical conditions but no burst occurred in this case.

In Fig. 5 (1-7) appears a series of records taken in 4201W10. At first the only hole available here was a bootleg only 12" deep (H7) in the south wall. On July 25 at 11-10 a.m. a severe burst occurred about 100' west of this geophone. It was not recording at the time as it was on a 3-4:6-7 schedule. No records were made in this section prior to July 22 so the

history begins then - much too late to provide an adequate background of data for the burst which occurred three days later. On July 23 the snapping in 4201W10 was disturbing to men working there. Rock and timber were both "talking". On July 24 conditions were less noticeable and on July 25 at 10 a.m. the place was quiet so far as could be told with the unaided ear.

Examining the records, we find no indication of bursting conditions. The disturbance in sample 3 is shown in its entirety. It was thought at the time to have been caused by rock slides, then to have been due to a temporary open circuit as explained in the case of Fig. 5 (10), but in the light of later experience it may safely be interpreted as a small pre-burst.

There was no increase of (recorded) snapping prior to the burst and none of any account after, although it is probable that the frequency of snapping is as great or greater immediately after a burst as before it. There was a slight increase on July 25 (sample 5) and on July 26 (sample 6) but not nearly as much as on July 31 (sample 7) six days after the burst.

It is to be remembered that the geophone was in a bootleg only 12" deep and therefore certainly in the loose. Apparently the contact of the block with the wall was poor until July 31 when the shifting due to the burst and after adjustments made good contact and we get the after snapping as it should have recorded. With the after snapping six days late as great as shown, we can only guess what it might have been at the time of the burst.

This series serves to show the futility of using leftover, short holes for pick-up geophones. On Aug. 7 the geophone was put into a hole 6' deep drilled in the south wall beside H7. This hole (H19) gave very active records. (See Appendix II). It was superceded by a 30' D.D. hole (H26) which was completed on Sep. 23. By the end of October, the snaps at this hole were down to about one per min.

Fig. 6 (1-13) shows the history of activity in 4201W8 leading up to the holing through of a 16' rill from 4301W8 on Sep. 5. Records 1-9 and 10a to 13a were all made on the same recording equipment at H4. The b-series, 10b-13b, was made from a geophone in a 30' D.D. hole (H21) close to H4. It is to be noted that:

(1) The series in H4 shows a definite growth up to the time of greatest stress Sep. 5.

(2) The series in H21 shows a much more marked increase on Sep. 4. It is unfortunate that H21 was not occupied prior to Sep. 2.

It is concluded that a 30' hole is much more informative than one 6' deep. In this case the hole (H4) is the best of all the 6' holes drilled for this study(about 20 of them).

If, then, a 30' hole is more informative than a 6' hole, what could one expect from a 100' hole? To answer this question H21 was deepened on Sep. 22 to 103'. Several "pull out" tests were then run as follows: A geophone (G2) in the good 6' hole (H4) was run without change on Obert unit 222. A geophone (G4) was run on Obert unit 111 for four minutes at a depth of 100', then another four minutes at a depth of 94' and so on at depths successively 6' less. The comparative records from the second of these pull-out tests are given in Fig. 7, those from the geophone in the deep hole being given first. On each record a sensitivity test (T) is recorded by tapping (generally five times) on a steel anchor bolt let into the south wall of the recording station at a distance 125-150' from the geophones.

It will be noted that the tests (T) show up well on each pair of records indicating that contact with the rock was good at each setting and that the bottom of the 100' hole is more active than the bottom of the 6' hole. It raises the questions:

(1) How deep would one need to go to get beyond the zone of compression?

(2) How would the simultaneous recordings from a 30' hole, say, compare with those from the 100' hole?

To answer the latter question a 30' D.D. hole (H28) was drilled close to H4 and H25. The comparison tests were made through a long series of records from H28 and H25. (See Appendix II).

Fig. 1

Pleating Equipment
and Press for Making
Record Books

Fig. 3

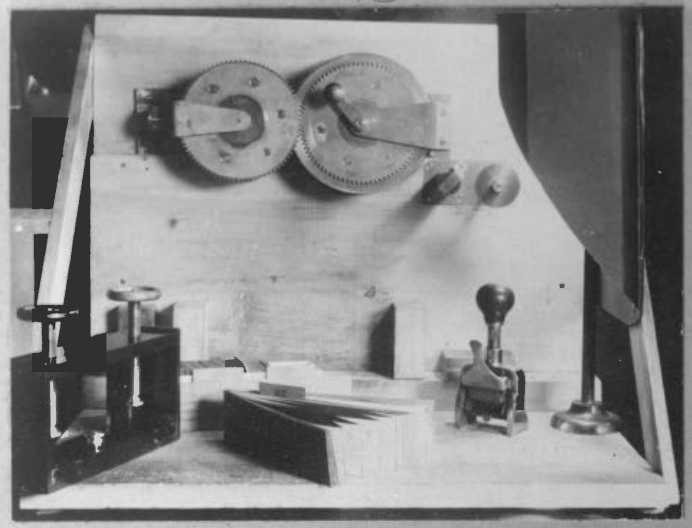
Recording Unit, No. 2C
after Fire on Sept. 22

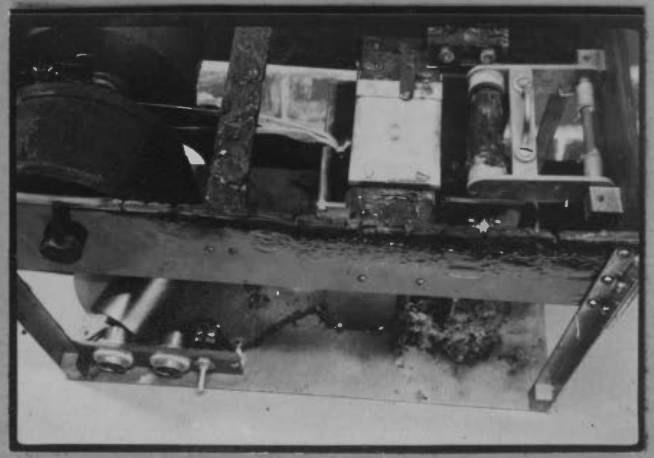
Fig. 2

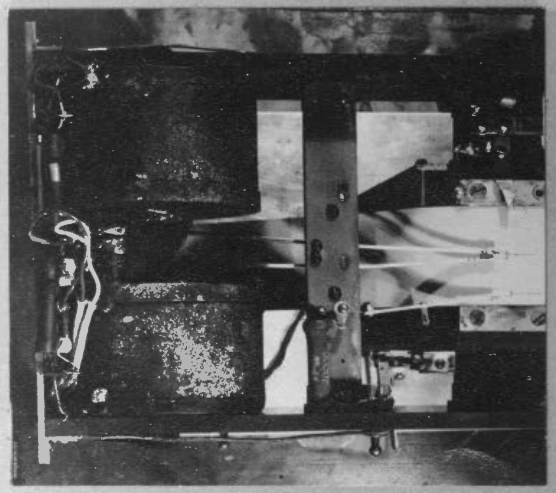
Top View
of Repaired Recorder
Showing Added Stylus

Fig. 4

Recording Unit, No. 2C
after being repaired
Note Added Manual Stylus







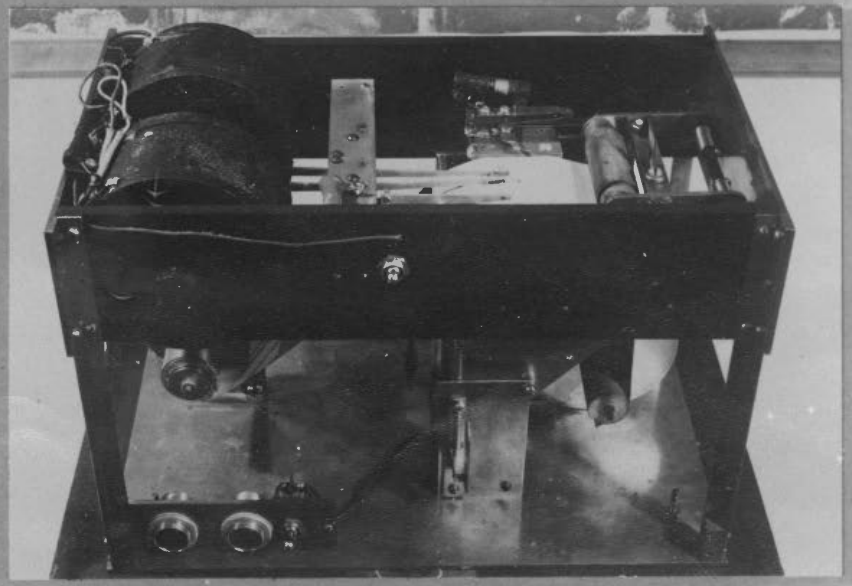


FIGURE 5

I History of Activity in 4201'10 in Relation to the Burst of July 25. (Nos. 1-7)

II A Sample of Rapid Activity Increase in 4201'7. (No. 8)

III Some Typical Interference. (Nos. 9-13)

(9) Blasting in another mine.

(10) Open or nearly open circuit in geophone cable.

(11) Poor connection in geophone cable, generating "static" by electrolytic action.

(12) Electrical surges on power circuit.

(13) Ore running in pass some 800 ft. distant. Note the skip periods of about 70 to 80 sec. and the reduced interference after the skip has been running some 20 min., thus reducing the amount of ore in the pass.

FIGURE 6

History of Activity in 4201W8 up to and after bringing through a raise from 4300' level on Sept. 5.

Nos. 1-9; 10a-13a: Records made in a 6 ft. hole (H4) by geophone No. 2 on Unit 222.

Nos. 10b-13b: Records made in a 30 ft. hole (H21) by geophone 4 on Unit 111.

Note:- Holes 4 and 21 are drilled side by side in the south wall of 4201W8.

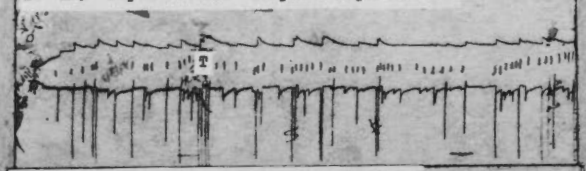
FIGURE 7

Relative Activity at Various Depths in a 100 ft. D.D. Hole (H28) and in a 6 ft. P.D. Hole (H4) at full depth.

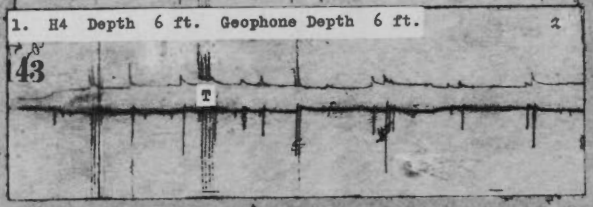
*

Keeping geophone 2 at full depth in hole 4 (6 ft. deep) and operating on Obert Unit 222 as a check, the geophone (G4) in the adjacent 100 ft. hole (H28) was operated for about two minutes each time at depths successively 6 ft. less, the amplifying and recording being done on Obert Unit 111. At least once on each pair of records, a test is applied (T) by tapping (generally five times) on an anchor bolt set in the wall at the recorders - 125 to 150 ft. away from the geophones.

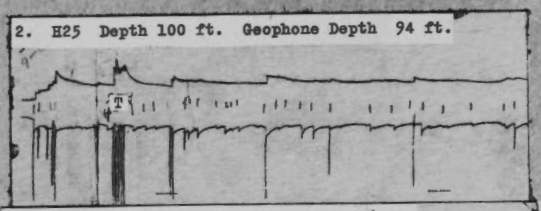
1. H25 Depth 100 ft. Geophone Depth 100 ft.



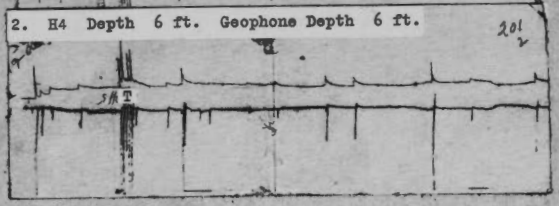
1. H4 Depth 6 ft. Geophone Depth 6 ft.



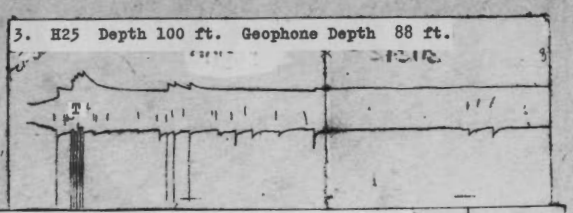
2. H25 Depth 100 ft. Geophone Depth 94 ft.



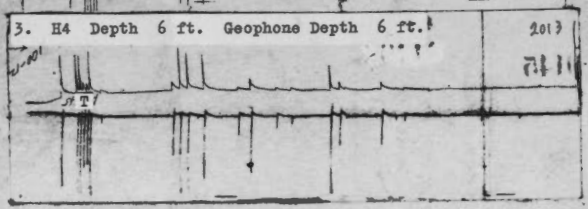
2. H4 Depth 6 ft. Geophone Depth 6 ft.



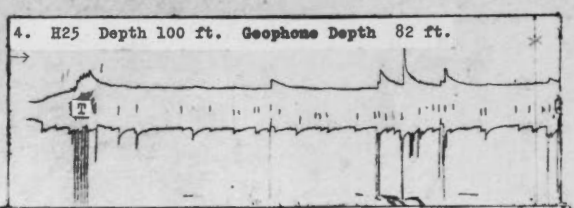
3. H25 Depth 100 ft. Geophone Depth 88 ft.



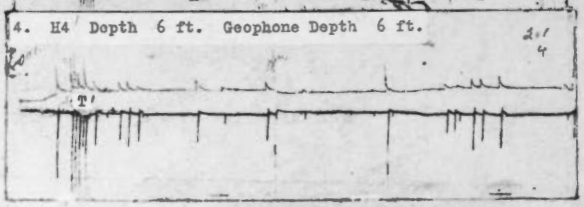
3. H4 Depth 6 ft. Geophone Depth 6 ft.



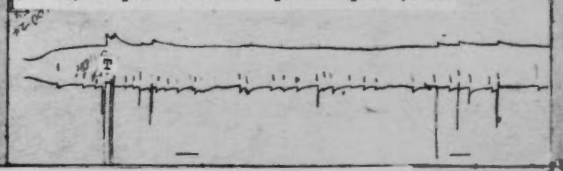
4. H25 Depth 100 ft. Geophone Depth 82 ft.



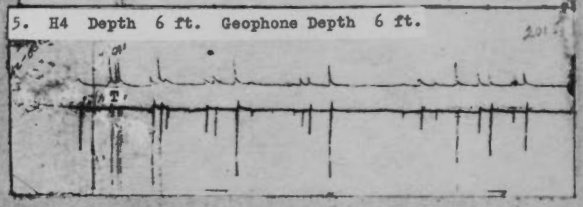
4. H4 Depth 6 ft. Geophone Depth 6 ft.



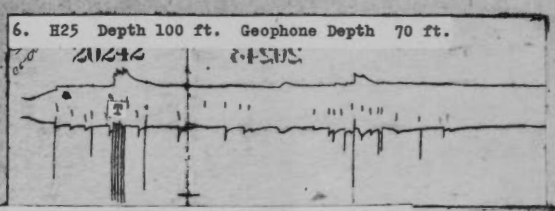
5. H25 Depth 100 ft. Geophone Depth 76 ft.



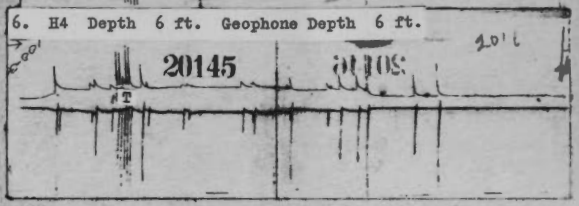
5. H4 Depth 6 ft. Geophone Depth 6 ft.



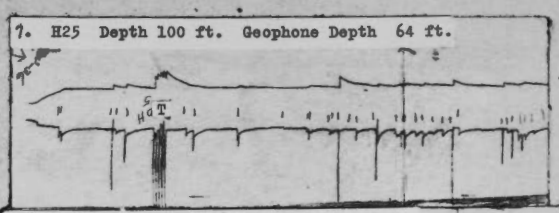
6. H25 Depth 100 ft. Geophone Depth 70 ft.



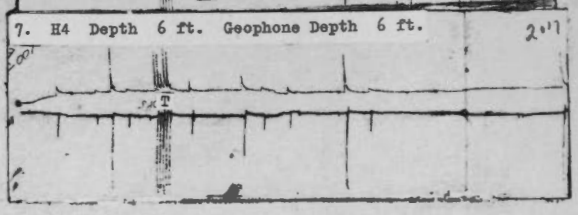
6. H4 Depth 6 ft. Geophone Depth 6 ft.



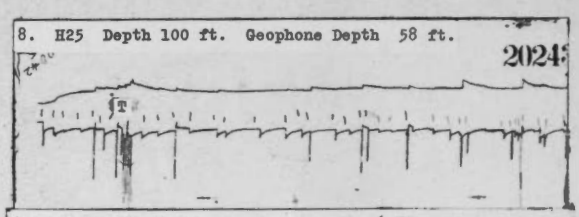
7. H25 Depth 100 ft. Geophone Depth 64 ft.



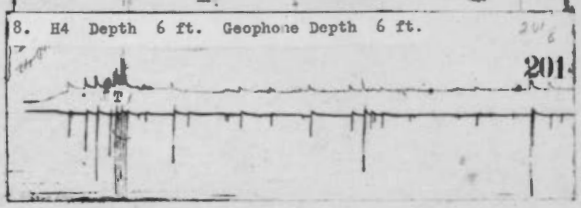
7. H4 Depth 6 ft. Geophone Depth 6 ft.



8. H25 Depth 100 ft. Geophone Depth 58 ft.



8. H4 Depth 6 ft. Geophone Depth 6 ft.



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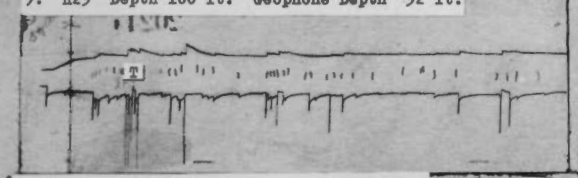
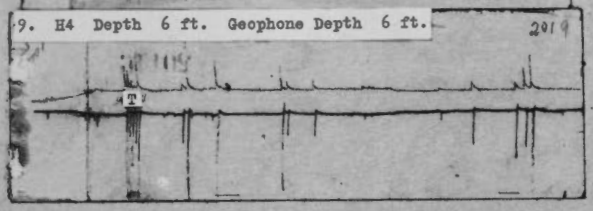
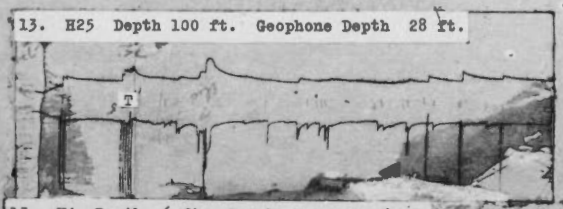
9. H25 Depth 100 ft. Geophone Depth 52 ft.



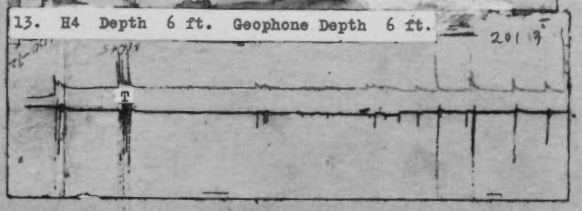
9. H4 Depth 6 ft. Geophone Depth 6 ft. 2019



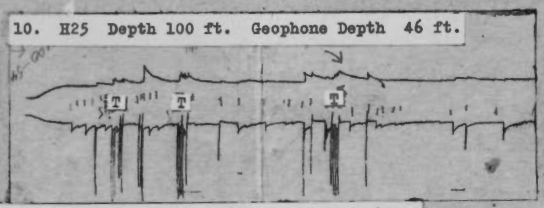
13. H25 Depth 100 ft. Geophone Depth 28 ft.



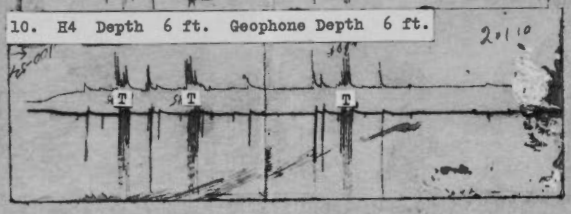
13. H4 Depth 6 ft. Geophone Depth 6 ft. 2013



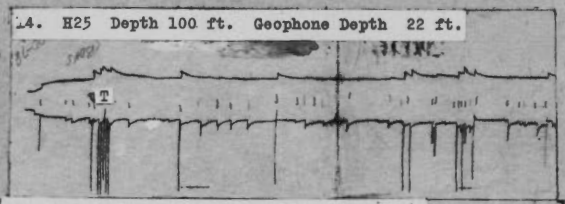
10. H25 Depth 100 ft. Geophone Depth 46 ft.



10. H4 Depth 6 ft. Geophone Depth 6 ft. 2010

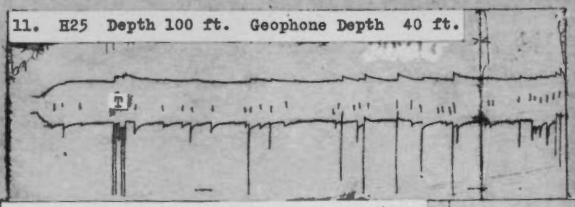


14. H25 Depth 100 ft. Geophone Depth 22 ft.

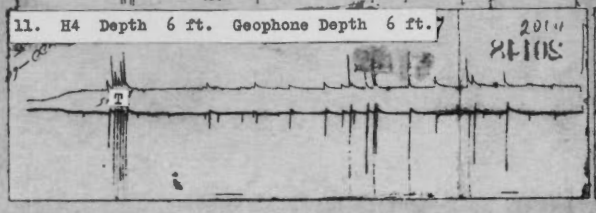


14. H4 Depth 6 ft. Geophone Depth 6 ft. 2014

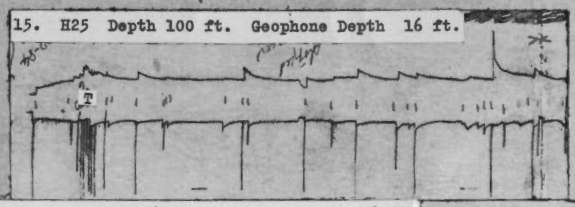
11. H25 Depth 100 ft. Geophone Depth 40 ft.



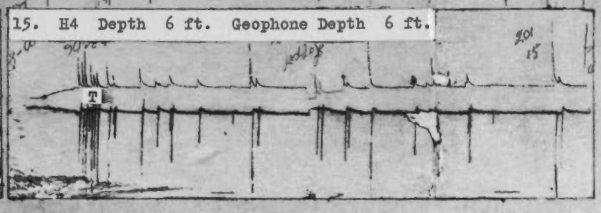
11. H4 Depth 6 ft. Geophone Depth 6 ft. 2011



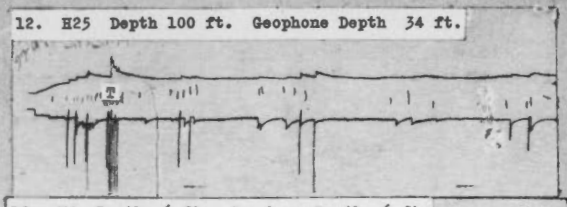
15. H25 Depth 100 ft. Geophone Depth 16 ft.



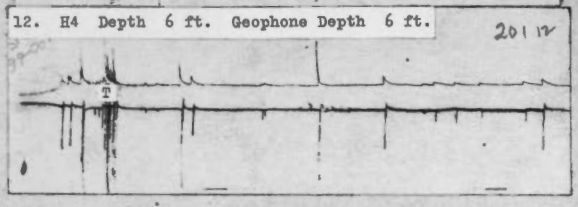
15. H4 Depth 6 ft. Geophone Depth 6 ft. 2015



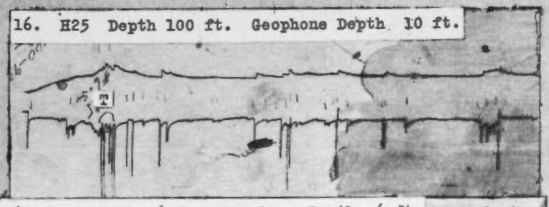
12. H25 Depth 100 ft. Geophone Depth 34 ft.



12. H4 Depth 6 ft. Geophone Depth 6 ft. 2012



16. H25 Depth 100 ft. Geophone Depth 10 ft.



16. H4 Depth 6 ft. Geophone Depth 6 ft. 2016 2014