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OFFICIAL PROCEEDINGS

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PROCEEDINGS OF THE CENTRAL RAILWAY AND ENGINEERING CLUB OF CANADA MEETING.

PRINCE GEORGE HOTEL, TORONTO, JANUARY 17, 1911.

The President, Mr. G. Baldwin, occupied the chair.

Chairman,—

I will now call the meeting to order.

The first order of business is the reading of minutes of the previous meeting. As everybody has had a copy of the Journal, it will be in order for someone to move that the minutes be adopted as read. Moved by Mr. Wickens, seconded by Mr. Herriott, that the minutes of the previous meeting be adopted as read.

The next order of business is the remarks of the President.

As we have a very interesting paper to-night on "Diamond Mining in South Africa," I will cut my remarks short, which I would not otherwise have done.

Like the rest of the Executive, I feel very pleased that such a good number have turned up to hear this paper. We are used to papers on steel, cast iron and other metals, but the paper to-night is something out of the ordinary, and will, I am sure, be very interesting.

I am doubly interested because I may possibly hear something about an old friend of mine, Mr. Ford, who went out to the diamond mines in South Africa, about the same time that I came to Canada.

The next order of business is the announcement of new members.

NEW MEMBERS.

M. Watts, Architect, Bridge and Building Dept., G. T. Ry.,

Toronto.

G. Herbert, Chemist, Canada Foundry Co., Toronto.

E. M. Thomas, Chief Electrical Engineer, G. T. Ry., Toronto.

J. Reid, Timekeeper, G. T. Ry., Toronto.

A. Stuart, Inspector, Canada Foundry Co., Toronto.

W. O. Maclean, Foreman Patternmaker, Canada Foundry Co., Toronto.

W. W. Garton, Machinist, Christie Brown Co., Toronto.

Olas Endinger, Structural Steel Inspector, Dominion Bridge Co., Toronto.

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G. D. Bly	S. Violet	D. Campbell
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M. McGrath	N. D. Whatmough	W. Dony
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H. H. Wilson	W. Pollock	C. A. Jefferis
G. Black	E. Logan	J. F. Campbell
A. W. Carmichael	A. M. Wickens	A. J. Gaul
H. G. Fletcher	J. Herriott	
L. S. Hyde	C. L. Worth	

Chairman,—

I remember that at the last meeting Mr. Newman made some remarks in reference to an exception that was taken to a statement made by Mr. Hacket in his paper on "Railroad Signaling," and I understand Mr. Worth to say that he would ask Mr. Hacket to deal with this matter.

Secretary,—

I may say that I have forwarded a copy of the last proceedings to Mr. Hacket, and brought this matter before him, but up to the present he has not made any reply, probably he will do so by the next meeting.

DIAMOND MINING IN SOUTH AFRICA

BY ALFRED J. GAUL, C.E., Mem. Can. Min. Inst.

Gaul & Girouard, Civil Engineers, Toronto.

The diamond mines of South Africa are distributed over a large area of country, being found in all the provinces of the Union, with, so far as the author knows, the exception of Natal. The centre of the industry is, however, located in that part of Cape Colony formerly known as Griqualand West, with the chief scene of operations at Kimberley.

GEOGRAPHICAL

Kimberley is situated on the main line of the Cape Government Railways, and is distant approximately 600 miles from Cape Town. Kimberley is practically the geographical centre of British South Africa. It is here that the De Beers Consolidated Mines, Ltd. have their headquarters, with the producing mines dotted around, covering an area of some 16 square miles. The mines directly under the control of the company in the Kimberley district are five in number, being

- | | |
|-----------------|---|
| (1) De Beers, | area, 13.72 acres. |
| (2) Kimberley | " 10.37 " |
| (3) Bultfontein | " 23.54 " |
| (4) Du Toitspan | " 31.79 " |
| (5) Premier | (now known as Wesselton to distinguish from the Premier Mine near Pretoria, Transvaal). About 35 acres. |

It is with these Kimberley mines that the paper will more particularly deal.

EARLY HISTORY

Doubtless the early history of the diamond industry will be of interest. Africa is and always has been the traditional home of the Queen of Sheba, King Solomon's Mines, and the marvels of Ophir. It would take too much time to go into the details of the early exploration of the continent by Portuguese and other travellers, suffice it to say that as far back as 600 B.C., Phœnician sailors sailed down the Red Sea and returned with gold, ivory and feathers, and it is surmised that they obtained their treasure from that part of the east coast of Africa, now known as Sofala, almost due east of the ancient ruins of Zimbabwe. In the fifteenth century, the Portuguese made several expeditions into the hinterland of the Sofala coast, with the object of locating the source of all the gold that

trickled to that part of the coast through Arab caravans. Ancient workings and ruins are to be found throughout Rhodesia, the origin and date of which have never been actually proved, but the general belief is that they are the mines and storehouses which supplied the gold of King Solomon and Judean times.

Nothing much was done in the way of discovery until 1867. A few years prior to this a number of Boers had trekked into the country around the Vaal and Orange Rivers. The children of one of these settlers gathered the small pebbles, which were bright and of many colors, and prized as playthings. The farmer's vrouw noticed one day among the pebbles, one of exceeding whiteness and brilliancy. She did not take the trouble to pick it out from the others, and it eventually became mixed in the dirt around the farmhouse. However, she mentioned the fact to a neighboring Boer, Schalk Van Niekirk by name, who asked to see it. After a long search it was found, and he was so struck by its beauty, that he offered to buy the stone. The good vrouw laughed at the idea, and told Van Niekirk to take it if he thought it was worth having. He took the stone home, having only a vague idea that it might be of value, and placed it in the hands of a travelling trader named John O'Reilly, who undertook to ascertain its nature and value. It was shown to the Jew traders around Colesburg, who would have nothing to do with it, saying it was pretty enough,—probably a topaz—which nobody would buy. Eventually it came to the notice of Civil Commissioner Lorenzo Boyes at Colesburg, who found it would scratch glass. He remarked that he believed it to be a diamond. After much discussion as to the probability of it being a topaz, it was sent to the leading mineralogist of Cape Colony, in an unsealed envelope, in the ordinary post-cart. When the letter was handed to the mineralogist, Dr. Atherstone by name, the stone rolled on the floor.

Dr. Atherstone picked it up and read the enclosing letter. After examining the pebble he wrote Mr. Boyes congratulating him, telling him it was a true diamond, weighing $21\frac{1}{4}$ carats, and worth \$2,500, also there must be lots more where it came from. The stone was eventually exhibited at the Paris Exposition. Boyes, on receipt of this information, hastened to Hopetown, and the Van Niekirk farm and interrogated the phlegmatic farmers, raking over bushels of pebbles for two weeks without success. However, the news of the first diamond sharpened the Boers, who kept a very keen look out for what they call "blink klippe" (bright stones) in the river bed and valley. Ten months later, at the junction of the Orange and Vaal Rivers, the second stone was discovered, to which place Boyes hurried off poste haste and was again unsuccessful in finding

a companion to the newly discovered diamond, and came to the conclusion that the stone had been washed down by the overflowing of the Vaal River. In 1866 more stones were found by the natives on the banks of the Vaal. This strengthened Dr. Atherstone's theory of a diamond deposit, and he suggested that the Home Government should make a systematic examination, the Colonial Government being too poor. The suggestion, however, was not taken up, for while the suggestion was being made the announcement of a remarkable discovery caused a tremendous rush to the field, thus avoiding the necessity of a government investigation. This was in 1869, when a Griqua shepherd boy picked up a beautiful stone weighing $83\frac{1}{2}$ carats, near the Orange River. Schalk Van Niekerk paid what appeared to the poor boy the monstrous price of 500 sheep, ten oxen and one horse for the stone. Van Niekerk sold it to Lillienfield Bros. of Hopetown for \$56,000.00, who again sold it to Earl Dudley for, it is stated, \$125,000.00. The stone became known as the "Star of South Africa." The field soon became more defined by the finding of many smaller stones in the vicinity of the Vaal.

The first systematic prospecting was done by a party of Natal prospectors at the Mission Station of Hebron. Not having any success there, they moved twenty miles down the river to Pniel. Here for days they were doomed to disappointment and were on the point of giving up when they were rewarded by the appearance of a small diamond. Later some natives were induced to point out a kopje where they had found some diamonds; here the party found a deposit of extraordinary richness, and in three months were rewarded with half a tumblerful of stones, two or three hundred in number, from tiny gems to diamonds of 30 carats or more. The news leaked out and a motley throng of fortune hunters poured in. Every nationality of Europe was represented, mixed with the descendants of Guinea coast slaves, and natives of every dusky shade. One writer described the scene at Pniel as the "whistling, shouting, yelling, snorting, neighing, braying, squeaking, grinding, splashing Babel." Klipdrift (or Pniel) was as a swarm of bees whose hive had been upset. The diamond fields were centered at Pniel until 1870, when an overseer on a farm called Jagersfontein in the Orange Free State, found a 50 carat stone in the gravel around the bed of a spruit (small stream). Farmers flocked in and paid the widow of the late owner \$10.00 per month to work patches 20 feet square. The Boers smoked while the Kaffir servants delved Blink Klippe. In September, 1870, almost simultaneous with the Jagersfontein find, a more remarkable discovery was made at Du Toitspan, on the farm Dorstfontein, owned by Du Toit. Du Toit sold out his farm to Adriaan Van Wyk, who first charged \$2.00 per month for

working 30 feet square. He afterwards sold out to the predecessors of the London & South African Exploration Co. The adjoining farm, Bultfontein, was sold to a syndicate for \$10,000.00. The diamonds on this farm were first found in the plaster on the outside of the old Boer's house. Vooruitzigt, adjoining, was bought for \$30,000.00. These three syndicates, formed the nucleus of the companies who subsequently amalgamated, and are to-day known as De Beers Consolidated Mines, Ltd. The following is a record of farms which now comprise the diamond fields of Kimberley:

(a) Bultfontein—14,457 acres, granted by the British Government to J. F. Otto, December 16th, 1848.

(b) Dorstfontein—6,579 acres, granted by the Orange Free State to Abraham Dutoit, April 4th, 1860.

(c) Vooruitzigt—68,405 acres, was originally part of Bultfontein and was sold to D. A. and J. N. DeBeer, April 16th, 1860. The total area of these three farms is $58\frac{1}{2}$ square miles. At the present time the land owned by the company covers an area of about 493 square miles.

Kimberley and DeBeers Mines are situated on the farm Vooruitzigt. They were both discovered in the year 1871, Kimberley being found by a Kaffir.

In 1872 the workings began to cave, and roads were blocked, which prevented ingress to and egress from the centre claims, which necessitated the use of wire rope haulage to the rim of the crater. Hand power was in use until 1874, when the first horse whim was installed. This form of power was used for a year, and in 1875 the first steam hoisting plant was put into use. From this time on drainage and caving difficulties became very prevalent, for it can be well understood that it is not possible to work down to unlimited depth in a patch of land, say 20 feet square, thus it was that diggers amalgamated into small syndicates, which syndicates again combined, eventually forming the various companies who controlled each individual mine. It was in the early eighties that Messrs. Rhodes, Barnato, Rudd, and other leading men in the diamond industry, formulated the scheme of complete amalgamation of all the interests in the Kimberley field, with the prime object of controlling the price of diamonds by the restriction of the output. It may be of interest to know that the Kimberley Mine Syndicate first paid \$5,500,000 for the combined claims. The price paid by the DeBeers Consolidated Mines for the same property was \$26,693,250, giving an idea of the wealth behind the DeBeers Co. Mr. Rhodes had great difficulty in getting the amalgamation scheme through, and it is due to his determination that DeBeers is to-day as it is.

In those days Mr. Rhodes was anything but a wealthy man, and it was a common occurrence to draw \$25 on account

of his month's salary. General Gordon was, on one occasion, talking to Mr. Rhodes about the offer of a roomful of gold by the Chinese Government, as a mark of appreciation of his services in China. Gordon said, "Of course I refused it. What would you have done?" Rhodes replied, "Why, I should have accepted it, and as many more as I could get, for what is the use of having big ideas if you haven't the money to carry them out."

Since the consolidation the Wesselton Mine has been opened up and is proving to be as valuable as any of the other mines.

OCCURRENCE.

Geologically, the diamond is a crystalline form of carbon presumably formed through the agencies of heat and pressure. Diamonds are found in a matrix of volcanic breccia, locally known as blue ground, which latter consists of a hard clay containing a large number of crystals of various minerals such as diamonds, garnets, olivine, quartz, mica, etc. The deposits take the form of pipes, descending, it is supposed, to the heated portion of the earth's crust. These pipes are more or less cylindrical in section—varying in diameter from a few feet to many hundreds.

Atmospheric and other causes decompose the blue ground, forming in the vicinity of the pipes, on the surface of the earth, an overburden of soft yellow ground. The yellow ground invariably occurs at the outcrop of a diamondiferous pipe, and is the indication on which the diamond prospector pins his faith. Yellow ground extends to a depth of some 200 feet, where it gradually changes into the original and undecomposed blue, which, as the depth increases, becomes harder until it becomes very similar to concrete in texture. It may be pointed out that all volcanic pipes do not carry diamonds, there being several barren pipes in the Kimberley region. A feature of the diamondiferous pipe is the physical difference in the diamonds found therein, some pipes producing fine large stones of perfect color, as for instance, the DuToits Pan pipe, contrasting with others which give a small yellow tinged stone, *e. g.*, Bultfontein mine.

METHOD OF UNDERGROUND WORKING.

Since the days of individual digging, all work, with the exception of the new mine of Wesselton, has been carried on underground by means of shafts sunk through the rock at the side of the diamondiferous pipe, see Fig. 1, and drifts running into the blue ground. These shafts are equipped with the finest of hoisting plant, there being separate plant for rock and men. Until 1902, all the plant was operated by steam, since that time all works have been equipped with

duplicate plant, electrically operated, which the writer understands has again been augmented by the installation of a second electrical plant to be used in the case of breakdown, thus giving every operation three independent sources of power.

The blue ground, when mined, is trammed to ore passes, where it is dumped and gravitated to the lowest level, being received in bins holding exactly a skip load. The blue is then hoisted in skips to the surface and dumped into bins ready for loading into the surface trucks. All hoisting in the main shafts is done from the lowest level.

The following are the depths of the main rock shafts.—

DeBeers.....	2,466 feet
Kimberley	3,120* "
Wesselton	1,119 "
Bultfontein.....	1,084 "
Du Toits Pan.....	860 "

*Prospect shaft 178 feet deep at bottom of main shaft.

See Fig. 2.

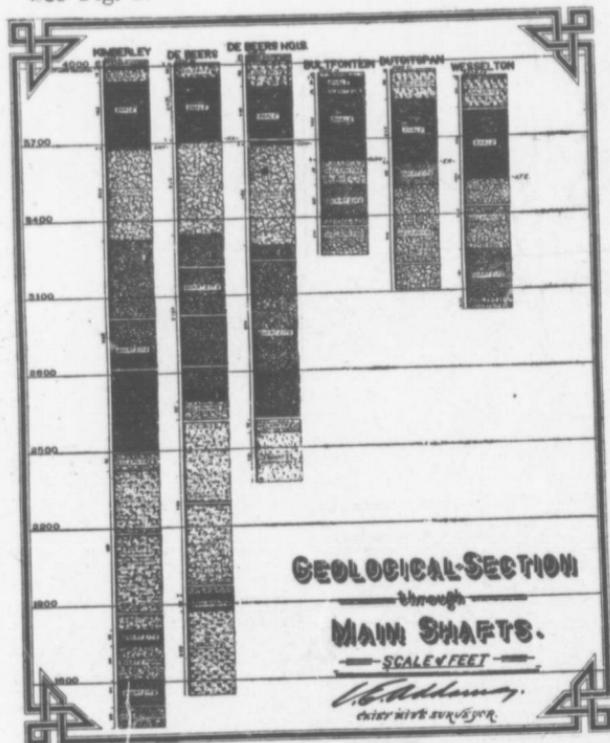


FIG. 2.

BLUE GROUND IN SIGHT, YIELD, ETC.

Mine.	No of Loads 16 c.f. ea. in sight.	Above level.	Average yield per load 16 Eng. carats	Average Value.	
				per load	per carat
				\$ c.	\$ c.
DeBeers. . .	2,777,000	2,040	.38	4.42	11.62
Kimberley. . .	1,600,000	3,120	.38	4.42	11.62
Wesselton . . .	25,000,000	980	.32	2.66	8.34
Bultfontein..	16,000,000	1,000	.37	2.90	7.82
Du Toits Pan	22,000,000	750	.23	3.82	16.58

DEPOSITING FLOORS AND WASHING.

In the early days of the industry, when work was solely carried on in the decomposed and disintegrated yellow ground, it was possible to wash the ground as it was mined. At the present time, however, the ore must be "weathered," which is accomplished by placing the ground on what are known as depositing floors, and allowing the elements to disintegrate the volcanic matrix, after which process the water is able to form a slime with the clay, allowing the coarser and heavier particles to gravitate, which is the system in use for the separation of the crystals from the containing mass. The floors consist of large areas of flat country divided into rectangles, and intersected by 18 inch gauge tram lines, over which the blue ground is drawn in side tip cars, operated by wire rope haulage. After the blue ground is mined it is delivered to the floors, where it is dumped and remains for a period of from ten to twelve months, subject to all climatic conditions during which time the deposited material is harrowed for the purpose of exposing the whole mass. The stock of blue ground on the various floors 30th June, 1910, was 7,776,059 loads. The harrows are operated by traction engine and wire rope, engines are located on each side of the floor, the harrow being drawn alternately from one side to the other. After the necessary time for disintegrating has expired, the blue is again loaded in cars and taken by mechanical haulage to one of the washing machines located on the floor, where, after being screened, it is fed into shallow circular pans, divided so as to form an annular space four feet in diameter between the outer and inner rim. Here the ground is swept round by revolving arms, attached to a vertical shaft, and carrying wedge-shaped teeth. These teeth are set to form a spiral, which forces the diamonds and other heavy minerals to the outer edge of pan, while the lighter waste material flows out at the discharge situated upon the

inner rim. At certain intervals during the day the deposit is drawn off and sent in locked cars to the Pulsator for further concentration. Every 666 loads of blue washed yield 6½ loads of deposit, which is further jigged to one load of concentrates. The waste material runs into a sump, see Fig. 3, from whence it is taken in skips to the top of a "debris" heap. Some of these "debris" heaps are 150 to 200 feet high, and cover several acres in area.

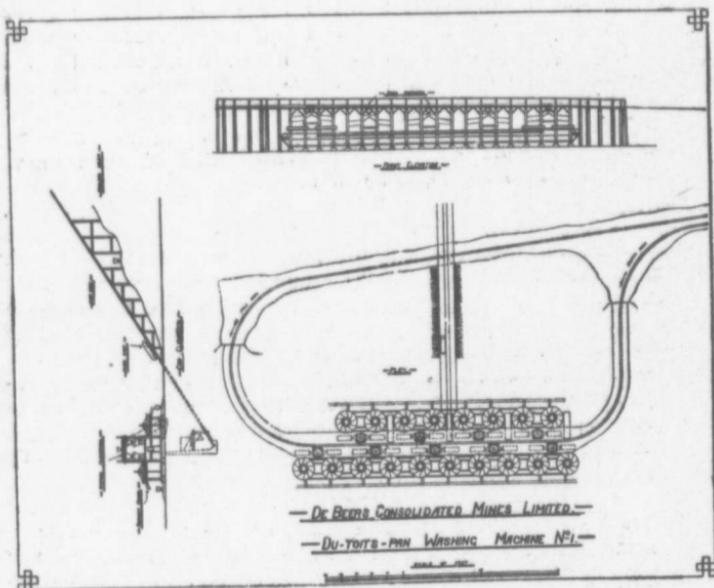


FIG. 3.

PULSATOR.

The gravel, when withdrawn, is placed in sealed side tip cars and taken to a machine known as the pulsator, in trains by means of electric traction, which is situated at the south end of the DeBeers Mine floors. The pulsator is a machine invented by a DeBeer's workman, and is on the principle of a gold amalgamating table, except that instead of amalgam coated plates or tables, the pulsator has greased plates over which the stones are passed. The inventor of the machine found that diamonds and garnets had an infinity for grease, and finally evolved the present type of pulsator. The waste gravel simply passes over the table, leaving the precious stones behind. The plates are periodically scraped and the grease with the

contained diamonds is melted down and the diamonds extracted. The grease being returned to the plates, the extracted diamonds are then hand sorted from the garnets and graded.

SORTING AND GRADING.

The sorting is done at the pulsator, and the grading at the head office in Kimberley, which building, it may be said, is strongly guarded, there being several of the DeBeers' guard on duty directly the offices close for business. A change in the staff of the diamond office is a rarity, new hands being taken on quite young who take the place of superannuated sorters. The graded stones are then sold to the marketing company, subsidiary to the DeBeers Consolidated Mines, who place the stones on the markets of the world. The mining company is distinct from the selling company. The diamond output for 1910 was about \$27,000,000.00.

MECHANICAL EQUIPMENT.

The mechanical equipment of the DeBeers Company's Mines is all that money can buy, and no expense has been spared in making the work of mining and recovering diamonds as perfect as possible. The early miners merely washed the yellow ground and hand picked the gravel, being rewarded with the larger stones contained therein, which it was almost impossible to pass over in sorting. At the present time large profits are being made out of the old debris heaps left by the first diggers, which heaps have passed into the hands of DeBeers; even streets are being torn up and the stuff washed to recover diamonds. It is quite a common practice for a man to take a street, tear it up, wash the ground, and replace with excellent macadam, and make a good profit out of the recovered stones. It can thus be said that Kimberley is actually paved with diamonds. The debris heaps have been washed in some cases three and even four times, each time with newer machinery, until now the last carat is taken, as there is very little chance of a diamond eluding the grease plates at the pulsator. The debris heaps have always given the washers a good profit.

The electrical power development station is equipped with three 1,500 kilowatt Westinghouse steam turbine units, and a battery of 12 Babcocks & Wilcox water tube boilers, mechanically fed. Each generating set consists of one 1,500 k.w. turbo-alternator, made up of one Parson's steam turbine direct connected to and mounted on the same shaft, with a three phase alternating current Westinghouse generator, having an overload capacity of 50% for short periods. An additional 4,000 k.w. unit is to be installed, as the present plant is carrying full load. In connection with the generating plant, an interesting bit of work was accomplished. The plant had

been in operation about two years, when it was found that the limestone rock in which the station had been built was virtually floating, causing trouble in the running of the machines. At this period only two units had been installed, but the third had been delivered, and the foundations were in. It was then decided to change the foundation. The work already in was removed, and the rock excavated, and a total of 1,700 tons of concrete put in its place. When the concrete had set, the unnecessary machinery about the mines was shut down, leaving just as much in operation as could be carried in a single unit, thus relieving the unit next to the new foundation. This machine was then moved to the new bed and reset, the load then being redistributed on the two machines. The whole operation took only about twenty hours, and there was no visible sign at any of the outside plants that anything unusual was taking place at the power station. The same operation was carried out in the case of the second machine and its place was taken by the new generator. The cause of the trouble in the foundations was the fact that the station was located on the side of a lake, the water having impregnated and saturated the surrounding limestone foundation.

Power is distributed by means of underground high tension cables to twenty-eight transformer stations around the works, where it is transformed by means of rotary converters from 5,000 to 240 and 110 volts alternating, and to 550 and 240 volts direct current to meet the varied requirements of the mines.

LABOR.

The unskilled labor on the DeBeers works is exclusively Kaffir. The company have their recruiting agents distributed throughout the native territories of Cape Colony. The "boys" for the different compounds are drawn as far as possible from the same tribe, as this minimises the risk of tribal fights, which are certain to occur where boys are mixed. The natives are engaged on a four months' contract and are "compounded" during the period of their engagement. When they enter the compound they give up their clothes, in place of which they receive company garments, their own being numbered and placed in a locker in the discharging room. The boy remains in the compound during the four months, passing to and from the mine in which he works by means of a tunnel, which joins the compound with the mine shaft. In this way he is kept from the outer world, and incidentally, many thousands of dollars' worth of diamonds. White employees have access to the works on production of a pass issued when joining the company. Searching is not customary, except in the case of suspicious persons. All natives have to go through what is

known as the detention house, before leaving the company's employ. Attached to the detention house is the discharging room, where the boys receive their clothes and pass into the outer world. Thus it can be seen that the chances of a native carrying stones out is small, for once they reach the detention house, they do not again come into contact with boys still at work in the mines. They spend two weeks in detention, during which time they are effectually searched. They wear no clothes and their hands are padlocked in leather mitts. In spite of this treatment, which to a white man would be degrading, the native thoroughly enjoys his two weeks' holiday, simply smoking, feeding and sleeping, for which he draws pay—perfect paradise for the Kaffir. The average pay drawn by a Kaffir is about \$15 per month, including board. Each compound contains between 1,500 and 2,000 boys, being laid out in the form of a rectangle, the rooms being arranged all around the sides. Each room is equipped with bunks for about 25 or 30 boys. In the center of the compound is a swimming pool, much in favor with the Kaffir, who dearly loves to sport in the water and then bask in the sun. At Christmas the boys have their annual sports, for which the company provide prizes.

Over the top of the compound is stretched wire netting about 15 feet above the ground, which prevents the boys from throwing diamonds over the walls to people outside. Around all the company's works is erected a barbed wire fence 14 feet high, with a second fence eight feet away on the inner side. Cases have occurred where boys have been in the DeBeers compound for over twelve years, taking an occasional holiday to visit their kraals, but always returning to Kimberley. DeBeers have never, in all the labor famines South Africa has experienced, been short of native labor. During 1910, \$665.00 was spent in recruiting labor. They treat their boys well and have a splendidly equipped labor department, in charge of men who understand the native, almost better than they do white men. The pulsator plant is the only exception to recruited labor. In this case the work is carried on by means of convicts, obtained from the government. The company feed and house the boys and pay the government at the rate of 25 cents per day per head. An escape is a rare thing. The boys appear to be happy and contented enough, about 1,000 being employed.

In the mine and floor compounds there are boys who make small fortunes as tailors. One boy left after eight years' work, taking with him over \$4,000. Skilled labor commands about \$4.00 per day, the white pay roll being about \$300,000 per month. The average number of employees during 1910 was,—white, 3,133; native, 20,022.

It is worthy of note that labor disturbances are an unknown

thing in Kimberley. The DeBeers Benefit Society takes care of the health of the employees, who pay a small sum monthly and whose contributions are supplemented by the company dollar for dollar. Some ten or twelve of the best medical men of Kimberley, mostly specialists, are retained by the society, which men give a certain percentage of their time to the needs of the society. Well equipped hospitals are maintained in the compounds, with efficient staffs of nurses and attendants, where the native laborer is well cared for in the case of sickness.

GUARD SYSTEM.

For the purpose of preventing the stealing and sale of diamonds an act known as the Illicit Diamond Buying Act was passed. Under the terms of this act any person found in possession of a diamond, without a license from the authorities describing the weight and characteristics of the stone, was liable to seven years hard labor. It is a very rare thing for a person charged to be acquitted. The law is enforced to the letter, in spite of which, the writer, at a meeting of the company, heard the chairman state that I. D. B. was more prevalent than ever, for experts on the London and Amsterdam diamond markets recognised many stones that came from the DeBeers properties, but through other channels than the DeBeers Company. Diamond experts not only know from what part of the world a diamond comes, but, in the case of Kimberley stones, the particular mine.

The native laborers are all carefully watched about the works by guards who patrol the floors and search suspects. A general reward of 60 cents per carat is paid to all employees, white or black, who find stones, and take them to the company's office. As stated above, white employees have free access to and from the works, only being searched if suspected. The Criminal Investigation Department have charge of the outside work of tracing illicit diamond buyers, which is done by means of "trap" stones and boys. The trap boy takes a stone that has been previously weighed, described and identified by the C. I. D. to a suspect and offers it for sale, being accompanied by police officials, who keep in the background. If the suspect buys the stone, the native leaves and informs the awaiting constables, who, armed with a warrant, arrest the buyer, who is usually convicted. The accepted evidence being the money in possession of the native, who was previously searched, and found to be without money. The great Table Bay breakwater, extending over a mile to sea, has been built for the greater part by I. D. B. convicts, who excavated the new dry dock, measuring some 1,200 feet square, and about 40 feet in solid rock. The excavated rock being dumped into the sea having first been made into concrete blocks.

LANDED ESTATE.

DeBeers have laid out a model village on the farm Voorintzigt, houses being rented to employees at nominal rentals. The avenues are laid out with tall eucalyptus trees, which give the place excellent protection during the hotter part of the year. The writer has noticed that where these trees grow, mosquitoes are not as troublesome. Kenilworth, the name of the model village, is provided, at the company's expense, with a club, reading room, rifle range, and large sports ground. In addition, DeBeers are ground landlords of more than half the city of Kimberley. The company will not sell ground, but gives long leases instead. There are strict building regulations, varying in different localities. Trading is only allowed in one section, the result being a charming and well built residential section. There is a distinct line of demarcation between the old freehold section and DeBeers sections of the city. Beaconsfield, one mile from Kimberley, is also owned by DeBeers. It is the old town formerly supported by the mines of Du Toitspan and Bultfontein. A lower standard prevails here, and there are no trading restrictions.

Kenilworth and Beaconsfield are both connected with Kimberley by an electric car system, as is Alexandersfontein, Kimberley's pleasure resort. See Fig. 4. Here a fine hotel has been erected and equipped by DeBeers, and is much in favor as a week end resort. Alexandersfontein was one of the Boer encampments during the siege of Kimberley.

MINES IN OTHER PARTS OF SOUTH AFRICA.

Outside the colony of Cape of Good Hope, there are several producing mines, notably the "Premier" near Pretoria, where the great "Cullinan" diamond was found. This was the largest diamond ever known in the world. It was a "blue white" measuring $3\frac{1}{4}$ inches long x 3 inches square, about one-quarter size of an ordinary brick, and weighed 3,253 English carats, or $1\frac{1}{4}$ pounds. The stone was subsequently purchased by the Transvaal Government, and divided into three sections, and presented by the colony to the late King. The divided stone now forms part of the crown jewels; the splinters formed in cutting were more recently presented to Queen Alexandra. Since the discovery of the Cullinan diamond, several stones of phenomenal size have been found in the mine, one quite recently weighing over 300 carats. It may be added that most of these stones are not perfect crystals, being portions of larger stones, the remainder of which have not been found.

The Transvaal Government own 60 per cent. of the mine. Water for washing purposes is supplied to the mine from Wilge River, by means of a 30 inch pipe line 16 miles in length, the construction of which cost about \$500,000. The pipes

vary in thickness from three-sixteenths to five-eighths inch, formed of curved steel plate, with an electrically sealed lock bar running the full length of the pipe, each pipe is 30 feet long and weighs from 1,800 to 3,300 lbs. The pipes were transported from the railroad, over some rough country for an average distance of five miles, by means of ox wagons, each carrying two pipes and drawn by fourteen oxen. The pipes are joined by collars, fitting over the pipe and the joints caulked with lead and oakum.

The Jagersfontein Mine, mentioned above, in the Orange River colony, is the most noteworthy in that province, having produced many valuable stones. The Jagersfontein is about fifty miles from Kimberley, almost due east.

There are several other smaller mines scattered through South Africa—each producing its quota of stones, and it is surprising to find that, although the output has increased many fold during the past twenty years, the value per carat, at the mine, is steadily rising. The rapid rise of wealth in the United States is to a great extent responsible for this, for that at present is by far the largest market, and even a greater cause is the restricted sale, catering to the market, as occasion demands. During the financial panic of 1907, very few stones were put on the market. Now, however, the mines cannot produce fast enough. The DeBeers Company, during the past year, have disposed of all their reserve stock, and foretell a big increase in the price of diamonds. Their profits during 1910 were about 13½ million dollars.

One cannot speak of Kimberley without thinking of a man whose memory is respected throughout the length and breadth of British South Africa, a man who passed away at the time when his example and forethought was most needed, and whose dream of a unified South Africa is now an accomplished fact, and whose benevolence and public spirit have given the world educational facilities previously undreamed of. To South Africa he gave his beautiful estate, Groot Schuur, situated on the slopes of Table Mountain, overlooking Table Bay, the grounds as a public park for Cape Town, and his fine residence as the official home of the premier of United South Africa. It is hardly necessary to mention the name of Cecil John Rhodes, spoken of previously in connection with the consolidation of the diamond interests. One of the greatest imperialists Britain ever had, and whose schemes are now beginning to materialize. His protege, Rhodesia, after much tribulation and many setbacks, is now coming into its own. The Cape to Cairo Railway is rapidly becoming an accomplished fact; it is yet too early to say whether it will be a financial success, all we can say is that Mr. Rhodes saw a successful future to the project when he launched the scheme, and that experience

has taught us to believe in him. His ideas were too great for an ordinary individual to grasp. One of the greatest marks of respect to his memory was the overwhelming majority at the first Federal election, in favor of his able lieutenant, Dr. Jameson, who has risen from being a doctor in a small way in the early days of the diamond industry, to be the accepted leader of the British party in South Africa—a position which, had he lived, Mr. Rhodes himself would have held.

The prosperity of Kimberley is due to the united efforts of the few men, who, twenty years ago, determined to consolidate the mining interests, and so do away with costs, litigation and unrestricted output. Diamonds are a luxury, and no harm is done by keeping up the cost. Lord Randolph Churchill, when visiting the mines some years ago, remarked, "all for the vanity of women," which remark was overheard by a lady who added, "and the depravity of man."

The writer is indebted to Gardner F. Williams' book, "The Diamond Mines of South Africa," for the early history of the diamond fields.

Mr. Gaul,—

In reference to the remark which the President made as to Mr. Thurston Ford, I may say that I have had the pleasure of meeting him; he is the most popular man in Kimberley and is the secretary of the Benefit Society in connection with the DeBeers Mines. Mr. Ford took an active part in the defence of Kimberley during the Boer War.

Mr. Lewkowicz,—

There is one thing I would like to ask, and that is, if it is necessary for certain kind of clay to be found before crystals can be discovered?

A sort of yellow clay beneath which blue clay was found in the south-west section of the James Bay district, and I would like to know if the finding of this clay indicated the presence of diamonds?

Mr. Gaul,—

Blue clay found on the surface is no indication of the presence of diamonds, As I pointed out in my paper, the blue clay in which diamonds are found is at a considerable depth, and not on the surface. Some of the Kimberley pipes are absolutely barren, as far as diamonds are concerned.

Mr. Lewkowicz,—

What I spoke about was dug up, and was not found on the surface.

I would like to move a very hearty vote of thanks to Mr. Gaul for the very interesting paper he has given to us to-night.

I now feel certain that what we thought was blue clay containing diamonds was not so, and all I can say is, that I wish I had heard Mr. Gaul before.

Mr. Gaul,—

I thank you all for your very kind attention. While I am not an expert in the actual mining of diamonds I have endeavored to tell you what sort of work diamond mining is, from an outside point of view, and I refrained from being too technical. I thank you all.

Mr. Cole,—

As to the rock formation of the pipes, is it of granite or what?

Mr. Gaul,—

The surface of the ground is a red soil, which is evidently the result of the decomposition of the underlying basalt. Below the soil is basalt or dolomite. Underlying the basalt is the black carbonaceous shale which is certainly of the Karroo age and probably represents the Upper Dwyka shale of Cape Colony.

Below it comes a thin representation of the well known Dwyka Conglomerate, which is a coarse grit running many hundreds of feet in thickness in some parts of South Africa. It usually underlies the coal areas of Cape Colony. To my knowledge coal has never been found below this formation. In the Kimberley district the Conglomerate has dwindled to a thickness of from five to ten feet.

Below the Conglomerate is the next great development of igneous rocks. This rock is called malaphyre. It is an amygdaloidal non-porphyrific rock, which is considerably decomposed. The structure part, from amygdaloids, is essentially that of a coarse grained volcanic rock, and it is apparently not holocrystalline, although decomposition has proceeded so far that it is difficult or impossible to determine the original nature of the interstitial matter. Dr. Stelzner determined it to be olivine diabase.

The dominant minerals are a plagioclase feldspar and green chlorite pseudomorphs representing some member of the ferro-magnesian group.

Below the malaphyre begins another series of sedimentary rocks called quartzite. So far as regards their petrographical character these rocks were originally feldspathic sandstones or

arkoses which have been cemented into hard lustrous quartzite of varying degrees of fineness. In some cases a rapid alternation of coarse and fine layers produces a well marked lamination, so that they are often spoken of as shales, but the so-called shales are of essentially the same composition as quartzites.

Below the sedimentary rocks is another development of melaphyre in all respects, similar to that referred to above; but in this case the thickness varies between fifty to seventy feet.

Below this melaphyre there is another great series of igneous rocks, which, though much decomposed, appear to be on the whole of a distinctly acid character, called quartzporphyry. These rocks must be regarded as forming one continuous series of a volcanic nature, but it is not clear whether some of the non-vasicular types are true lava flows or not. It is possible that some of them may be of the nature of sills or other intrusive masses injected into a previously existing series of lavas.

Below the acid volcanic series comes another small development of sedimentary rock. Under the microscope it seems to consist of an alternation of layers of very fine grained quartzose sediment and lenticular patches and streaks of crystalline calcite.

In Kimberley mine under the last mentioned series at 2,520 feet from the surface there was discovered a well defined conglomerate about 50 feet thick, which has lately been proved to be the Vaal River Conglomerate which outcrops in the districts north of Kimberley.

At DeBeers Mine the shaft has not passed into the Vaal River conglomerate; but at a depth of 2,137 feet a rather pale grey granite was met with. It shows a somewhat gneissose structure. It also shows clear glassy quartz, white and pink feldspar, and slightly greenish mica. Up to the present the shaft has been sunk 329 feet in this granite.

In Fig. II, a section is given showing the complete petrographical structure of the five mines, as determined to date.

I might say that this description of the Kimberley formation is taken from a report of Mr. Elpheus Williams, General Manager DeBeers Consolidated Mines.

Mr. Whatmough,—

As the blue clay is not hoisted to the surface, will you kindly explain the system by which it is handled?

Mr. Gaul,—

Main tunnels are driven across the crater upon its longer

axis, and, at right angles to this, smaller tunnels are driven out every 22 feet 6 inches until they reach the hard rock on the side of the mine. These tunnels are widened, first along the rock until they connect one with another, and, at the same time the roofs, or "backs" are stopped up until they are within a few feet of the loose ground above, thus forming long galleries, filled more or less with blue ground, upon which the men stand when drilling holes in the backs. The working levels are 40 feet apart vertically. The broken blue ground lying in the galleries is taken out, as a rule, before there are any signs of the roof giving way. At times this is impossible, and the roofs cave upon the broken ground, and the blue ground is covered with reef. As the roofs cave or are blasted down, the blue ground is removed, and the loose reef lying above it comes down and fills the gallery. Tunnels are often driven through this loose reef, and the blue ground, which has been cut off and buried by debris, is taken out; but it is generally left for those working the next level below to extract.

After the first cut near the rock is worked out, another cut is made, and in this manner the various levels are worked back, the upper level in advance of the one below, forming terraces. The galleries are not supported in any way by timbers, but all tunnels in soft blue ground are timbered with sets of two props and a cap of round timber, and where necessary are covered with inch and a half lagging.

Soft blue ground is drilled with long jumper drills sharpened at both ends. In hard blue ground, short drills and single hand hammers are used. The native workers become very skilful in both methods of drilling.

The blue ground, when removed from the chambers, is tipped into passes to the tramming level. At this level it is again loaded into trucks and sent to the shaft by either a mechanical rope haulage or by electric locomotives. At the bottom of the shaft the blue ground is tipped into chutes with a capacity just equal to one skip load. DeBeers, Kimberley and Bultfontein skips hold 5 tons (128 c. f.), Du Toit's Pan and Wesselton skips 8 tons (160 c. f.)

The blue ground is then hoisted through the shaft in skips and dumped automatically into bins at the surface. All hoisting through the main shaft is done from the lowest level; the blue ground from the upper levels being dropped through passes to this level.

Mr. Lewkowicz,—

In reference to locating diamonds in the clays. How many tons of clay is it necessary to displace to find diamonds. I should like to know what the percentage is?

Mr. Gaul,—

In the course of my paper I mentioned the average value per load of blue ground from the various mines.

Chairman,—

I have an announcement to make, and that is, that the Executive have seen fit to have another Smoker on February 27th. Everyone will receive a notice prior to that date.

Mr. Duguid was to have been here to-night to have been presented with a Past-President's jewel, but he is unavoidably absent.

The Secretary has asked me to notify you that the Club dues for 1911 are now payable. He also asked me to request you to be careful to fill out the attendance cards, so that the names of all present can be recorded in the next Journal.

The next paper will be on "Wireless Control of Trains," by M. Prentice, Wireless Engineer of the Wireless Train Control Co., Toronto.

The Executive are asked to stay after the close of this meeting for a few minutes.

If there is nothing else to come before the meeting it will be in order for someone to move an adjournment.

Mr. Jefferis,—

I would like to know if there are any other reporters in the room connected with Engineering Journals, with the exception of our own Club reporter? If there are, and they intend reporting this meeting, I should be pleased if they will get their information from the Secretary.

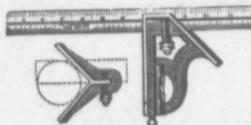
A great deal was said at the last meeting and reported incorrectly in some outside Journals. There is no objection to reporters from other magazines attending these meetings, the meetings are always open, and there is nothing said, which if correctly reported, could not be backed up, but if speakers here are to be misquoted, it is hardly fair to them.

This Club, I understand, carries great weight on the American side, especially among railroad companies, and I understand that a statement was made before the Inter-State Commerce Commission that was entirely disputed at the last meeting by men who are, I think, in a position to know and to stand by what they said.

As I said before, there is not the least objection to any reporter making notes on the Proceedings here if he wishes to, but he should get his information from the Secretary, so that there would be no mischance of mis-quoting the speaker.

Moved by Mr. Herring, seconded by Mr. Wickens, that the meeting be adjourned. Carried.

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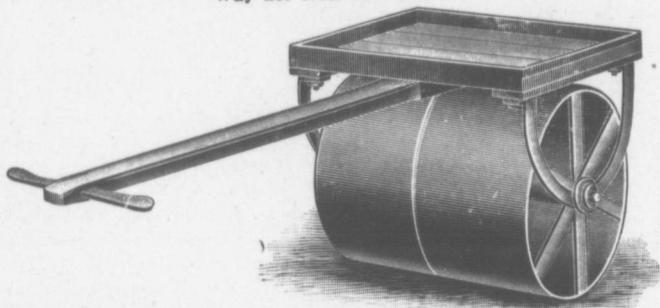
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