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Lucky Tiger

December 19th, 1938.

Mr.J.W.Radil,
Knight, Boland & Riordan,
810 Balfour Building,
San Francisco, Calif.

To Edward Wisser, Dr.,

To professional services,examination of Boston Mokelumne shaft and report, 7 days @$50.00 per day.....	$350.00
Expense in field.....	12.50
Expense on report,prints,photos,tracing cloth,etc.....	14.49
	$376.99
Paid December 10th,1938.....	50.00
Balance due.....	$326.99

ESTIMATE ON REPAIR OF SHAFT.

BOSTON MOKELUMNE MINE, CALAVERAS CO., CALIF.

No matter what the extent of the repairs to the shaft itself, the slide from the hillside south and southeast of the shaft must first be brought under control by removal of material already slid or about to slide, and building a retaining wall beneath the slide area. Hence a separate estimate is given for this work. Following this are two alternatives in repairing the shaft.

1. Control of Shaft Slide.- About 160 yards of material should be removed. A track is laid to the base of the slide, and mine cars are available, so this would be done by hand. The cost to do this should not exceed $250.00. The work would include not only removing the broken rock and soil from the slide proper, but rearranging large boulders between the glory-hole and the headframe.

Sixty-five linear feet of retaining wall would completely protect the shaft collar, headframe etc. The height should be about 10 feet. This would mean roughly 1200 linear feet of 10" round timber; fir should be used. At 10cents per linear foot, the cost would be $120.00. The wall would be of cribbing as shown in the accompanying sketch; the cribs would be filled with large boulders and finer rock. Cribs of this type last well even after considerable rotting of the timbers; not the case with square sets.

Summary:	Removing 160 yards slide rock	$250.00
	Timber for retaining wall	120.00
	Placing retaining wall and misc.	130.00
	Total	$500.00

2. Repairs to Shaft.

A. Assuming use of skips now at the mine, for unwatering and extraction. The shaft timbers are so universally rotten that complete retimbering is called for. There would be little difficulty, owing to the lack of weight on the shaft, in realigning it sufficiently to allow of passage of the skip in the central compartment. But it is too late to bring the sets completely back into line. Once they take a lean, they will continue to deform. Also, rot is so far advanced that most of the present timbers will shortly fail by rot. Assuming complete retimbering, cost of this to the present water level would be about as follows.

About 4000 board feet of timber are needed to retimber the 25 feet of the shaft from the collar to the water level. At $40.00 per M, this would come to $160.00, not allowing for miscellaneous items such as blocks, wedges, possible new hoisting rope, power, etc. Call total material $350.00. For labor, assume 8 men and a foreman, for the wall plates will be heavy and the shaft is flat. Taking $45.00 total daily wages and 12 days for the job, we have $540.00 total labor.

Summary:	Material	$350.00
	Labor	540.00
	Misc, for contingencies	110.00
	Total	$1000.00

It should be carefully noted that the above estimate concerns repair of the shaft near the collar and above the water level. I have no means of knowing the condition of the shaft below the water level.

B. Assuming shaft to be placed in shape for examination only. It is perfectly accessible at present; but to quiet the minds of the timorous, the fallen timber and rocks should be removed from the collar, and a few minor repairs be made underground. Removal of the material from the top of the collar is covered in the estimate for control of the rock slide. Replacement of some of the rottenest of the lagging and set timbers might amount to about 20% of the cost of complete retimbering, i.e. $200.00, although the exact amount is entirely dependent on the wishes of those using the shaft, for as I have said, the shaft is perfectly accessible and safe down to the water level. Such repairs would not permit use of the skip for unwatering. But a far quicker and cheaper method of unwatering would obviate use of the skip and the consequent extensive repairs to the shaft. This would be to use an electric sinking pump, if power is still available, fastened to a low truck and let down the central skip compartment on the rails. Clearance is ample for this.

Recapitulation.-

A. Complete retimbering.

Control of Rock Slide.....	$500.00
Repairs to shaft.....	1000.00
Total.....	$1500.00

Unexpected difficulties in the shaft might add $500.00, so my best estimate is $1500 to $2000.

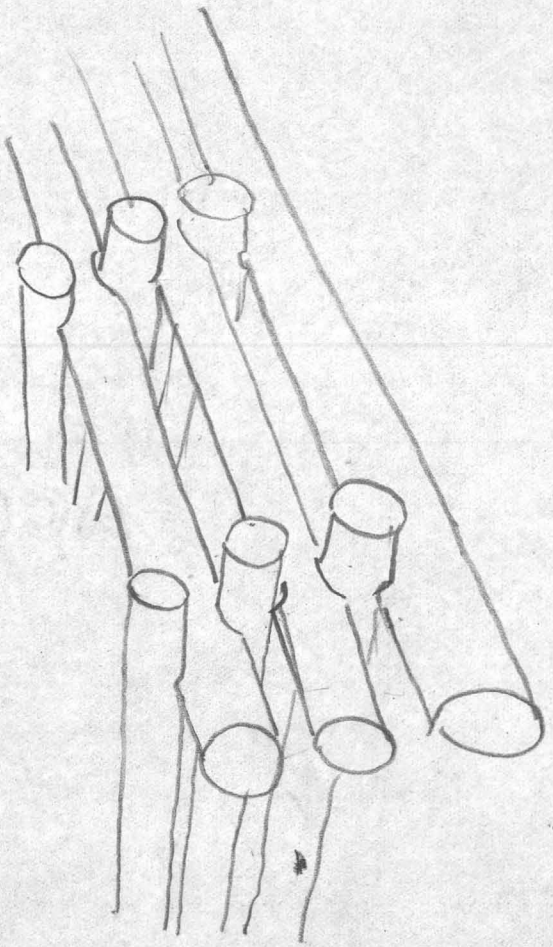
B. Repairs to permit examination of mine.

Control of Rock Slide.....	$500.00
Partial repairs to shaft....	200.00
Total.....	$ 700.00

Say $700 to $1000.

December 19th, 1938.

Edward Wisser
Consulting Mining Engineer
and Geologist.



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REPORT ON THE

BOSTON MOKELUMNE SHAFT

Calaveras, Co.

BY

EDWARD WISSER

12

San Francisco, December 19th,1938.

Mr.J.W.Radil,
Knight, Boland & Riordan,
810 Balfour Building,
San Francisco, Calif.

Dear Sir:

In accordance with your request I submit herewith my report on the condition of the Boston Mokelumne shaft, Calaveras County, California, and the possible effects upon the shaft of mining operations conducted by the Lucky Tiger-Combination Gold Mining Company at the Boston Mokelumne mine between July, 1933 and July, 1935.

I examined the shaft and the adjacent mined area during the four days from December 6th to 9th,1938. The shaft above the water level was thoroughly examined, measured in detail and photographed. The Plus 16 adit level was surveyed by Brunton compass, and a similar survey made of the adjacent surface. The area was studied with special reference to rock slides and mining subsidence, so far as conditions of accessibility permitted. A plan of the surface, two dimensional drawings of the shaft,three vertical sections taken across the area, and seven photographs accompany this report.

The study has convinced me that the Boston Mokelumne shaft was so located, prior to operations by the Lucky Tiger-Combination Gold Mining Company, as to subject it to hazards of surface sliding and to movement of its upper sets of timber; that considering those hazards,it is in remarkably good shape today despite three years and five months of apparently complete neglect. Further, I feel certain that maintenance of the shaft during the tenure of the Lucky Tiger company, and excavation of the gloryhole have materially retarded the factors leading to the deterioration of the shaft inherent in its original location.

Yours very truly,

Edward Wisser

Edward Wisser
Consulting Mining Engineer
and Geologist.

San Francisco,
December 19th,1938.

REPORT ON THE BOSTON MOKELUMNE SHAFT.

INTRODUCTION.

The Boston Mokelumne shaft, an inclined shaft sunk in the vein, near the bottom of a canyon and directly under a steep hillside of loose and weathered rock, forms the subject of this report. The Boston Mokelumne vein strikes about North 22° East and dips 42° to 55° East. A glory-hole extending from about 50 to 180 feet south of the shaft along the vein, and additional evidences of surficial mining extending some 90 feet south of the glory-hole are the only indications of mining now observable, except for an adit driven south along the vein footwall from a point about 40 feet southwest of the shaft and now caved about 90 feet south of the portal.

The steep hillside, (which is entirely a natural hillside having no relations to mining operations), under which the collar of the shaft is located, has slid toward the collar, covering the latter with a small amount of debris. The shaft sets, where visible above the water level, now at 18.8 feet vertically below the collar, or 28.5 feet measured along the footwall side of the shaft, are tilted to some extent down the pitch of the shaft, and to a less extent toward the north side of the shaft. The question has arisen whether mining operations conducted by the Lucky Tiger-Combination Gold Mining Company between July, 1933, and July, 1935 might have influenced the present condition of the shaft. The present report sets forth the writer's views upon this question.

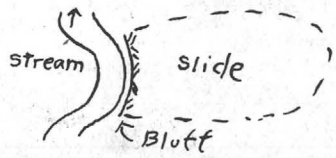
LOCATION. TOPOGRAPHY. GEOLOGY.

The Boston Mokelumne mine lies approximately two miles northeast of the town of Mokelumne Hill, in Calaveras County, California. A northwest-flowing branch of the Mokelumne river flows a short distance west

and north of the glory-hole and shaft, and the shaft was sunk close to the southeast wall of this stream canyon, and only 20 feet above the elevation of the stream. The shaft, glory-hole and a portion of the stream are shown on the "Plan of Workings near Shaft", accompanying this report.

The general area is one of rather high relief; the canyon walls are in general steep. Since the rock, largely micaceous schist, has weathered deeply in most places, and since rock soil rich in slippery mica is prone to slip, the steep slopes and weak rock soil and weathered rock have induced a number of landslides unrelated to any mining. One of these may be seen about 500 feet south of the glory hole and several hundred feet east of the vein; the mine dwelling houses have been built on a far larger natural slide which has materially altered the earlier course of the stream by pushing it from the slid area toward the north. The older channel, in the heart of the slide, has been exposed by placer miners.

Most of these natural slides have been caused by undercutting of the canyon walls at bends in the stream convex toward the areas that slid:



Such a bend in the stream formerly existed just north and northeast of the shaft. Its position is indicated on the "Plan of Surface near Shaft". The stream has been diverted by means of a concrete culvert and rock retaining walls to the course it now occupies; but at the site of the shaft collar, and for about 200 feet northeast of the collar, the stream has undercut the naturally steep wall of its canyon, forming a very steep, moss-covered bluff except where a portion of this bluff has slid off toward the shaft collar.

The country rock of the area has been briefly mentioned. It is predominantly schistose, and where weathered is friable, "talcy" or "soapy",

and extremely weak structurally. Lenses occur of massive, comparatively fresh meta-diorite.

The vein, striking about North 22°East and dipping 42° to 55° East, is poorly exposed, but it appears to be a shattered zone in the schistose rock above a well-defined, massive meta-diorite footwall. Stringers and bunches of quartz occur in this zone, and in the adit mentioned (Plus 16 Level) a continuous body of quartz and pyrite several feet wide was observed along the footwall. The average width of the vein zone seems to be about 40 feet. At the glory hole the hangingwall as well as the footwall is hard massive rock; but at the shaft, which as I have said was sunk in the vein, the hangingwall is schistose, talcy and very weak.

THE BOSTON MOKELUMNE SHAFT.

The shaft is an old one, and had been existence for some years prior to the start of Lucky Tiger-Combination Gold Mining Company operations in July, 1933. The choice of its location by the Boston Mokelumne Mining Company subjected it to three hazards unrelated to the mining of ore.

1. It was sunk in the vein. The vein-matter,consisting of the weak schistose rock with quartz stringers and bunches, had been shattered by the stresses that produced the vein fractures, and by later tectonic stresses that utuilized the vein zone as a plane of weakness. This is a common thing with veins; vein outcrops, through the processes of oxidation of sulphides and other vein minerals, are decomposed and structurally weak even where tectonic shattering has not occurred.

2. The shaft collar was subject to probable landslides from the steep erosional slope of decomposed friable schist overhanging it.

3. The shaft collar,located practically in the stream bed,had to be elevated well above solid rock. Extraction shafts,if inclined,are prefer-

ably sunk in the footwall of the vein, since the footwall, as in this case, is commonly stronger than the vein itself. But where an extraction shaft is sunk in the vein, good practice demands that the collar set be placed in comparatively solid vein-matter. It was not safe to place the collar of the Boston Mokelumne shaft on solid vein-matter, for in the location selected the vein outcrop lay too close to the elevation of the nearby stream. The collar lies entirely in fill, mainly dump material, and the shaft is in fill to a vertical depth of about 12 feet below the collar, or 16 feet measured along the inclination of the shaft. Further, this fill lay on a side slope, the natural slope of the canyon side. Fills on such slopes invariably creep, even without undercutting on their downhill side, such as was done in the case at hand by the stream. It is to be expected that such a shaft as this one would need constant attention lest its upper part, in the fill, be dragged out of line and toward the stream by the creeping fill; and that even below the fill, the weak, friable vein-matter would call for constant maintenance to keep the shaft in shape.

Present Condition of the Shaft-Surface.-Photo No. 1 shows the collar, headframe, and the slide above the collar. Section C-C1 is a profile of the hillside above the shaft collar, and shows the naturally steep slope and the slide area. Photo No.2 shows the slide area from the steep hillside northeast of the shaft, and Photo No.3, the general area east and northeast of the shaft.

Photos 1 and 2 show well the fact that the glory-hole is entirely distinct from the shaft slide. The latter is unrelated to mining, and entirely related to the steep natural bank of the canyon wall. In such material and with such a slope slides are inevitable. That they occurred throughout the period of mining at the Boston Mokelumne mine, including the long period preceding the Lucky Tiger-Combination Gold Mining Company op-

erations, is indicated by the fact that a retaining wall between the shaft collar and the hillside was in existence in July,1933,before the Lucky Tiger company took over the property.(Deposition of R.T. Mishler, in charge of the Lucky Tiger operations at the Boston Mokelumne mine, taken June 15th,1938, page 8). This retaining wall was rotted in July, 1933, and rock and soil from the shaft slide had reached the shaft collar and fallen in the shaft. Sliding, once started on a steep slope,is impossible to stop without material lessening of the slope or other radical measures. The fact that the hill was sliding many months before the Lucky Tiger started their glory-holing merely confirms the notion already advanced that the sliding was unrelated to mining operations,but entirely caused by stream and hillside erosion, processes somewhat accelerated, perhaps,by excavation at the shaft collar, but inevitable under the conditions, whether any human excavations had been made or not. Photo No. 2 shows well the lack of any relation between the glory-hole and the shaft slide.

The Lucky Tiger-Combination Gold Mining Company replaced the rotted retaining wall in July, 1933, with a series of square sets backed by rock walls. During the three years and five months that have elapsed between the relinquishment of the mine by that company and the present, these sets have naturally rotted and collapsed, permitting a moderate amount of rock and soil to slide in over the shaft collar. See Photo No.1. Planks placed over the shaft have prevented this material from entering the shaft. The shaft is perfectly accessible to the water level, now at roughly the elevation of the stream, i.e. 1818 feet vertically below the shaft collar.

Section A-A1 shows the profile of the ground between the glory-hole and the shaft, and Photo No.2, the fact that little disturbance has occurred below the glory-hole despite the collapse of the retaining wall. A few large boulders have fallen to the level of the dump.

The collar set timbers are rotten, but otherwise undamaged. The ore bin and headframe are likewise undamaged to any appreciable extent, but their timbers are rotting. The headframe, with its sheave wheels, rails etc., seems to be in perfect alignment with the collar of the shaft. So far as the headframe goes, replacement of a few rotted timbers would permit resumption of hoisting at once.

Condition of the Shaft-Underground.- Photo No.4 shows the central compartment from just below the collar set. Photo No.5 shows the south side of the shaft (that toward the glory-hole).

Study of these pictures must convince anyone conversant with mine timbering and the behavior of ground that little or no weight is evident upon the timbers. Note the lagging in the top foreground of Photo No.4. The white fungus shows that it has rotted,but it nevertheless is quite undisturbed. This is all the more remarkable because most or all of the lagging in the shaft is 1 x 12" planking; the usual mining practice calls for 2 x 12s. The failed lagging just below the first shaft set shown has failed from rot, not pressure.

Toppling of the shaft timbers toward the left (north) is evident,but the dividers and wall plates show no bending or cracking whatever. Turn to Photo No. 7 to see how mine timber behaves under strong pressure. That photo will be discussed below.

While the shaft timbers in Photo No.4 have toppled toward the north, the toppling is almost or quite confined to the members of the sets above the floor, for the rails are in perfect alignment. Loosening of the sets through loosening of wedges is well shown near the upper left hand corner of the picture,where three loose wedges are shown.Loosening of the joints of the shaft sets permits the sets to topple. Blocking and wedging of all timbered mine workings must be constantly attended to in operating mines. It seems to the writer to be little short of miraculous that during the

three years and five months since the mine was last operated, no more extensive disturbance to the shaft timber has occurred; for so far as I know, no maintenance whatever has been given the shaft in this time.

The shaft sets toppled to the north because the dump, creeping toward the stream , lay in that direction; relatively solid rock,with only minor fill, lay to the south.

The "Drawing of Shaft Set 4" in the envelope shows the nature of this deformation toward the north. Any pressure from the south must have toppled the south set as much or more than the sets toward the north,by active shoving. But the extent of toppling increases toward the north, being zero on the south side of the shaft. This indicates lack of support on the north, not shoving from the south. Photo No.5 entirely confirms this notion; it shows undisturbed rotten 1" lagging. Such material would instantly show, by rupture, any appreciable pressure against it. At the upper left hand corner of the picture is shown a loosened wedge; below this is a divider, toppled slightly toward the north (i.e. toward the camera) but to a greater degree down the shaft. In Photo No.5, note the undisturbed pipe and rail, the electric wires precisely as they were put in, and the undisturbed vertical braces below the collar set. The end plate of the collar set shows bending caused by toppling of the sets in the direction of the shaft inclination; but it is unbroken. Since the vertical strut beneath it is undisturbed, the latter was placed after bending of the collar set end plate.

The "Vertical Cross-Section of Shaft" in the envelope shows the amount of the toppling in the direction of the shaft inclination. Toppling is at a maximum near the bottom of the fill (also shown on Section A-A1), and appears to be decreasing with depth. That a great deal of this toppling occurred prior to repair work in the shaft is perfectly shown by the sound divider in Set 4,still perpendicular to the rails,while just above it the rotten divider it relieved shows decided toppling. The in-

ference seems justified that the sound divider was placed by the Lucky Tiger-Combination Gold Mining Company, some time between July, 1933 and July, 1935, and that toppling down the slope of the shaft has been largely arrested since the installation of this and similar newer timbers.

Some idea of the rate of movement of the shaft timbers may be gleaned from Mishler's evidence, in the deposition cited, and from the present condition of the shaft.

In April, 1933, the condition of the shaft according to Mishler (page 6 of his deposition) was as follows:

"When I arrived at the mine, the man in charge, a Mr. Potter, was making repairs at the mouth of the shaft in order to keep up passage for the skip....The hangingwall of the shaft, immediately beneath the collar... was badly caved, it had been depressed for, I should say, a distance of eighteen inches from its former position, so that the skip could barely squeeze through the opening...immediately beneath the collar the shaft had also been pushed north, away from the old workings, a matter of, I should say, three or four inches. The collar of the shaft had been depressed also a matter of a few inches, and was out of line with the rest of the shaft."

Turning to the "Vertical Cross-Section of Shaft", it will be noted that the collar is not at present depressed, although Photo No. 5 shows it bent slightly toward the hangingwall. Any extensive further toppling down the slope of the shaft would have either depressed the collar or pulled the top shaft set proper away from the collar. The wedge shown in the upper left hand corner of Photo No. 5 is still sticking there, although loose. Hence any such pulling away of the shaft set from the collar set since the placing of the wedge was very slight indeed.

Whatever movement of the shaft took place during the tenure of the Lucky Tiger company was corrected by that company, to some extent. On

page 108 of the deposition cited, Mishler states:" I said that during the time we had control of the Boston,we had to repair the shaft,that resulted from the thrust from the east about six times;and that we had to repair the condition that resulted from the thrust from the south three of four times during that interval." However, on page 89 of the same deposition, Mishler states that when he was last on the property, in May or June, 1935,the shaft was about three inches out of line toward the north. The corrective work by the Lucky Tiger company therefore merely retarded the process of distortion of the sets. This was unavoidable,for once sets get out of line so that their members are no longer mutually perpendicular, the tendency is for increased distortion in the same directions along which the distortion originally started. The only way to have avoided this would have been to retimber the shaft completely from the collar down. The Lucky Tiger company,naturally enough in view of the disappointing results of their venture at the Boston, contented themselves with replacing rotten timbers ,jacking distorted members closer into line, and adding extra timbers.

The shaft, then, according to Mishler,was some three inches out of line toward the north about a month before the Lucky Tiger company abandoned the property. The "Drawing of Shaft Set 4" shows the maximum northward distortion today to be 3 1/2 inches. The shaft, therefore,has moved scarcely at all since that time. It has therefore moved much less since relinquishment of the property by the Lucky Tiger than before that time; it would appear that the corrective repairs done by that company have halted the process of distortion.

The center compartment skip was measured, and the clearance or lack of clearance in that compartment. The following table shows the present conditions with respect to clearance.

Shaft Set No.	Clearance past Dividers. N Side Top	N Side Bottom	S Side Top	S Side Bot.	Clearance past Top Wall Plate. N Side	S Side
1.	1/2"	1/2"	-2 1/2"	3"	Ample Clearance	
2.	6 1/2"	3"	-1/2"	3 1/2"	5"	6"
3.	5 1/2"	4"	3 1/2"	5"	0	-1"
4.	7 1/2"	5"			-3 1/2"	-2 1/2"
5.	7 1/2"	1 1/2"			- 1/2"	-2"

Assuming the skip would just clear as operated by the Lucky Tiger company (shown by adzing of timbers to permit clearance), the sets have moved as follows since the skip was last used:

Set 1. Top of divider on south side, 2 1/2" plus 1/2" for former clearance equals 3".

Set 2. Top of divider on south side, 1".

Set.3. No proven movement of dividers. Hangingwall plate, north side, down 1/2"; south side, down 1 1/2".

Set 4. Hangingwall plate, north side, down 4"; south side, down 3".

Set 5. Hangingwall plate, north side, down 1"; south side, down 2 1/2".

Three inches were adzed off the hangingwall plate of set 4 in the middle compartment (see Photo No.4, bottom hangingwall plate visible, and "Drawing of Shaft Set 4") The timber, quite rotten, was evidently in place when the Lucky Tiger company started operations. Prior to their operations, and during them, it sank a minimum of 3". Since the stoppage of operations it has sunk an average of 3 1/2" further, assuming the skip had a clearance of 1/2" when last used. The time taken to sink the initial 3" (minimum) is not known, but the adzing suggests that settling was gradual. Lack of deformation of the dividers supporting the plate, and lack of movement of the track and footwall plate show that the settling was due to toppling down the direction of slope of the shaft and not pressure. Evidently the toppling is still going on, but at the rate of less than an inch of downward movement per year.

Since the toppling down the slope of the shaft extends below the fill into relatively solid rock, its initial cause probably lies at depth. Mishler mentions a cave in the shaft just above the 500' level, where the rock was similar to that in the hangingwall at the collar. The shaft had to be repaired at this place when the Lucky Tiger company took over; doubtless the weak rock at this place had caused earlier caves and started toppling of the sets toward the cave. Once a set gives way, support is withdrawn from the next set above, for the blocking becomes loosened, and the equilibrium of the timbered shaft destroyed, in addition to the withdrawal of support at the point where the caved set was located. Blocking is used primarily to brace joints. Loosening of joints causes toppling of the sets, quite indepedently of any pressure upon them.

Shafts near their collars need continuous tightening of their blocking and wedges, for a reason explained by W.H.Storms, in his standard reference book, Timbering and Mining, McGraw-Hill Book Co., 1909 edition:

"It must be understood that, while blocking and wedges are employed to hold shaft timbers firmly in position, that any alternation of wet and dry will have the effect, during the dry periods, of causing the timbers, blocks and wedges to shrink, sometimes to such an extent that the latter become loose and drop out; security is then at an end, for the timber sets then have a tendency to settle by gravity, and every little subsidence or disarrangement is increased from set to set until there is danger of collapse of the entire structure." The Boston Mokelumne shaft above the water level is subjected to alternating wet and dry conditions ; Photos 4 and 5 show a number of loose wedges.

Beside the creep of the fill, causing the northward movement, and the supposed cave near the 500 foot level, causing the movement down the slope, and the alternating wet and dry conditions further loosening the blocking at the joints, rotting of the timbers has undoubtedly contri-

buted its full share toward the observed distortion of the shaft. Mine timbers start to rot at their ends,where they meet to form a joint in the set,because even slight weight on the timbers is concentrated at such joints; the pressure on the timbers slightly deforms and disrupts the wood fibre, and makes it prone to decay at the disrupted parts. In Photo No.4 rot may be clearly seen at the tops of the dividers;the toppled divider shown at the left in Photo No.5 is also visibly rotten near its top. In the "Drawing of Shaft Set No.4",it is evident that rot has contributed to the sinking of the hangingwall plate.

The rotting of mine timbers is unavoidable,and purely a function of time, even where the timbers are treated with preservatives. Three years and five months is not a bad life for a mine timber,especially near the surface. It is rather remarkable that the timbers evidently installed by the Lucky Tiger company are in as good condition as they are; but the "Vertical Cross-Section of Shaft" shows that the shaft as a whole is in very poor condition due to rot of the timbers. The pressure from the surrounding ground must be very light indeed to permit the shaft to stay completely open, for most of the timbers have the strength and consistency of punk.

The fact that the shaft lies within the vein;that it is collared in fill;that the sets have started to topple and that they are rotten makes the notion of any real weight or pressure on the shaft where accessible completely out of the question, for even very moderate pressure would long since have caved the shaft. Considering the three years and five months of supposedly complete neglect,the condition of the shaft today is remarkably good.

MINING OPERATIONS.

There follows, for convenience, a summarized table of operations by the Lucky Tiger-Combination Gold Mining Company at the Boston Mokelumne

mine, taken from the deposition by Mishler cited above.

March,April, 1933. Property first examined by Lucky Tiger engineers.
July 5th,1933. Contract between Lucky Tiger and Boston Mokelumne Co. signed.
Shortly after July 5th,1933. About 75 yards of loose material mucked from hillside above shaft;new retaining wall built;shaft repaired. Unwatering by bailing commenced. Water level was below 300' level.
September-October,1933. Reopening of old adit level (See Plan of Surface) was commenced.
October,1933. Unwatering of shaft completed.
November,1933. Reopening of old adit was stopped-ground too heavy to hold. A new adit,the Plus 16 level (see Plan of Surface and Section A-A1) was started.
April, 1934. Glory-hole and top-slice mining started above Plus 16 level.
July, 1934. Glory-hole mining completed.
July,1935. Top-slice mining completed. Cut and fill stope between 100' level and old adit completed (date of starting this stope not established);cut and fill stope above 125' level completed.(Date of starting unknown).
July 9th,1935. Contract terminated.

The glory-hole is shown on the "Plan of Surface" and on Section A-A1; the latter shows also the position of the top-slice. So far as any possible effect on the shaft is concerned, the top-slice may be eliminated ;it is a small affair and lies some 280' south of the shaft. The glory-hole, much closer, warrants consideration.

Since the bottom of any glory-hole operations lies some 16' above the collar of the shaft,breaking of the ground by glory-hole mining could not have affected the stability of the shaft directly. It might, however, have affected it in two indirect ways:(1) By increasing the tendency for surface material to slide toward the shaft.(2) By a general weakening of the ground to the south of the shaft, and consequent increase in the tendency for the broken ground to squeeze northward toward the shaft through hydrostatic pressure of the overlying loose material. These possibilities will be analysed.

(1). Section A-A1 shows the original surface above what is now the glory-hole. The slope ofthe ground toward the shaft,before any mining was started,was as high as 30° over the north end of the present glory-hole. The glory-hole has reduced the slope at this place to 11°,hence the

tendency for northward slides has been radically reduced. The steep slope between the north end of the glory-hole and the shaft has nothing to do with any mining operations connected with the glory-hole. It is, roughly, the original slope, as is plainly shown in Photo No.2 and Photo No.3. While some excavation has been done here in the days before the Lucky Tiger company took over (Mishler, deposition, page 6), Section A-A1 shows a rib of solid rock above the vein footwall and extending (see "Plan of Surface") at least partly across the vein, at the north end of the glory-hole. The Lucky Tiger company relieved the danger of slides on this slope by removing loose rock (Mishler, deposition, page 51) before they conducted any glory-hole mining.

But it was not only by reducing the original slope of the ground toward the shaft that the glory hole decreased the danger of slides. The whole acted as a bowl-like trap to catch loose rocks that might have slid even on the decreased slope, especially in wet weather. This is plainly shown on Section A-A1. The solid rib of rock at the north end of the glory-hole, which acted as a barrier toward slides directed toward the shaft has been aided in this function by a rock pile built above it and west of it, so that the actual present slope at the north end of the glory-hole is actually southward, away from the shaft.

The glory-hole acts as a trap for a very considerable area above it. The glory-hole is separated from the shaft slide (see "Plan of Surface") by a nose; northeast of this nose, rocks would fall toward the shaft slide; southwest of it, toward the glory-hole. The independence of the glory-hole, on the one hand, and the shaft slide, on the other, is thus complete. The shaft slide, an old feature, has adversely affected the shaft; the glory-hole has materially lessened the danger of slides from the slope to the south of the shaft headframe from overwhelming the headframe.

(2). Any squeezing of the ground northward from the seat of mining operations toward the shaft must have been caused by downward pressure, i.e. a compressional stress due to gravity acting on broken material and accompanied by a corresponding lengthening or tensional stress acting at right angles to the downward stress, that is, horizontally. There is no conceivable direct northward stress or shove that could have operated. Obviously, the greater the amount of overlying broken material, the greater the downward stress and the greater the accompanying horizontal tensional distortion that might have squeezed ground against the south side of the shaft. Conversely, any operation that would have decreased the amount of overlying material would by the same token have decreased the northward squeezing below. The glory-hole mining did just that, as may be seen from Section A-A1.

But there are grave reasons for thinking that no northward squeezing occurred at all, entirely apart from the undisturbed condition of the south side of the shaft shown in Photo No. 5. In the first place, while the old adit level was found completely flat, and while reopening proved not feasible due to the tremendous weight of the broken ground, the portal of the adit has not been moved north at all. All indications point to ground movement straight downward, not toward the shaft. Secondly, the Plus 16 adit level was started partly in the vein footwall, but with its eastern portion in the vein. Section A-A1 and Photo No. 6 show that there is practically no weight on this adit under the north end of the glory-hole. The sets near the portal are perfectly plumb. Contrast Photo No.6, looking toward the adit portal, with Photo No.7, looking toward the collapsed, interior portion of the adit. Also, the top half of the raise between the old adit and the Plus 16 adit is entirely solid. There is little doubt that the portion of the old adit between this raise (see Section

A-A1) and the portal had caved as much through shear neglect of its timber as from any great initial weight upon it. Mishler states in his deposition (page 123) that the ground in the old adit was heavier 150' in from the portal than between that point and the portal. The weight was decreasing northward, toward the shaft.

Finally, the cut and fill stope between the 100' level and the old adit, 140' from the shaft at its nearest point had an influence on the direction of ground movement. Peele's Mining Engineers Handbook, 2nd Ed., states the following (page 878): "Effectiveness of Filling. Effect of vertical movement is reduced, but not prevented. Ordinary filling is compressible...and never fills excavations completely. When roof settles, the resistance of filling, weak at first, increases rapidly, and soon stops movement." The cut and fill stope would have caused subsidence below the old adit level, and from about 140' to 220' south of the shaft. It did, as shown on Section A-A1, and by the rail bent downward on the left hand side of Photo No.7. Such downward movement doubtless contributed to the collapse of the Plus 16 adit above the cut and fill stope. Glory-hole mining ended in July, 1934 (see Time Table, page 13); in May, 1935, Mishler states (deposition, page 114) that the Plus 16 level was still open, 10 months after glory-hole mining had ceased. Now the cut and fill stope was among the last mining operations conducted, ceasing only in July, 1935. It is therefore logical to assume that the latter work was a major factor in the collapse of the Plus 16 level. If so, it is proven that subsidence associated with the cut and fill mining extended to the surface. It was a feature superimposed on the earlier, surfical glory-hole subsidence. If that is the case, than the general ground movement north of the shaft was quite positively directed downward toward solid rock at depth, and since the block between the old adit level and the lower levels, and between the cut and fill stope and the shaft, was very solid, (Section A-A1)

the shaft was insulated against disturbance not only by this solid pillar, but more importantly by the fact that the ground movement was not directed toward the pillar. Examination of the south side of the shaft, of course, completely confirms these ideas.

A scarp of recent appearance encloses a considerable area on the hill slope southeast of the glory-hole. A portion of this scarp is shown on the "Plan of Surface". Within this enclosing scarp the ground is hummocky, and indicates some landsliding. However, no soil whatever has spilled over the east rim of the glory-hole, and that rim shows no signs of having been disturbed by other than the glory-hole excavation west of it. Tension cracks parallel the east rim; any real pressure from the east would instantly close these.

Section B-B1 shows the mechanics of this landsliding. The angle of draw for excavations is that between the horizontal and a line drawn between the bottom of the excavated area and the farthest limit of disturbance on the surface. The true surface of failure, however, is curved, as shown by the dashed line on the section. (See, among many references, Peele, Mining Engineers Handbook, 2nd Ed., page 874, fig. 550 and text). Below the surface of failure or "plane of stability" the ground is undisturbed. The movement of the ground above the surface of failure is rotatory, along the curved surface, so that the moving block as a whole is tilted. The maximum actual movement is along the surface of failure; the minimum, in the case at hand, at the top of the east rim of the glory hole. The result is that the vein hangingwall, near the lower limit of extensive mining, moves strongly toward the footwall; near the top of mining it moves scarcely at all. The effect is a locking of the moving block beneath the region of greatest mine excavation. Equilibrium is attained and further movement inhibited.

The collapsed portion of the Plus 16 adit checks the above mechanics perfectly. It would be expected, had the hillside block of ground slid straight down the slope toward the adit, that the top and east corner of the adit sets would show the greatest pressure. Photo No. 7 shows that the pressure was predominantly horizontal, from the east, and caused by the tilting of the hillside block to the east. Because of the locking action, I venture to predict no more extensive disturbance in this area, other than minor slides in wet weather. Since these slides will be direc- toward the glory-hole or south of it, no harm to the shaft can possibly ensue. Slides, it is true, will continue above the shaft; but the natural slope on which they will occur has no relation to the glory-hole subsidence.

CONCLUSIONS.

It is concluded that the shaft is in remarkably good condition considering the hazards its original location have given it, and the three years and five months of complete neglect it has suffered since the Lucky Tiger company left the property; that the shaft shows no sign of pressure from the south, and that its distortion is due to lack of pressure on the north and caved conditions in the shaft itself below water level. Further, and independently of any study of the shaft, it is concluded that mining operations by the Lucky Tiger-Combination Gold Mining Company have decreased the tendency for rock slides toward the headframe, and by removal of overlying rock have decreased the tendency for rock squeeze northwards toward the location of the Boston Mokelumne shaft.

Without corrective measures, surface slides toward the shaft will continue, and without retimbering, the upper portion of the shaft will eventually collapse, as all timbered mine workings do without attention. But these matters are unconnected in any way with mining operations conducted by the Lucky Tiger company during their tenure of the property, except in so far as these mining operations have served to halt the progress of

deterioration. Operations of the Lucky Tiger-Combination Gold Mining Company have had no deleterious effect whatever on the Boston Mokelumne shaft.

Edward Wisser

San Francisco, Calif.
December 19th, 1938.

Edward Wisser
Consulting Mining Engineer
and Geologist.

Photo No. 1.

Shaft collar and headframe. Shaft slide back of collar;collapsed retaining wall on collar. Top of glory-hole seen above headframe,with massive footwall on the right. Portal of Plus 16 level visible through headframe.

Photo No. 2.
Rim of Glory-Hole,upper left. Portal,Plus 16 Level, center. Headframe,right. Shaft slide,lower left hand third of picture.

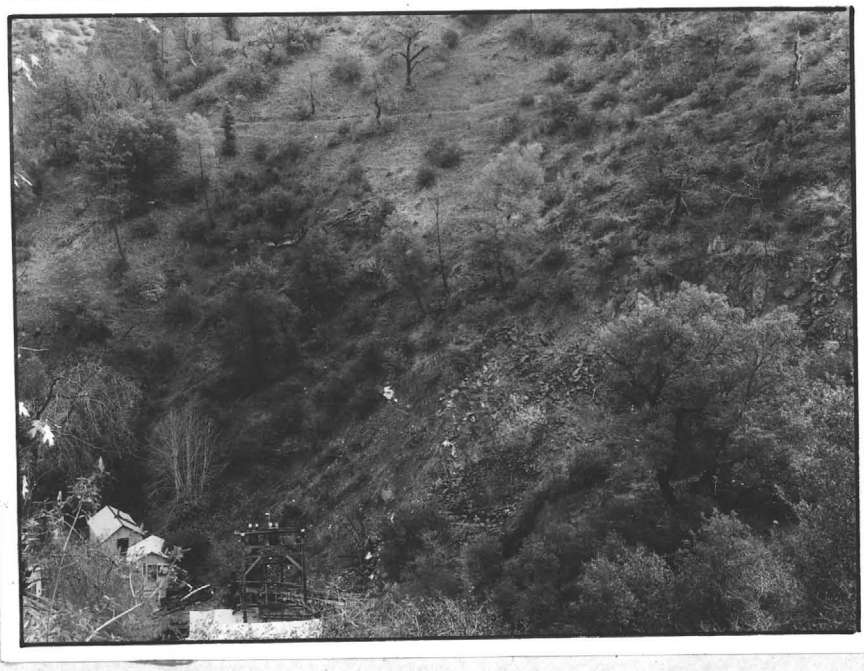


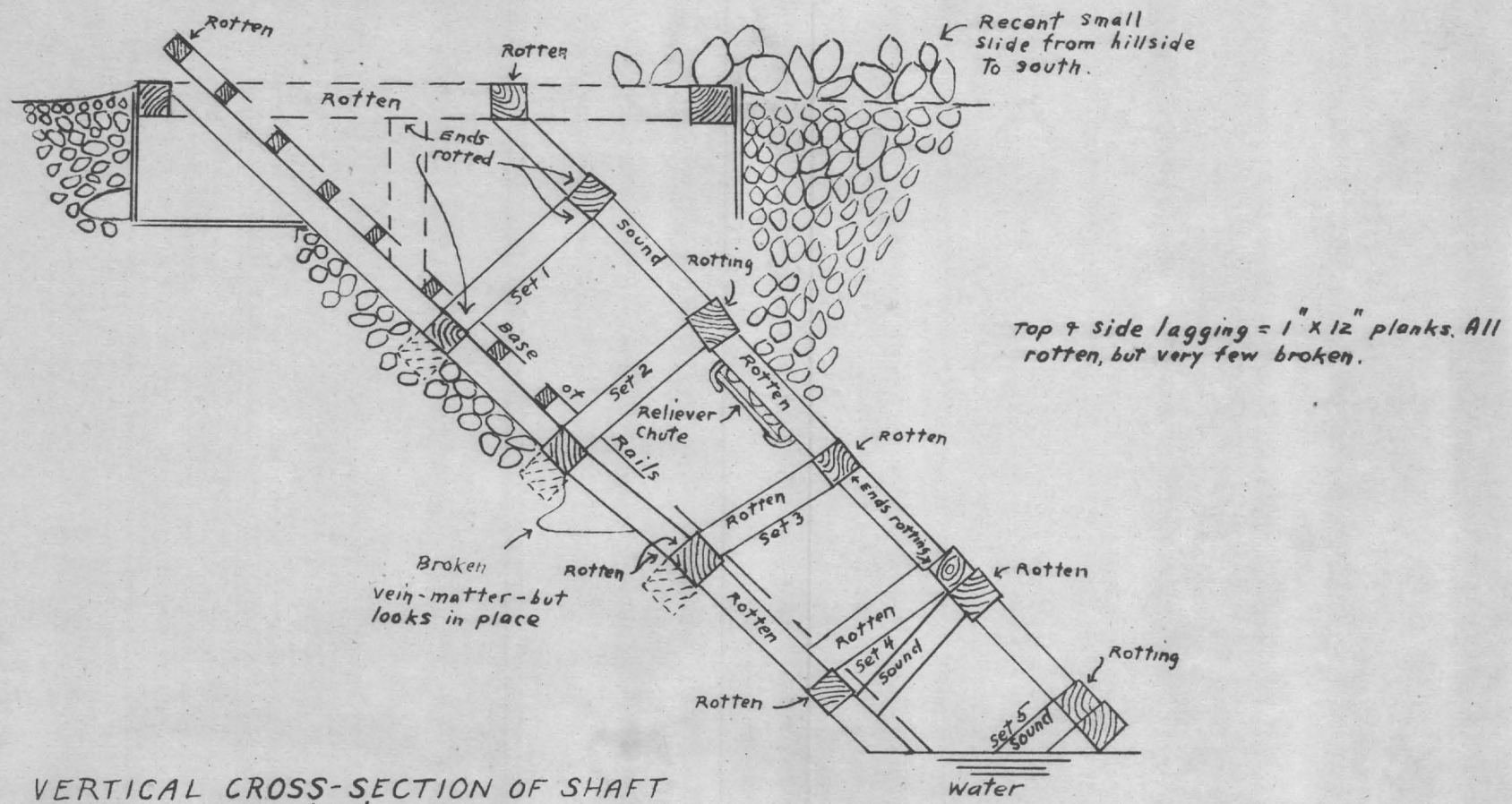
Photo No. 3.
Headframe,lower left. Shaft slide, to right and diagonally upward from head-frame. North end Glory-Hole back of tree near right edge picture.

Photo No. 4.
Looking down central compartment of shaft from just below collar set. Water is at bottom end of visible portion of rails.

Photo No. 5.
South side of shaft. End plate of collar set at top of picture. Book rests on divider of Shaft Set No.1.

Photo No. 6.
Plus 16 Level. Looking toward portal. Ground little disturbed.

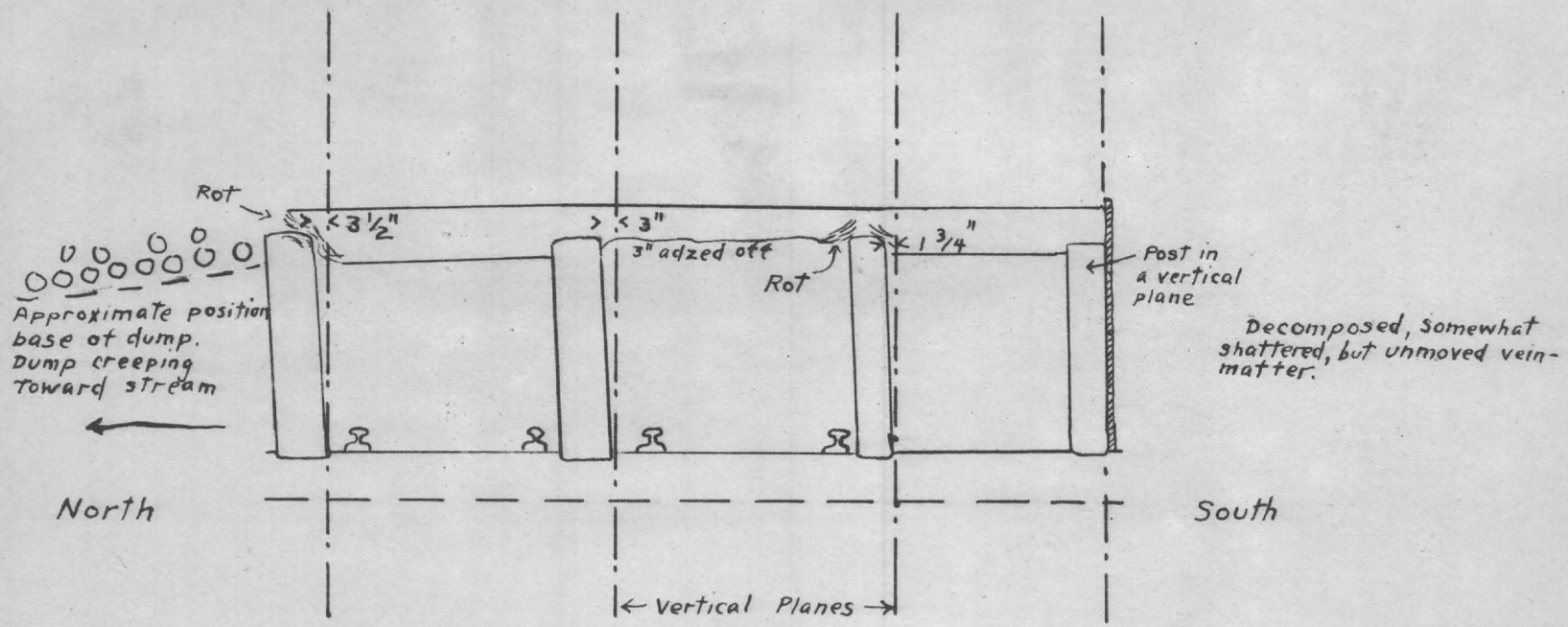
Photo No. 7.
Plus 16 Level. Looking south, toward crushed portion. Extreme side pressure from left.



VERTICAL CROSS-SECTION OF SHAFT

Scale 1" = 5'

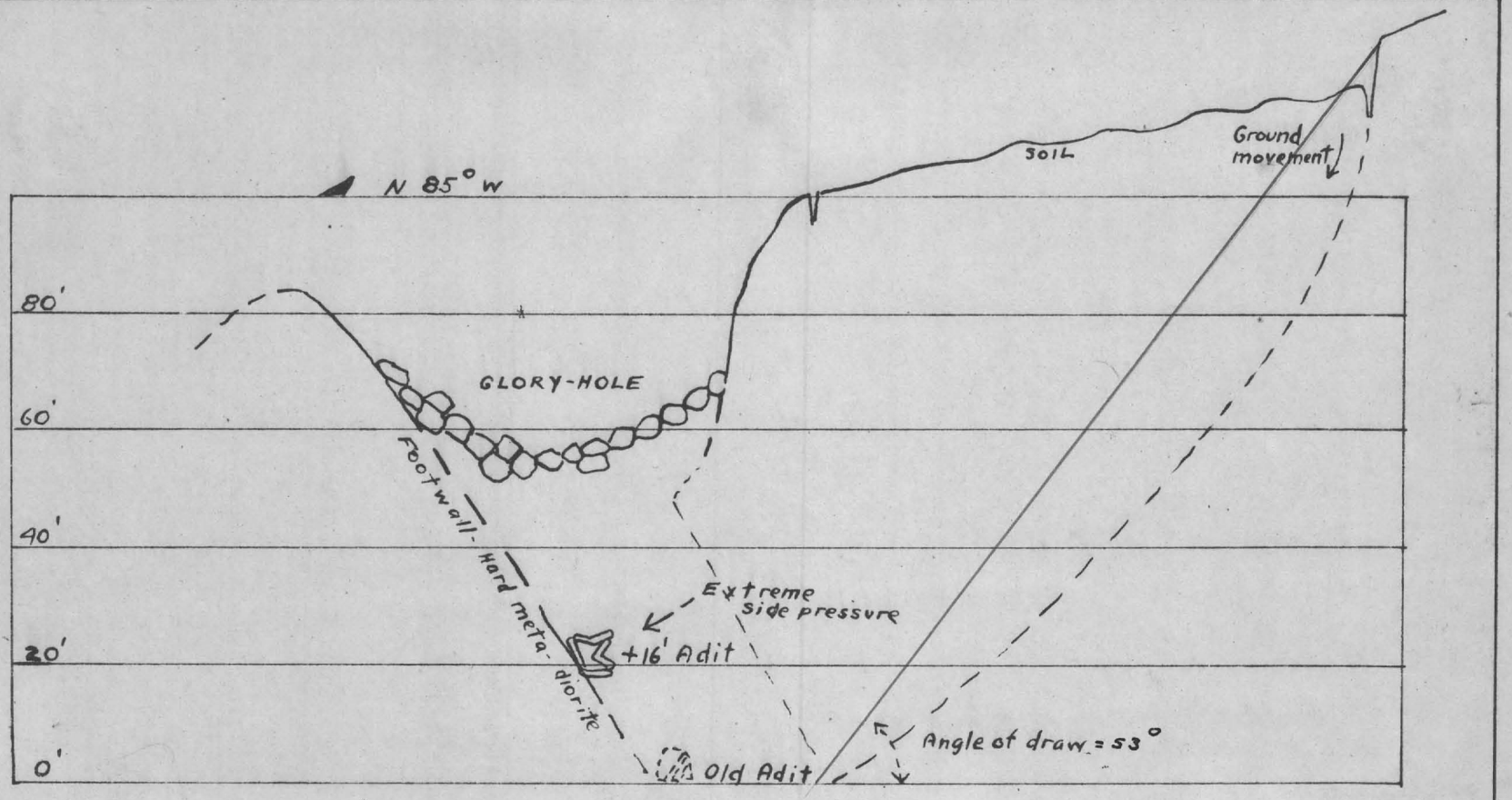
(North Skip Compartment). Timbers shown solid are those dividing north skip compartment from center skip compartment.



DRAWING OF SHAFT SET 4
LOOKING DOWN SHAFT
Scale: 1"=3'

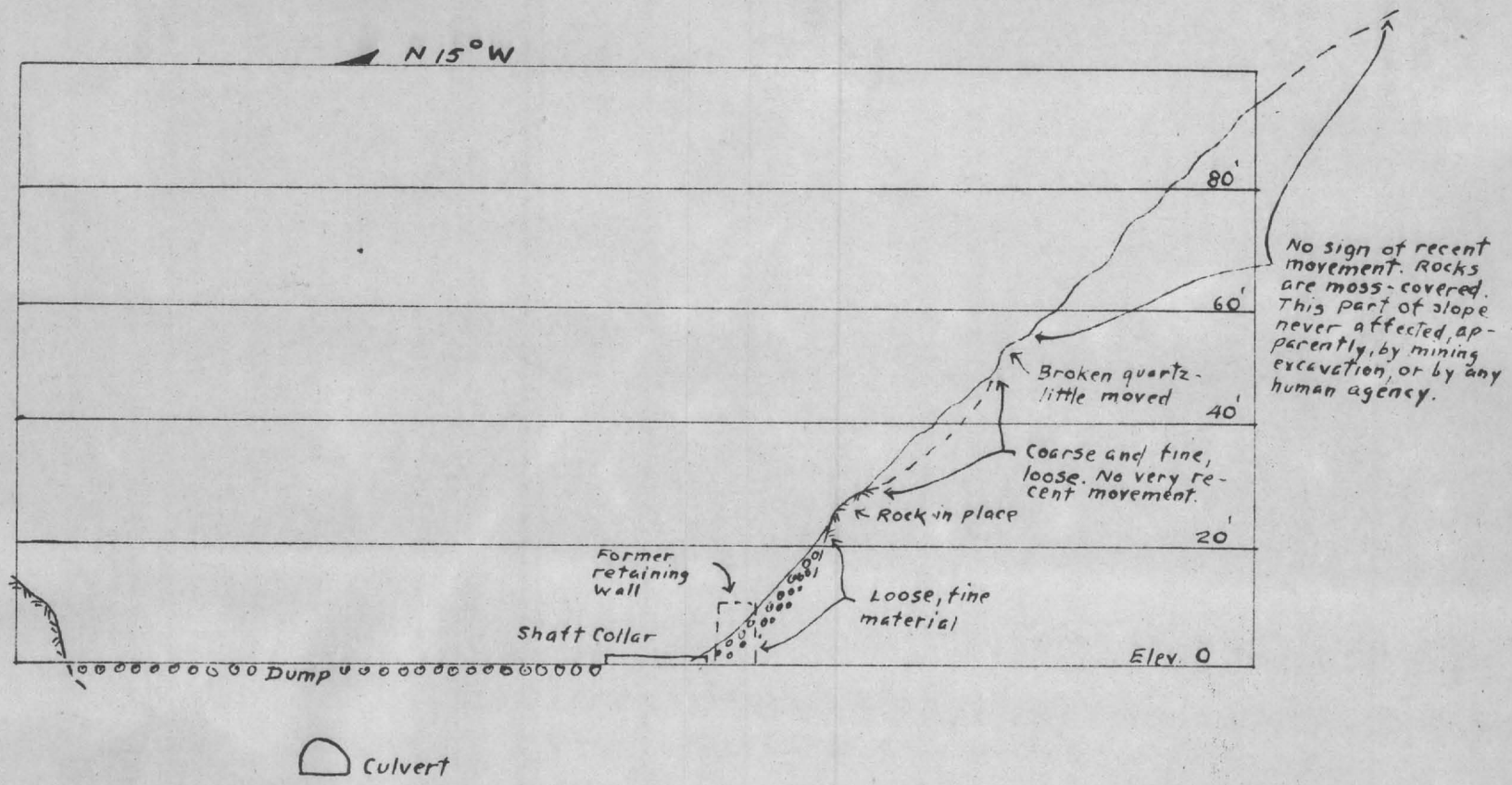
Showing lack of distortion on the south and progressively greater distortion toward the north.

Section B-B₁



VERTICAL SECTION B-B₁
Transverse to Glory-Hole
Scale 1" = 30'

Section C-C1

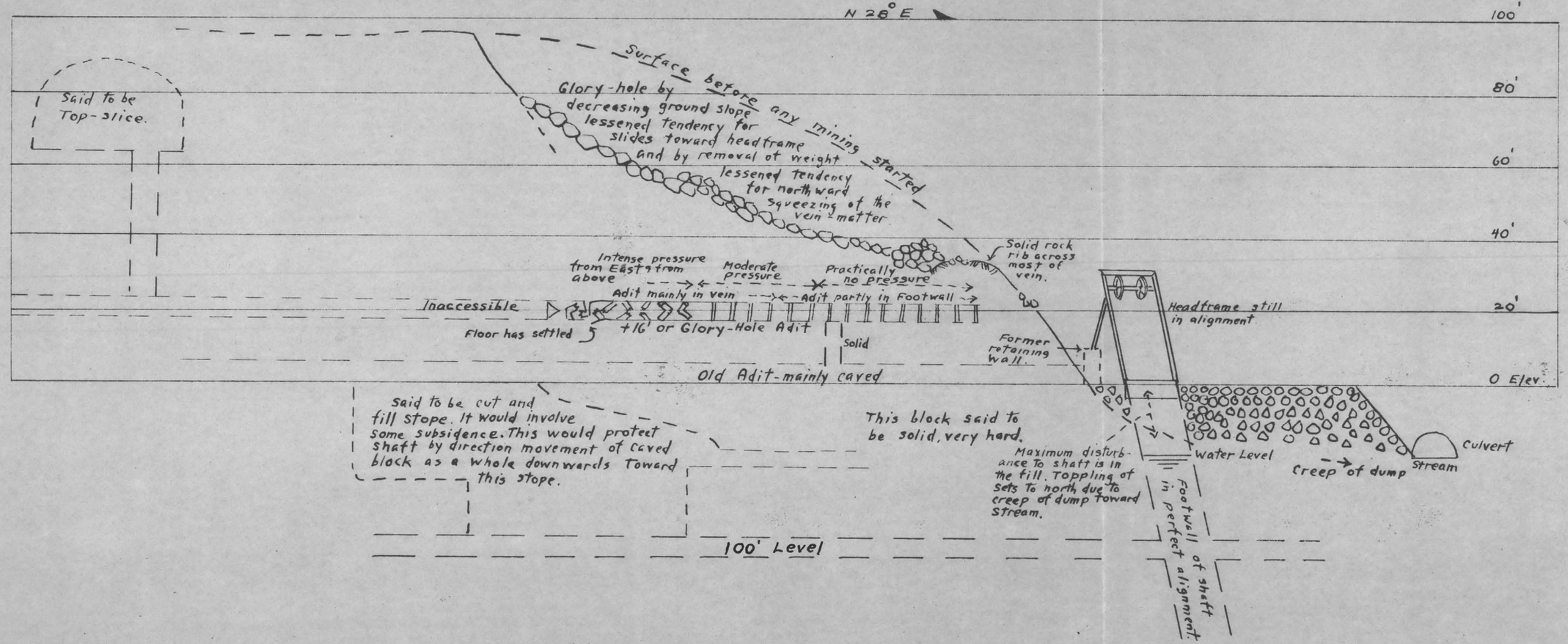


VERTICAL SECTION C-C1

Through Shaft Collar + Shaft Slide.

Scale 1" = 30'

VERTICAL SECTION A-A,
Longitudinally through Glory-Hole & Shaft Collar
Scale 1" = 30'



Section A-A,

DIVISION OF MINES
WALTER W. BRADLEY, STATE MINERALOGIST

STATE OF CALIFORNIA
DEPARTMENT OF NATURAL RESOURCES
RICHARD SACHSE, DIRECTOR

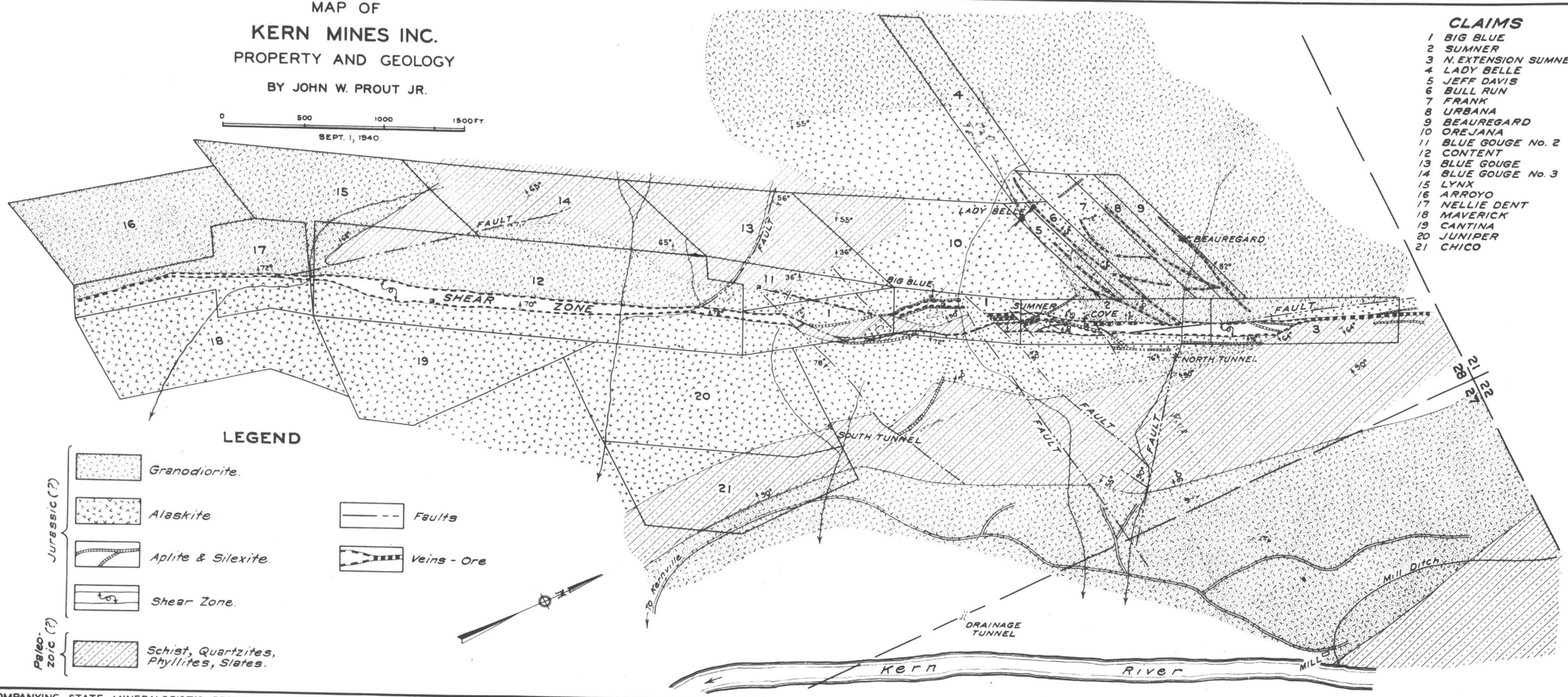
PLATE III.

MAP OF KERN MINES INC. PROPERTY AND GEOLOGY

BY JOHN W. PROUT JR.

0 500 1000 1500 FT.

SEPT. 1, 1940.



ACCOMPANYING STATE MINERALOGIST'S REPORT XXXVI OCTOBER 1940.

GEOLOGIC BRANCH, OLAF P. JENKINS, CHIEF GEOLOGIST.

B

A

enlarge A to B