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SILVER-LEAD ORE MINING AND THE VARIOUS SYSTEMS OF STOPING AND TIMBERING EMPLOYED IN BROKEN HILL, N.S.W.

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Introduction.—As this district was so far distant from the capital of the colony, and its mode of approach so circuitous, he was afraid that many residents of Sydney, and towns on the eastern portion of the colony, never thought of paying this, "Australia's Silver City," a visit, unless one's professional or business duties required their presence here, to learn personally the many and various lessons everywhere available, and to become familiar with the really wonderful and interesting features and deposits which Nature had so lavishly bestowed in the mineralogical world, and yet seemed to almost ignore or overlook this district when disposing of topographical beauties of landscape and vegetation. So it was to those whose life was necessarily spent in other parts of this colony where they answered their call of duty, and yet felt an interest, either for business or other reasons, that his paper was specially addressed and prepared, and for that reason he would endeavour to make his remarks more of an explanatory than dictatorial nature. He was sure there were many members of our Association who were much more familiar, and had had many more years' experience in the various methods of timbering, filling, and ore extraction, etc., than himself, and as a junior member of our Association he naturally felt much more at home in the seat of a student or listener than in the desk of a teacher or lecturer; but he hoped that over 14 years' experience in connection with mines and engineering works (the last four of which had been spent in Broken Hill, where he had been very closely connected with all the datails of mining and the extraction as Mining Surveyor and Civil Engineer to the Sulphide Corporation, the output of whose mine, "The Central," was over 4000 tons of sulphide ore per week, and came next to the Great Broken Hill Proprietary Company), would merit the favour of your careful and, he hoped, interested attention; and if his paper was of interest or profit to any members of our Association, and in any way advanced its interests and influence, he would feel amply repaid.

Broken Hill.—He must confess that the impressions of a new arrival on coming to the Barrier were anything but pleasant or reassuring, for after spending a whole night in rattling over a couple of hundred miles of almost desert country one saw the line of lode about 1½ mile in length, with its long chain of chimney stacks, poppet heads, engine houses, concentrating mills, and immense mullock and tailings heaps, etc., it was hard (unless to the mining man who had been on similar fields) to imagine that this was the now world-famed Barrier Range or Broken Hill, from which almost countless fortunes had been extracted—and as many more remained awaiting consummation. The original Broken Hill was now a thing of the past, having been entirely removed by the large open cuts from which the oxidised ore was being extracted down to about 200 or 250 feet. He might here state that the original or native name of this place was Willyama.

Early Mining.—No doubt all your members had read of the finding of silver by the stockman on Mount Gipps Station and of Rasp's Shaft (Rasp himself being a station hand at the time), and of the almost romantic mining of earlier years, when only the oxidised ores of the upper portion of the lode were worked (or even attempted) down to 300 or 400 feet, and, as on all new fields, the methods adopted were of the rudest description until, with the great advance in output and rush of population, more modern and advanced systems were employed; and with the arrival of American mining engineers and managers came the square set system of timbering, as carried out in the ore mines of America and elsewhere. Therefore, he thought it would not be out of place for him to make this system the first to describe.

Square Set System.--Plate I, Fig. I., showed a perspective drawing of the square sets, showing sizes of timbers and all joints. All timbers were of 10in. x 10in. Oregon, the vertical ones called legs and the horizontal ones caps and struts; they were all cut to the required scantlings in the sawmills (and some of the mines had their own sawmills, and brought the timber in long lengths straight from the port, and cut all timbers according to templates). They were then sent underground quite ready for the miners and timbermen to frame up in the stopes, either in large numbers at a time in an open cutting or large open stopes underground, which were frequently taken out up to 100ft. long and from 30ft. to 50ft. wide, two sets (14ft. high) and the back of roof arched. When the ore was hard and compact (and he could assure you it was hard sometimes, especially in the class of ore containing Rhodonite), he had frequently seen five drills blunted to put a hole one foot, but when the ore was friable it was then timbered close up to the working face on the upper floors. The miners are always working close to the face and back, which they could easily examine to make sure of its safety. One disadvantage of keeping the timbers so close to the face was that frequently a heavy shot would throw, and thus knock down several sets and shake others, thereby causing delay and rendering the working face unsafe until the timbers were re-erected. Laths of 10in. x 2in. Oregon were laid on each floor as the stope rises upwards to the next level, and shutes for conveying the broken ore to the sill floor and thence to the trucks are provided at convenient intervals, and slides placed to run the ore to the shutes from the working face. These may be seen on the plan and section showing the stope on the square set system. It would also be noticed that the end sets of each floor were wedged firmly to the foot and hanging walls of the ore body, and frequently notches or hitches cut to secure a solid bed. In theory, these seemed admirable, but in practise, without being filled with mullock, as they now were, they failed lamentably, for after the ore had been extracted any movement or pressure of the walls of the lode caused an entire collapse of the sets, like a top brick house. These had gained the weird name of "creeps," and a more complete state of chaos could hardly be imagined than a creep—broken and splintered timbers, and masses of ore and mullock in one almost unapproachable mass, often rendering further safe working that portion of the lode almost impossible, and thereby losing large quantities of ore left in the debris, but it was a noticeable fact that in those mines where the managers did not rely on the timbers alone but judiciously filled the sets in with mullock from wall to wall (leaving only the necessary openings for shutes and gangways, etc.), when any movement came in the walls of the lode the timbers and surrounding filling stood the burden, and these mines were singularly free from creeps. Some idea of the immense strain, or pressure, imposed on these timbers could be imagined when he stated that he had seen a piece of 10in. x 10in. Oregon timber compressed to barely 3in., and he had seen a 10in. x 10in. vertical leg driven 4½in. into the horizontal cap and sill at its ends without bending the leg, and frequently noticed when there had been any lateral pressure the huge 10in. piece of Oregon splintered like a piece of willow on the convex side, while the concave side (though bent 1ft. out of straight) was still unbroken.

Life of Timbers.—Re the life of timber underground, a great deal depends on its location, for in some mines he had noticed Oregon that had been in for approximately 10 years almost sound, whilst in others the same class of timber, if put in a badly ventilated stope, in about three or four years has completely decayed by a kind of mouldy dry rot. In the upper portions of one mine he noticed a lot of joggled logs of blue gum, from 6in. to 9in. diameter (brought from the river in the early days), and they were worm-eaten and quite rotten, whilst the mulga and black oak, both hard native local timbers, were quite sound; but as these latter are usually only about 4in. to 8in. diameter they are almost useless for underground timbering, except as laths (or for latticing the sides of square sets and enclosing the mullock filling) as they are used in Block 14. He omitted to mention when describing the mullock filling of the square sets that 10in. x 2in. laths were used by most mines for this purpose, whilst others, having their own sawmills, rip all the 10in. x 2in. in halves and used the 5in. x 2in., thus effecting a small saving in the amount of timber required; but he had noticed that these lighter laths frequently give way when any great pressure from the mullock was thrown on them.

Cost of Timber.--Another great detraction to the square set timber was the great cost of timber and the liability to fires. When one considered the great amount of timber required to timber up a lode (and they had one in the Central over 270 feet from foot wall to hanging wall, about the greatest width on the Barrier, and taken out in blocks 50 feet wide right across this great width from one level to another, viz., 100 feet), the total of super feet is enormous, and at approximately 15s. per 100 super feet the cost greatly reduces the profits.

Fires.—Then again the liability to fires, of which we undoubtedly had two instances, viz., the fire in Block 11 of about five years ago, and the fire in Block 12 of two years ago, both of which were still burning, which caused great expense in extinguishing and greatly hamper the working of the upper portions of the lode. It would be readily seen that so much timber of an inflammable nature was a great menace, and specially when the stopes were well ventilated by winzes from the upper workings; these served as vents or chimneys, and spread the deadly gases throughout the mine, and caused loss of life, as it did on both occasions, when men went below to locate and attempt to overcome the fire before it gained too strong a hold. He had endeavoured to explain at some length the advantages and disadvantages of this square set system, and he hoped, with the aid of the accompanying drawings, he had been able to make them clear to all. Perhaps it would be seen that the deduction to be drawn was that this system was an admirable one when combined with mullock filling, but at the same time an expensive one.

Later Systems.—Owing to the sulphide ore requiring more costly and tedious treatment and preparation before being suitable for smelting, than oxidised ores, and the many and various expenses incidental to its mining, owing to its hardness and work of extraction and handling, it behoved managers and others interested should devise some safer and cheaper methods, which were also more suitable to the class of ore to be mined and treated; and thus, born of actual experiment and necessity, these later methods had gradually evolved into their present forms, and their now almost universal adoption on almost every mine in the line of lode, with sundry slight modifications to suit individual cases, proved their efficiency. He must mention that the square set system was far from annihilated, as it was still used where applicable, especialy on the sill floor, where many gangways were required, also shutes, outlets, etc. Here the sets were on solid bottoms, and well wedged against the hanging and foot walls, or the sides of the stopes; they were firm and permanent, and with the 10in. x 3in. planking on top to carry the mullock filling, formed most convenient passages about the workings. So it was still used in conjunction with these later systems, as a very valuable and necessary adjunct.

Underground Open Cut Systems.—To many, this at first might sound a little erroneous or misleading, as the term, open cut, was generally accepted or applied to those excavations from the surface downwards, but the above name is that usually given by the miners to those large open stopes which are worked under this system. The drives were first put along the foot and hanging walls, and then crosscuts driven at convenient intervals. Winzes are also sunk through the ore body from the upper level, to meet the workings on the next level below. These winzes served several important purposes; firstly, they ensured a complete and lasting ventilation to the stope during its upward way, by carrying off all noxious gases as they form on the lower workings, or were given off by the sulphide ore, and thus enabled the miners to work with a greater degree of comfort, and also to do a fair shift's work, which could hardly be expected in a hot stope with a constant atmosphere of about 90 degs., where a singlet and pants seemed almost too much; second, the winze served as a pass or shute, through which the mullock filling was conveyed from the upper levels and, by a succession of shutes and winzes from the surface, was deposited where desired. This system was entirely successful in the Central mine, for the mullock was broken in a large open excavation on the surface, and conveyed in side tipping trucks of capacity of one cubic yard, and drawn by horses through a tunnel and discharged into a shute, from which by a series of winzes and shutes, etc., it was distributed throughout the whole mine where required; thirdly, the winze was used as a starting place or face from which to work the stope; and, fourthly, after the ore was extracted, say the first 10ft. or 20ft., it was timbered up closely into two compartments—one compartment served as a shute or pass for the ore to sill floor as the stope worked upwards, and the other compartment as a ladder-way, and means of ingress and exit for the miners and others to the upper workings of the stope. The sides of the initial drives on the sill floor were extended to the desired width along the lode, and thus the stope was formed on the sill floor and the sill timbers placed in position, and then mullocked up. On top of these timbers the bedding for the filling was placed, being 10in. x 10in. and 10in. x 3in. timbers, so arranged as best to carry the great burden imposed. Above these sollars, as they were called, the only timbering was that of the shute and ladder-way, all other space being filled in with mullock from wall to wall as indicated, which was placed in layers of from 7ft. to 12ft.; and as the broken ore fell and the traffic was all on the mullock filling, each succeeding layer got well rammed, and solidified before the next one was placed on it. In the large open stopes in the Central mine, almost all the boring was done by machine rock drills driven by compressed air. These brought the ore down in large pieces, frequently from 7ft. to 8ft. long, but generally from 3ft. to 6ft. by about 2ft. wide; they were then bored, by hammer and drill, and popped into smaller sizes, then spawled into suitable sizes, seldom more than about 1ft. long, for throwig down the shute, and removal in the trucks, which were all end tipping and hold about 16cwt. of broken ore. When the back or top portion of the stope was heavy, or seemed dangerous and likely to come away, bulkheads were built under it, which consist of 10in. x 10in. timbers, placed at right angles to each other, one above the other and tightly wedged. When bulkheads were built on the mullock filling, a bed of 10in. x 4in. sollars were first laid on the mullock, and distributed the pressure over as large an area as possible, then the first 10in. x 10in. timbers forming the bulkhead were laid transversely across these sollars; these timbers were afterwards removed, and the burden shot down, and the same timbers used over and over again. He thought it would be advisable, before drawing attention directly to the advantages and disadvantages of this particular system of stoping, to describe a somewhat similar modification of the same system called the sloping stope system. This method is extensively used on the Broken Hill Proprietary Mine, and he must here express his indebtedness to E. J. Horward, Esq., C.E., mining manager, for his kindness and courtesy in granting him permission to copy his drawings, showing this system. In many instances the same description would apply as in the foregoing notes on open cut stoping, viz., the level on the sill floor was first formed, taking notice that the width of the stope depended on the nature of the ore to be mined, or its ability to support itself by leaving the back in the form of an arch. The whole stope when formed was somewhat in shape like an isosceles triangle, of which the level or sill floor formed the base and the winze the apex; also the winze (as before) was sunk from the level above, and that the stope was started from the winze, as in the other open cut system, whilst the winze served the same purposes of ventilation, and as a pass for mullock filling into the stope, also for the ore to the sill floor. The great difference was that the stope slopes laterally to each side instead of going up with a level or even floor, and as these sides rose with the stope, provision must be made for preventing the mullock filling from running into the adjoining stope as it rose; this was done by placing 10in. x 4in. stringers vertically at the sides of the stope about 5ft. apart, which overlapped at the ends; these were then covered with 10in. x 2in. laths, placed horizontally, against the face of ore. These could be removed and used over and over again; when the adjoining stope was afterwards being worked, the stoping generally advanced forward from 5ft. to 8ft. at a time, and from 8ft. to 12ft. upwards. The advantages of these sloping sides were that the broken ore fell on the 10in. x 4in. sollar boards placed on the incline plane of the mullock, and thus rolled to the shutes at the sides without further handling (excepting, of course, the large pieces, which required hand boring and popping as before mentioned). It would be noticed on referring to the drawing that the stope was filled in with mullock to within 2ft. or 3ft. of the back, and the stope is always worked downwards, starting from the winze, but if the back was heavy or faulty it was secured by 10in. x 10in. legs resting on the sollars (or on bed-logs left in the mullock) at right angles to the sollars (and also to the back, as they were nearly parallel); these were tightly wedged and blocked, and only removed as the ground was taken out. When the stope was about 9ft. high the sollars were taken up and stored aside for further use. The stope was again mullocked up to within 2ft. or 3ft. of the back, when the shutes were again built up a proportional height and the sollars placed again on the mullock, the sloping process as before taking another slice from the back, also starting from the winze downwards. He would now very briefly describe another modification of this system as adopted in the Central Mine (where he had the honour of being engaged), and a method which up to the present was not used in the other mines (as it was generally in the Central), with most satisfactory results. The lode for its entire length through M.L., No. 9, had been surveyed into parallel blocks each 50ft. in width (i.e., 10 sets each 5ft. wide); each alternative division was a block and the next a stope. The whole level was gradually developed by a drive along the footwall, and by crosscuts to the hanging wall, thereby determining the width of the lode along its entire length, and the stopes were then carried from the foot wall to hanging wall on the sill floor, and the whole filled with square sets, leaving every facility for forming the necessary gangway, shutes, etc. These were then filled in with mullock (as before mentioned in the portion on square set system), and the stope started on its course upwards, being exactly 50ft. wide by the entire width of the lode at that point, thus leaving a pillar of ore 50ft. wide on each side of it from wall to wall, which will carry all pressure during the mining of this stope. A run of square sets was put on each side of the stope as it went upwards, forming a gangway and ladder-way, the sides of which were lathed or paddocked off, thereby confining the mullock filling to the centre of the stope. The ore was broken by machine drills driven by compressed air, and in the same lifts and proportions as in the before-mentioned open stoping system, the ore falling on the mullock filling in the centre of the stope was popped and spawled into suitable size for handling and trucking to shaft for haulage to the surface. One great difference in this system from the others was that the winzes (6ft. x 5ft) were always sunk 100ft. apart at the side of each alternate stope (being half in the stope and half in the adjoining black(, thereby saving a second winze when the block was being taken out at any future time. The ore from the adjoining stopes having been all extracted and the space filled with mullock, this same winze would then be available, and serve the same purpose for the remaining block. The same advantage re ventilation, mullocking, and stoping all apply to these stopes, as in the foregoing open cut and sloping stope systems, and they were mullocked up in the same manner, excepting that the shutes for conveying the ore from the working faces to the sill floor were placed in the runs of sets placed on the sides of the stopes for that purpose, and shutes could be placed at any suitable intervals for the workings.

Comparative Remarks.—Having thus briefly described the various methods of underground stoping, he would now venture to draw attention to the advantages and disadvantages of them. Firstly, the whole of the ore body was, or at least eventually could be, extracted, and after extraction of the lode material comparatively few, if any, large voids or openings were left, which also left the surface areas for works, mills, and machinery, etc., almost free from risk of subsidence. Secondly, the great advantage evident from the presence of the mullock filling, in lieu of a forest of timber, was the immunity from risk of fire. Thirdly, the miner was always in reach of the back, i.e., from 3in. to 9in., and could readily sound and examine the back of the workings, and thereby make sure it was safe; and this would ensure a great freedom from accidents caused by masses of ore falling on men whilst at work immediately under them, though, unfortunately, recent experiences had shown that, as far as human knowledge or judgment could avail, a place might be sounded and examined by miners with a lifetime experience and reported as safe, when, a few hours afterwards, the back fell in and revealed a fault or crack which the sounding did not make known, and, unfortunately, serious or fatal accidents resulted. But even then this could not be in any way compared to the great risk incurred by men when re-erecting square sets that had been knocked down by a heavy charge, when sometimes a charge would bring away more ground than anticipated, for then a dozen or more sets would come down, and the men would have to work under probably a dangerous back in re-erecting them or staging before they could actually examine it and assure themselves of its safety. Fourthly, another great advantage was the saving in expense of timbers. Of course, against this must be placed the cost of quarrying the mullock filling on the surface, and conveying it to the stope; however, this would be required in any case in filling the square sets. Fifthly, the great advantage of good air, and as the mullock filled in all spaces except the winzes and stope itself where work was going on, this ensured a current of air always at the working faces, which also carried off the smoke after firing, and should add to the miner's health and comfort, and remove much that in former days made the miner's life a hazardous and unhealthy one.

Conclusion of Underground Stoping.—Having described and compared the various systems of underground stoping and ore extraction, he was afraid he would weary you if he were to attempt to describe as fully, and go into detail, re the one other important method employed, and by which such a large amount of oxidised ore had been, and was still being, removed. He referred to the open cut system and surface extraction; but would briefly describe its operations and give some idea of its method and the extent of its workings, which really had to be seen to be appreciated. In reference to the open cut system, which he purposed making the last one to describe in this paper, he would endeavour to be brief, yet explicit.

Open Excavations.—The large open excavations were one of the chief sights of Broken Hill, and though photos. and description might give a slight idea of their extent, he thought they must be seen to be understood or appreciated. Imagine a huge open cavern three-quarters of a mile long, for they extended from the north boundary of Block 10 to the south boundary of Block 14, thus traversing the whole of the Broken Hill Proprietary Company's Blocks 11, 12 and 13, each of which was 20 chains along the line of lode and 20 chains wide. The widths of these cuttings varie dfrom 120 feet near the viaduct in Block 11 (in what was known as Smith's cut) to about 350 feet wide across Baxter and Sadler's immense cutting in Block 12. There was also a great width of 300 feet opposite McGregor's shaft in the centre of Block 11. The cuts were now down about 200ft. level, and they were recovering a large amount of timber that was used underground in the square set system of stoping in the old 200ft. level workings, the ore from which was then hauled up the various shafts before the open cuts reached their present depths. The great mass of overburden (mullock-country, rock, etc.) that had been removed in the extraction of the ore could be imagined by the immense heaps on both sides of the line of lode, reaching (near the outer portions) a height of 60ft. and more (the angle of repose being about 37). The areas covered by the base of these heaps, following the area described by the toe of the various dumps, would almost equal in area the adjoining bases of the lode; in fact, supplementary leases had been taken up on the eastern side of the lode on which the mulock heaps and debris had been deposited.

Incline Tramways.—One of the most interesting features of the works was the system of incline tramways by which the waste was removed from the cuts. The grade was 2 to 1 approximately; they were always double lines, and two end tipping trucks called dobbins were used, being hauled by a ¾in. wire rope attached to a hauling engine having a loose drum and 9in. cylinders approximately 15 h.p.; the empty dobbin runs down the incline while the full one was being drawn up, thus aiding the traction of the loaded one. On arrival at surface near the engine-room the full dobbin was stopped by placing a sprag in the wheel (this was a piece of hard-wood about 18in. or 2ft. long, and 4in. in diameter), the hauling rope was detached, and a horse hitched to the dobbin, which was then drawn along a surface line of 3ft. 6in. gauge, and being an end tipping truck was run to the end of the bank, where a cradle or tipping trough of old sleepers was formed. The sudden impact of the front wheels with this cradle caused the dobbin to discharge its load over the end of the dump; of course, as the dump increased the cradle or tipping trough was removed to the outer edge, the invert being generally about 6in. below the level of the line.

Horses.—It was remarkable the instinct of the horses used in running out these dobbins. A boy ran along-side, and on nearing the end of the dump pulled a strap fastened near the breaching, which released the fastening attaching the horse to the dobbin. The horse immediately ran off the line and allowed the full dobbin to pass him, and then trotted up behind and turned round, ready to be re-hitched to the empty dobbin to draw it back to the cutting again, often needing nothing more than the word from his driver. The horses used in this class of work were a splendid type of draught animal; unfortunately, those working in the bottom of the cuts (where the oxidised ore was mined and dust frequently blows about) sometimes got leaded, and then soon became the same type of wreck tht men are when they suffered from the same malady; but since the stopping of the smelters on the Barrier, he was pleased to say was now not such a menace or nearly so prevalent as in the early days. This, he thought, was largely due to the greater cleanliness of the workmen, and the increased facilities given them by all the mining companies, for each and every mine had its own changing house, where the men could all indulge in a hot or cold plunge or shower bath. Yet it was remarkable how many miners and others went home daily covered with black, sulphide dust, looking more like aboriginals than white men.

Flying Fox.—The next most important method of extraction, and that by which the greater portion of the ore from the open cuts was raised to the surface, was the flying fox, which was the name given to the large skip which was hauled up and conveyed along an aerial ropeway, and thence discharged into large bins at the sides of the railway lines on the surface, from which it was conveyed to the mill, or else to the smelters. To the new arrival (or one who had never seen an aerial ropeway before) these were certainly one of the most notable and interesting features of the place. A mast was erected on each sidt of the cut, and a cable stretched over a saddle near the top; th ecable was anchored securely on either side, while on the surface was located the hauling engines, of same type as used on the inclines, having a loose pulley and reversing gear. An attachment called a bicycle ran along the main cable across the cut, having on it four pullies; the upper two travelled along the cable, whilst the lower two were used in hoisting the skip vertically from the bottom of the cut, and the same rope (called the travelling rope) then hauled the bicycle (and, of course, with it the skip) along the cable; when it was over the bin on the surface, a self-acting catch held it steady whilst it was lowered and discharged its load into the bin. The skip was again hoisted, and was run out along the cable and again lowered into the cutting; in the meantime, a second skip had been filled, and it was attached and hauled and discharged as before.

Capacity of Skips.—The skips were about 1ft. 4in. deep and 4ft. wide and 5ft. long, and hold about one cubic yard; they were suspended by four chains, one at each corner, the back two being fixed to the skip, whilst the front ones were fastened by hooks, which were undone to release the load (these skips were used for many purposes besides hauling ore, for he had seen a workman with a broken leg hauled up to the surface and deposited safely, thus saving a steep climb up the banks). This was spoken of appreciatively by the surgeon who attended the case. The sides of the cutting were designed with a batter of a $\frac{1}{4}$ to one, and would meet at a depth of about 250ft., but owing to frequent slips of the sides they at present were very irregular. Some very heavy firing was done in these cuttings, which disturbed the ground for a great distance, and raised large clouds of dust up in the air, but frequently immense burdens and masses of the rock were removed.

Ore Body.—The ore body in the centre of the cut was from 25ft. to 50ft. in width, and of a distinctive colour from the surrounding country rock. The open cutting in Baxter and Sadler's contract, Block 12, and also in Smith's cutting, Block 11, were now working immediately above the fire area, and frequently pieces of burnt timber and moulten rock were found. These cuts were of great use in coping with the fires underground by pouring large quantities of water down the shafts right above the fire area.

Drive Sets.—There was just one other feature in closing to which he would draw attention, viz., the massive drive sets as used in the double track drives, where horse traction was used underground. The application of these would be self-evident from the drawing. They were specially designed to withstand heavy vertical and lateral pressure, and were placed at intervals according to the nature of the back or country they had to hold.

Stables Underground.—It might be of interest to know that the horses were all stabled underground, and seemed to thrive well, for they were all in very good condition and took kindly to their work. The stables are lighted with electric light, and quite as sweet and clean as the average stable on top. Plate I. shows various views of the mine.